Series HE-26
December, 1975

2.000 ABSTRACTS ON CASSAVA

(*Manihot esculenta* Crantz)

Volume I

CASSAVA INFORMATION CENTER
CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

Series HE-26
December, 1975

2.000 ABSTRACTS ON CASSAVA

(*Manihot esculenta* Crantz)

Volume I

CASSAVA INFORMATION CENTER
CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

CIAT is a non-profit organization devoted to the agricultural and economic development of the lowland tropics. The Government of Colombia provides support as host country for CIAT and furnishes a 522-hectare farm near Cali for CIAT's headquarters. Collaborative work with the Instituto Colombiano Agropecuario (ICA) is carried out mainly at its Experimental Centers at Turipaná and Carimagua. CIAT is financed by a number of donors represented in the Consultative Group for International Agricultural Research. During the current year these donors are the United States Agency for International Development (USAID), the Rockefeller Foundation, the Ford Foundation, the W.K. Kellogg Foundation, the Canadian International Development Agency (CIDA), the International Bank for Reconstruction and Development (IBRD) through the International Development Association (IDA), the Interamerican Development Bank (IDB), the United Nations Environment Program, the Ministry of Overseas Development of the United Kingdom and the governments of the Federal Republic of Germany, the Netherlands and Switzerland. In addition, special project funds are supplied by various of the aforementioned entities plus the International Development Research Centre (IDRC) of Canada. Information and conclusions reported herein do not necessarily reflect the position of any of the aforementioned agencies, foundations or governments.

Each entry in this volume is distinguished by a hyphenated number appearing before the author. Only the first half of this number is continuous throughout the book and therefore is used to link the text with the Author and Subject Indexes.

However, in ordering photocopies of documents to the Cassava Information Center, the complete hyphenated number should be used. Please, address your requests to:

Cassava Information Center
CIAT
P. O. Box 6713
Cali, Colombia

\\\

CONTENTS

A00 BOTANY, TAXONOMY AND GEOGRAPHICAL DISTRIBUTION 1

B00 PLANT ANATOMY AND MORPHOLOGY 12

C00 PLANT PHYSIOLOGY 21

C01 Plant Development 28
C02 Cyanogenesis 35
C03 Chemical Composition, Methodology and Analyses 41

D00 CULTIVATION 65

D01 Soil, Water, Climate, and Fertilization 96
D02 Cultivation Practices: Propagation, Planting, Weed Control, and Harvesting 116
D03 Energy Productivity and Yields 144

E00 PLANT PATHOLOGY 157

E01 General Descriptive Studies 160
E02 Bacterioses 166
E03 Mycoses 176
E04 Viroses 190
E05 Mycoplasmal Diseases 211
E06 Nematodes 212

F00 PEST CONTROL AND ENTOMOLOGY 214

F01 Injurious Insects and their Control 220
F02 Rodents and other Noxious Animals 240

G00 GENETICS AND PLANT BREEDING 241

G01 Breeding, Germplasm, Varieties and Clones, Selection 248
G02 Cytogenetics 272

IV

H00	NUTRITION	276
H01	Cassava Foods and Nutritive Value	281
H02	Nutritive Disorders in Humans	321
H03	Animal Feeding	336
H04	HCN Toxicity and Detoxification (For HCN content, see C03)	387
I00	PROCESSING, PRODUCTS, AND USES	397
I01	Cassava Starch and its Properties	397
I02	Uses, Industrialization, Processing, and Storage	421
I03	Industrial Microbiology	489
J00	ECONOMICS AND DEVELOPMENT	497
K00	OTHER ASSOCIATED COMMODITIES	528
K01	Rotational Schemes and Intercropping	529
K02	Descriptive and Comparative Studies	533
Z00	GENERAL	534
	AUTHOR INDEX	550
	SUBJECT INDEX	563

FOREWORD

This collection of abstracts related to cassava (*Manihot esculenta* Crantz) is a first cummulation in book form of bibliographic materials processed in the Cassava Information Center at CIAT.

Cassava is a staple food for approximately 400 million persons in the world. Nevertheless, systematic research on this important root crop has been sporadic and it is only recently that research institutions, such as CIAT, have undertaken major efforts to improve its production in order to contribute to the solution of mankind's most urgent problem — hunger.

The Cassava Information Center was established at CIAT with the aim of providing the necessary information services to support research activities in cassava. It is jointly financed through CIAT's core budget and a special grant of the International Development Research Center (IDRC) of Canada. The Cassava Information Center collects all bibliographic materials on cassava and processes them in such a way that information for scientists and researchers is immediately available.

The mechanized system presently used by the Center allows users to receive information on cassava as soon as documents are processed. This service is provided through abstracts cards which are distributed regularly to subscribers. Also, specific topic searches are performed in terms of the descriptors appearing after each bibliographic citation. Requests are met by providing the user with those abstract cards directly applying to the topic or topics requested.

The present volume includes 2,000 abstracts corresponding to documents held by the Center and available to users in photocopy. Other cummulations will follow. It is hoped that this collection of abstracts will not only be used as a standard bibliographic tool, but will also stimulate further use of the Cassava Information Center's other services.

Fernando Monge, Ph.D.
Library and Information Services

A00 BOTANY, TAXONOMY, AND GEOGRAPHICAL DISTRIBUTION

0001-2368 JONES, W.O. **A map of manioc in Africa.** Geographical Review 43(1):112-114. 1953. Engl., Illus.

Cassava. Maps. Plant geography. *Manihot esculenta.* **Africa.**

Cassava (manioc or tapioca), *Manihot utilissima,* is the least known of the great food crops that the New World gave the Old. Estimates of cassava acreage from various sources are sketched on a map, which represents the absolute and relative distribution of cassava in Africa as it was in 1948 or thereabouts. The map is considered useful as a first approximation. *(Summary by Tropical Abstracts)* A00

0002-0019 CROIZAT, L. **New and critical Euphorbiaceae chiefly from the southeastern United States.** Bulletin of the Torrey Botanical Club 69(6):445-560. 1942. Engl., Sum. Engl., Illus.

Manihot. *Manihot walkerae. Manihot carthagenensis.* **Plant anatomy. Taxonomy. Identification USA.**

Three new species of **Croton** L. and one of **Manihot** Mill. are recorded for the flora of southwestern Texas. A fourth species of **Croton** L. from Sonora, Mexico is described. Lastly, a summary review is given of **Tetracoccus** Parry under which are recorded 3 new subgenera and 2 new combinations. The Latin diagnoses required for these publications are given in an appendix. *(Author's summary)* A00

0003-0449 ROGERS, D.J. **Manihot, man, and computing machines; summary of talk at Fairchild Tropical Garden.** Fairchild Tropical Garden Bulletin 24(3):11-13. 1969. Engl., Illus.

Cassava. Taxonomy. Uses. Development. Manihot. Identification. Cassava programs. Development research.

This short summary of cassava includes a botanical description, relatives of cassava, its habitats and uses, origin of the cultivated species and suggestions for further research. It is stated that by employing well-trained scientists and using a computer as the tool for correlating the data, the time lag that now exists for cassava in large-scale agricultural research should be overcome quickly. *(Summary by J. L.S.)* A00

0004-0315 LOPEZ J., L. and HERRERA E., H. *Manihot carthagenensis,* **una yuca silvestre con alto contenido proteico.** *(Manihot carthagenensis, a wild variety of cassava with high protein content).* Bogotá, ICA, 1970. 14p. Span., 9 Refs.

Cassava. *Manihot carthagenensis.* **Taxonomy. Ecology. Uses. Roots. Dry matter. Plant development. Plant geography. Composition. Protein content. Fibre content. fat content. Plant breeding. Ash content. N. HCN content. Colombia.**

The characteristics of *M. carthagenensis,* as well as its geographic and ecologic distribution, are described and results are given of chemical analyses of the roots (moisture, protein, fiber, fat, ash, nitrogen-free extract, partial dry matter and HCN). *M. carthagenesis* offers attractive possibilities for plant breeding because of its tolerance to twice-yearly dry seasons in clay-sandy soil conditions or even semisaline soils under very low annual rainfall (200-250 mm), its high protein content in the roots, and because its flesh does not blacken when exposed to light. Its continuous flowering and partial deciduous conditions should also be noted. It appears that the flower-bearing shoots are produced only during the rainy season; shoots produced in the dry season tend to develop a rhytidome, which does not appear in the rainy-season shoots. *(Summary by P.A.C.)* A00 C03

0005-0858 MASON, R. R. **Cassava varieties in Fiji.** Agricultural Journal 27(3|4):88-93. 1956. Engl., Sum. Engl., 4.Refs., Illus.

Cassava.*Manihot esculenta.* **History. Leaves. HCN. Taxonomy. Cultivars. Productivity. Nutritional requirements. Fertilizers. Identification. Tuber productivity. Petioles. Stems. Tubers. Dry matter. Timing. Plant height. Fiji.**

Cassava has become a very important food crop in Fiji; the acreage in 1954 was estimated to be almost half the total acreage of root crops. The average yield is probably about 5 tons|acre. Sixteen varieties of cassava are described, together with the results of 4 variety trials. Varieties have been grouped according to the color of the young leaf-bearing part of the stem. Leaf shape is not generally of much use as a character for recognition, apart from a highly distinctive crinkle-leafed variety. It was concluded that the variety Vula Tolu is the most useful, early-maturing variety. Tables are included on root yield, dry matter percentages, plant height and percentage of HCN. *(Summary by T.M.)* A00 D03

0006-0343 ROGERS, D.J. **Some botanical and ethnological considerations of** *Manihot esculenta.* Economic Botany 19(4):369-377. 1965. Engl., Refs., Illus.

Cassava. Ecology. *Manihot esculenta.* **History. Plant geography. Plant anatomy. Cultivars.**

Manihot esculenta originated in the tropics of the Western Hemisphere. The natural distribution pattern has been obscured by the transference of varieties during human migration. It is considered that the country where *M. esculenta* was first cultivated is likely to be either Brazil, Venezuela or Central America since a number of species, some of which bear morphological traits similar to the cultivars, occur naturally in Mexico. It is thought that one of the species was cultivated in Central America and was distributed from there to the areas of its present-day cultivation, where the cultivars, once introduced, would hybridize with naturally occurring natives. With each hybrid formed, the new germ would enable the cultivars to adapt to different ecological habitats and to prove for a wide range of conditions and applications. *(Summary by Plant Breeding Abstracts)* A00

0007-0123 SCHERY, R. W. **Manicoba and mangabeira rubbers.** Economic Botany 3(3):240-264. 1949. Engl., 8 Refs., Illus.

Manihot. Rubber. Secondary crops. Plant geography. Ecology. Plant anatomy. Manihot oil. Marketing. *Manihot glaziovii.* **Ceara rubber.** *Manihot dichotoma. Manihot piauhyensis.* **Piauhy rubber.** *Manihot heptaphylla.* **Brazil.**

An account is given of the distribution, ecology and technology of manicoba (**Manihot** spp) and of mangabeira *(Hancornia speciosa)* rubber trees. Since the trees are not adapted for plantation growth, the rubber from them will remain of minor importance. *(Summary by Chemical Abstracts)* A00 J00

0008-2208 CIFERRI, R. **Saggio di classificazione delle razze di manioca** *(Manihot esculenta* **Crantz).** [*Essay on the classification of cassava (Manihot esculenta Crantz) varieties*]. Firenze, Instituto Agricolo Coloniale Italiano, 1938. 58p. (Relazioni e Monografie Agrario-Coloniali no. 44). Ital., 11 Refs., Illus.

Cassava. *Manihot esculenta.* **Taxonomy. Cultivars. Identification. Plant anatomy. Dominican Republic.**

Data are given on problems faced in identifying and classifying the species of **Manihot** and subspecific taxa of *M. esculenta.* The cassava population of the Dominican Republic is classified into three groups of varieties (races) containing 35 subvarieties (subraces). A key to them is given. *(Summary by H.J.S.)* A00 B00

0009-1863. HENAIN, A. E. and CENOZ, H. M. **La mandioca (*Manihot esculenta* Crantz). I.** [*Cassava (Manihot esculenta Crantz)*]. Corrientes, Argentina. Universidad Nacional del Nordeste, Facultad de Agronomía y Veterinaria. Publicación no. 12. 1971. 61p. Span., 61 Refs., Illus.

Cassava. *Manihot esculenta.* History. Taxonomy. Plant anatomy. Productivity. Statistical data. Roots. Composition. HCN content. Stems. Leaves. Inflorescences. Flowers. Fruits. Plant development. Ecology. Cultivation. Land preparation. Fertilizers. Planting. Pruning. Pests. Diseases and pathogens. Viroses. Mycoses. Bacterioses. Injurious insects. Noxious animals. Argentina.

This general review of cassava covers Latin American literature well,chiefly from an agricultural standpoint, but also with respect to taxonomy and origin. *(Summary by Tropical Root and Tuber Crops Newsletter)* A00 D00 E01 F00

0010-2148 BAUDON, A. **Manioc.** *(Cassava) In* Annales du Musée Colonial de Marseille 10:96-105. 1912. Fr., Illus.

Cassava. Human health. Cultivation. HCN. Plant geography. Plant anatomy. Cultivars. Sweet cassava. Bitter cassava. Congo. Gabon.

Data on the geographical distribution of cassava cultivation and human consumption in Congo and Gabon are given. Native doctors take part in planning cassava cultivation. Morphological differentiation of bitter and sweet varieties is discussed. Observations showed that natives eating only cassava died early from an intestinal illness. *(Summary by H.J.S.)* A00 H00

0011-0993 AGBOOLA, S.A. **The introduction and spread of cassava in western Nigeria.** Nigerian Journal of Economic and Social Studies 10(3):369-385. 1968. Engl., 56 Refs.

Cassava. Development. History. Plant geography. Nigeria.

Cassava which was introduced into western Nigeria before 1840 is today one of the 2 most important food crops of the country. The paper is concerned with tracing the introduction and early spread of the crop and with assessing some of the initial factors which influenced its adoption in different places. *(Summary by World Agricultural Economics and Rural Sociological Abstracts)* A00

0012-3171 MARTINEZ—CROVETTO, R. **Una nueva especie de Manihot (Euphorbiaceae) de la flora argentina.** [*A new species of Manihot (Euphorbiaceae) of the Argentine flora*]. Bonplandia 1(4):273-277. 1964. Span., Sum. Span., Engl., Illus.

Manihot. Taxonomy. Argentina.

The author describes a new species of **Manihot**, *M.* ***hunzikeriana,*** belonging to the Argentine flora. *(Author's summary)* A00

0013-1656 JONES, W. O. **Manioc; an example of innovation in African economies.** Economic Development and Cultural Change 5(2):97-117. 1957. Engl., 53 Refs., Illus.

Cassava. Plant geography. Maps. History. Cultivation. Cassava products. Uses. Processing. Africa.

This study on the innovation of cassava in Africa gives a historical background of its introduction, providing evidence contrary to notions of conservatism, lack of inventiveness and economic irrationality amongst Africans. About 30% of all food acreage in the Belgian Congo is planted to cassava today. The popularity of this crop is due to its characteristics; high yields in calories per unit of land, easy multiplication by stem cuttings, high productivity (even on poor soils), a resistance to drought and insect pests (locusts), long storage-capacity in the field and simple processing into food. *(Summary by Tropical Abstracts)* A00 D00

0014-0378 CHANDRARATNA, M. F. and NANAYAKKARA, K. D. S. S. **Studies in cassava. I. A classification of races occurring in Ceylon.** Tropical Agriculturist 101(1):3-12. (Cont.). 1945. Engl., Sum. Engl.

Cassava. Taxonomy. Cultivars. Identification. ***Manihot esculenta.*** **Tubers. Leaves. Petioles. Stems. Cortex. Plant anatomy. Flowers. Sri Lanka.**

Races of cassava (*Manihot utilissima* Pohl) occurring in Ceylon are described and an artificial key to their identification is presented. *(Author's summary)* A00 B00

0015-0379 CHANDRARATNA, M. F. and NANAYAKKARA, K. D. S. S. **Studies in cassava. I. A classification of races occurring in Ceylon.** Tropical Agriculturist 101:214-222. (Cont.). 1945. Engl., Sum. Engl

Cassava. Cultivars. Taxonomy. Identification. ***Manihot esculenta.*** **Tubers. Stems. Leaves. Petioles. Cortex. Plant anatomy. Flowers. Sri Lanka.**

Races of cassava (*Manihot utilissima* Pohl) occurring in Ceylon are described and an artificial key to their identification is presented. *(Author's summary)* A00 B00

0016-0377 CHANDRARATNA, M. F. and NANAYAKKARA, K. D. S. S. **Studies in cassava. I. A classification of races occurring in Ceylon.** Tropical Agriculturist 100(4):219-230. (Cont.). 1944. Engl., Sum. Engl.

Cassava. Cultivars. Identification. ***Manihot esculenta.*** **Tubers. Stems. Leaves. Plant anatomy. Cortex. Petioles. Flowers. Sri Lanka.**

Races of cassava (*Manihot utilissima* Pohl) occurring in Ceylon are described and an artificial key to their identification is presented. *(Author's summary)* A00 B00

0017-0461 ROGERS, D. J. and TANIMOTO, T. T. **A computer program for classifying plants.** Science 132(3434):1115-1118. 1960. Engl. 9 Refs.

Cassava. Taxonomy. ***Manihot esculenta.*** **Development.**

The application of the electronic computer to taxonomy is described; an analysis of cultivars of *Manihot esculenta* is given as an example. *(Summary by Plant Breeding Abstracts)* A00

0018-2057 LANGLANDS, B. W. **Cassava in Uganda 1860-1920.** Uganda Journal 30(2):211-218. 1966. Engl., 37 Refs.

Cassava. Plant geography. Human nutrition. History. Uganda.

This paper deals with the geographical distribution of cassava in Uganda at the end of the 19th and the beginning of the 20th century. Since 1920, when the main expansion began, cassava has been adopted so rapidly that it has become the staple food in many parts of Uganda and an important secondary crop in the rest of the country. An appendix on cassava in the western Nile region for the period 1920-1950 is also included. *(Summary by J.L.S.)* A00

0019-0569 CRUZ, N. D. DA. **Nova especie do gênero Manihot Adans, do Estado de São Paulo.** *(A new species from genus Manihot adans, from the state of São Paulo).* Bragantia 24(28):359-368. 1965. Port., Sum. Port., Engl., 12 Refs., Illus.

Cassava. Manihot. ***Manihot jolyana.*** **Cytogenetics. Brazil.**

A new shrublike species, *Manihot jolyana*, was collected at Eugenio Lefévre in young secondary forest in the State of São Paulo. The plant is distinguished from *M. Pohlii* Wawra by the following characteristics: dense hairiness on branches, leaves and inflorescence; petiole size, 34 cm; number of leaf lobes, 5-7; shape, oblong-obovate; and chiefly the great number and density of flowers in the raceme, the greater size of these, (masculine 21 mm and feminine 15 mm), and different size of masculine and feminine flowers. This species is also characterized by a scale-form expansion of the petiole extremity, with the same indumentum of petiole, densely pubescent, on the upper limb and present in all the leaves. The foliar buds were treated with a saturated paradichlorobenzene solution and fixed in a mixture of 1 part alcohol and 1 part acetic acid. For staining and hydrolysis, acetic orcein and HCl N were used in mixture, using Sharma's method. *Manihot jolyana* was also found to have 2n = 36 chromosomes. *(Author's summary)* A00 G02

0020-0551 LEON, J. **Euforbiaceas. Yuca, mandioca** *(Manihot esculenta). [Euphorbia. Cassava (Manihot esculenta].* *In*______.Fundamentos Botánicos de los Cultivos Tropicales. San José, Costa Rica, Instituto Interamericano de Ciencias Agrícolas, 1968. pp.334-341. Span., Illus.

Cassava. Plant anatomy. Flowers. Fruits. Leaves. Taxonomy. *Manihot esculenta.*

Cassava is described from the standpoint of general botany and taxonomy. Brief notes on plant breeding and HCN and protein content are also included. *(Summary by H.J.S.)* A00 B00

0021-3383 RAISON, J. P. **L'introduction du manioc à Madagascar. un probléme non resolu.** *(Introduction of cassava into Madagascar: An unsolved problem).* Terre Malgache no. 13:223-228. 1972. Fr., 20 Refs.

Cassava. History. Plant geography. Malagasy Republic.

Discussions are presented on the introduction of cassava to Madagascar. Available data are contradictory and insufficient to establish the exact date. It seems cassava was introduced on the west coast of Madagascar before 1785. *(Summary by H.J.S.)* A00

0022-2361 ADRIAENS, E. L. **L'introduction du manioc en Afrique.** *(The introduction of cassava in Africa).* Bulletin Agronomique du Congo Belge 48(3):743-746. 1957. Fr.

Cassava. Maize. Groundnut. Human nutrition. Toxicity. Development. Plant geography. Africa.

This is a general history of plant migration from Asia and America into Africa, which includes the introduction of cassava and its dissemination throughout the continent. Cassava toxicity hindered its rapid adoption. South American and Indian methods of preparation were initially used, but local methods have now been developed. *(Summary by S. S. de S.)* A00

0023-0648 FLEMING, H. S. and ROGERS, D. J. **A classification of** *Manihot esculenta* **Crantz using the information carrying of a character as a measure of its classification rank.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd., Honolulu and Kapaa, Kauai, Hawaii, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v.1., pp.66-71. Engl., Sum. Engl., 2 Refs.

Cassava. *Manihot esculenta.* **Taxonomy. Identification.**

A method is described to determine the maximum number of characters possessed in common by the specimens of a study. The method is based on the mathematics of information theory, which allows simultaneous analysis of both quantitative and qualitative data. The cultivars of *Manihot esculenta* Crantz are used as an illustration of the method, which should prove valuable to those interested in crop improvement, disease resistance, etc. *(Author's summary)* A00

0024-0612 SMITH, C. E. **The new world center of origin of cultivated plants and the archaeological evidence.** Economic Botany 22(3):253-266, 1868, Engl., 35 Refs.

Cassava. Taxonomy. History. Plant geography.

This is a review of literature on the New World centers of origin of cultivated plants and the archaeological evidence. As regards cassava, there are many different opinions. Some authorities feel cassava originated in Brazil. It was probably brought into Peru as a cultigen. Indirect evidence shows it was present in northern Colombia and Venezuela at an earlier date. Cassava-like fibers and starch were found in Mexican material. There is, however, no satisfactory answer as of yet. *(Summary by T.M.)* A00

0025-0697 ROGERS, D.J. **A computer-aided morphological classification of** *Manihot esculenta* **Crantz.** *In* International Symposium on Tropical Root Crops, lst., St. Agustine, Trinidad, 1967. Proceedings. St. Agustine, University of West Indies, 1969. v.l. pp. 57-80. Engl., 6 Refs., Illus.

Cassava. Taxonomy. Leaves. Branching. Foliage. Tubers. Identification. Plant anatomy. Development. Cultivars. Petioles. *Manihot esculenta.* **Cassava programs.**

The variation in *Manihot esculenta* has been summarized, and a satisfactory method for dividing the cultivars into related constellations has been discovered. The relationships among the cultivars is reticulate; but by employing the graph theory model, the major categories have been discovered. It was found that recognizable groups are "strings" of clinical relationships. There will probably be some variations to the groups established—particularly when new biochemical information is found— but without the addition of further information, an investigator can reliably relate his materials to the categories provided. Classification is based on the collections made by the author, and no other herbarium material has been employed to structure the classification. The specimens used in this classification are housed in the herbarium of the United States National Arboretum, a central locality from which other interested workers may borrow these materials. *(Author's summary* A00 B00

0026- 1796 APPAN, S. G. **The North American species of Manihot delimited by computer-aided taximetric methods.** Ph. D. Thesis. Boulder, University of Colorado, 1969. 347p. Engl., Sum. Engl., 19 Refs., Illus.

Cassava. Manihot. Identification. Taxonomy. Plant anatomy. Flowers. Leaves. Roots. Seed. Stems. Inflorescences. Plant development. Growth. Morphogenesis. Maps. *Manihot esculenta.*

Interest in the genus **Manihot** has grown significantly of late since *Manihot esculenta* Crantz (the world's fifth major staple food crop) became a crop of vital importance to several developing nations. Since the publication of the major treatise on this genus by Pax in 1910, the concepts of biological species have been refined and enriched considerably, and Pax's delimitations now tend to be biologically unsatisfactory, especially from a plant breeding point of view. These delimitations were based on nebulous criteria, and the high degree of leaf polymorphism of **Manihot**, inadequate field knowledge of these populations, and lack of sophisticated delimitation procedures lead to several misconceptions in this treatment. Therefore Pax's species do not necessarily qualify as closed gene pools representing species in the light of modern concepts. The numerous wild species of **Manihot** represent a practically unexplored and unexploited reservoir of potentially valuable genetic variability, which can be drawn on and utilized in a program of genetic engineering of cassava (*Manihot esculenta* Crantz) to mold it to suit man's needs better. The key and fundamental step in such an interspecific breeding program is to accurately delineate the closed gene pools of **Manihot** in order to facilitate drawing population samples from them to be subjected to systematic evaluation of their biological properties, especially those qualities that are significant to crop improvement. The conventional taxonomic delimitation processes were found to be inefficient for a systematic analysis of complex populations such as **Manihot**. The computer-aided taximetric methods take advantage of the speed and efficiency of modern electronic data processing equipment. The method deploys a series of interlinked computer programs, the sequential and integrated application of which renders possible the precise and reliable delimitation of closed gene pools. The sequential steps of these procedures are depicted in the form of explicit flow charts. Extensive field studies were carried out to gain an accurate understanding of **Manihot** field populations. These field trips provided rare opportunities for gathering critical field data and abundant herbarium material. This not only made it possible to generate substantial basic data, commensurate to the needs for a scrupulous computer analysis, but also significantly enhanced the soundness and reliability of the decisions made. The results of the study of the North American segment of the genus **Manihot** are included. The South American segment is to be considered as the next phase. The 20 species constituting the North American segment of **Manihot** and the single closed gene pool representing the monotypic genus Manihotoides have been delimited. The gross morphology of these species has been described, their geographical domains have been delineated and their ecological adaptations have been defined. The findings of this study not only qualify as a foundation for instituting cassava improvement programs, but also serve as a model for delimiting and defining species (closed gene pools) with efficiency and precision by employing computer-aided methods. *(Author's summary)* A00

0027-4419 SOHMER, S. H. **Taxonomical and cytological studies of some cultivars of *Manihot esculenta* Crantz.** M. S. Thesis. Knoxville, University of Tennessee, 1966. 52p. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Taxonomy. Cytology. Microsporogenesis. Cultivars. Plant anatomy. Plant development. Mutation. Chromosomes. *Manihot esculenta*. Identification.

To say that the taxonomic problems presented by *Manihot esculenta* are great would be an understatement. To understand the situation of this species, more information is needed because this is a plant that has had a more unusual history than most cultivated plants due to the factor of vegetative reproduction. Work is needed on the interior mechanisms of this plant; and in the process of learning about it, it will also be possible to understand its relationship to the closely related wild species. In this study, an attempt has been made to understand *Manihot esculenta* Crantz through a short review of some of its history, through the construction of a key based on the morphological characters presented by the 85 cultivars found at IICA in Costa Rica, and through cytological work carried out on some of these cultivars. A study of microsporogenesis and the comparison of the meiotic metaphase I chromosomes of randomly selected cultivars was carried out. Photographs of microsporogenesis and photographs and camera lucida drawings of metaphase chromosomes were prepared. A hypothesis concerning the possible origin and evolution of the species was also presented. *(Author's summary)* A00 B00 G00

0028-0513 SCHEWERIN, K. H. **Apuntes sobre la yuca y sus orígenes.** *(Notes on cassava and its origin).* Tropical Root and Tuber Crops Newsletter no. 3:4-12. 1970. Span., Sum. Engl., 10 Refs.

Cassava. Taxonomy. History. Cultivation. Cultivars. Identification. Productivity. Plant geography. Toxicity. Brazil. Colombia. Venezuela.

Cassava, a highly variable tropical plant, is one of the 12-15 most important food crops of the world. Nevertheless, there has been little scientific study of its botany, cultivation, variability and improvement through breeding. Cassava is propagated from stem cuttings, which germinate rapidly and normally grow vegetatively for 6-8 mos; later the roots tuberize. Seeds are seldom produced, but the species is by no means highly sterile. Cassava is harvested for food 8-10 mos after planting or after 18-24 mos for industrial purposes. Harvest time is not critical; the roots can be stored in the soil until needed. Cassava is the cheapest known source of starch. Although rich in P, iron and vitamin B, cassava is low in calcium and protein. It is prepared in many ways; native methods (in addition to the foods and beverages made from it) are described. The foliage can also be cooked and eaten. Cassava is sometimes classified as sweet and bitter; both forms contain cyanogenic glucosides, which release HCN. In sweet forms, the substance occurs chiefly in the cortex; however, this cannot be used as a basis for classification because the HCN content varies according to locality and even for a given variety: The wild and weedy species of **Manihot** may be offshoots of cassava itself or crosses with wild species. These species occur in two principal areas, in the northeast of Brazil and in Mexico and Central America. The number of varieties of cassava is particularly large in the former area. It is difficult to believe that cassava originated in northeastern Brazil and spread north from there, for the generally accepted spread of culture was in the opposite direction. The early dates or archeaological remains in countries north of Brazil also suggest that cassava originated elsewhere. The northwest portions of the continent appear to be an equally probable center of origin, especially the arid zone along the coasts of Venezuela and Colombia, where wild species do occur. Moving from such a center of origin, cassava may well have hybridized with species both in Brazil and Central America to give rise to the diversity of forms in these regions. The archeological remains and ethnological data are in agreement with this hypothesis. This region, however, has not been sufficiently explored to provide conclusive data. *(Author's summary)* A00

0029-0862 ROGERS, D. J. **Studies of *Manihot esculenta* Crantz and related species.** Bulletin of the Torrey Botanical Club 90(1):43-54. 1963. Engl., Sum. Engl., 34 Refs.

Cassava. Manihot. *Manihot carthagenensis. Manihot esculenta. Manihot glaziovii. Manihot saxicola. Manihot twedicana.* **Plant geography. Cultivars. Plant anatomy. Guatemala. Brazil. Mexico. Venezuela. Guianas.**

The genus **Manihot** has at least two geographic centers of specialism: One region comprises the drier areas of western and southern Mexico and portions of Guatemala and the other the dry, northeastern portions of Brazil. Cultivars of *Manihot esculenta* may be found in these areas and extending into all of the lowland tropical portions of Central and South America and the West Indies. There is some evidence that the cultivars have hybridized with native species in each of these geographical centers to form a number of complexes. Many of the wild species of **Manihot** have the appearance of weeds derived from the cultivated complex. From ethnological evidence, the cultivars with low cyanogenetic glucoside content are more widely distributed than the cultivars with higher concentrations. From these data it seems that there is not one but several centers from which *Manihot esculenta* may be derived and one of the areas that has not been previously considered by those interested in the origins of cultivated plants is the Mexican and Central American area. *(Author's summary)* A00

0030-3102 CROIZAT, L. **Preliminary per uno estudio del genere Manihot nell'America meriodionale.** *(Preliminary study of the genus Manihot in South America).* Revista Argentina de Agronomía 10(3):231-226. 1943. Ital, Sum. Engl.

Manihot. *Manihot esculenta.* **Taxonomy. Plant anatomy. Plant geography. Identification.**

This is a preliminary monographic study of **Manihot** in South America. The author points out that it is impossible to rely on the work of Pax and Pax & Hoffmann to classify the genus because their concept of specific limits does not cover the speciation taking place in **Manihot**. The author further suggests that Ciferri errs in lumping many species together and concludes that no classification of the so-called *Manihot utilissima* or *Manihot esculenta* can be made unless the material in the herbarium of Pohl is carefully studied and due account is taken of the "races" described by Ciferri. To document current errors, the author makes a brief analysis of *M. dulcis* sensu Pax, showing that his binomial covers a collection of different entities. A total of 17 species are briefly reviewed, recent collected specimens being cited under each. To these 17 binomials, not less than 36 species or varieties are attached as new synonyms. From the remarks contributed by Ciferri on the so-called "Tipo Miseria," the author infers that the morphology of **Manihot** appears to be materially influenced by the ability of the root system to store food and suggests the necessity of physiological studies as a preliminary toward a fuller understanding of the taxonomy of the genus. *(Author's summary)* A00

0031-0793 PITTIER, H. *et al.* **Especies de Manihot de Venezuela.** *(Species of Manihot in Venezuela). In* Catálogo de la flora de Venezuela. Caracas, Vargas, 1947. v. 2. pp.83-84. Span.

Cassava. Manihot. Identification. Plant geography. Taxonomy. Venezuela.

Three cultivated species with their complete latin names are listed, in addition to 27 wild species identified down to the genus level. Their botanical characteristics are given, but the authors consider that all wild species might belong to *Manihot carthagenesis. (Summary by H.J.S.)* A00

0032-3197 ROGERS, D. J. **Some further considerations on the origin of *Manihot esculenta* Crantz.** Tropical Root and Tuber Crops Newsletter no. 6:4-14. 1973. Engl., Sum. Engl., 11 Refs.

Cassava. Taxonomy. Manihot. Cultivars. Hybridizing. *Manihot esculenta.*

Botanical evidence is still too tenuous to provide exact data on the progenitors of, or points of origin of the cultigen, *Manihot esculenta.* In each area of cultivation, numerous wild species are found which can, and apparently do, hybridize with the cultivars growing in that area. Such newly hybridized forms are "new" and constitute a point of origin. The most closely related wild species to *M. esculenta* is *M. aesculifolia,* which is widely distributed in Meso-america; but other wild species found in many regions of South America are also closely related. Too much emphasis has been placed on the differentiation between the sweet and bitter cultigens, to the point where some other types of arguments have been submerged in our thinking. The poisonous principle, a cyanogenetic glycoside, is found in many different plants, which have become important food species; and this has not deterred the development of the crop. Fermentation, which is probably better designated as "microbial conversion," may play roles other than those that have been ascribed to it. *(Author's summary)* A00

0033-3236 **MANIOC; ESTIMATED production in Latin America.** Agriculture in the Americas 7:120. 1947. Engl., Illus.

Cassava. Production. Maps. Latin America.

A map of Latin America is presented, showing areas of estimated production of cassava. *(Summary by H.J.S.)* A00

0034-2404 ROIG Y MESA, J.T. **Yuca agria.** *(Bitter cassava) In*________.Cultivation and uses of sweet and bitter cassava. Plantas Medicinales. (Part II) (Habana). 1945:726-727. Span.

Cassava. *Manihot esculenta.* **Bitter cassava. Plant geography. Therapeutants. Uses.**

Brief notes are given on bitter cassava. Information deals with common names ecological conditions and distribution, botanical description and uses. *(Summary by H.J.S.)* A00

0035-2022 HEISER JUNIOR C. B. **Cultivated plants and cultural diffusion in nuclear America.** American Anthropologists 67(4):930-949. 1965. Engl.,Sum. Engl., 82 Refs.

Cassava. *Manihot esculenta.* **Plant geography. South America.**

A survey of the principal cultivated plants in the Americas at the time of the Discovery reveals that a large number were limited to either Mesoamerica or South America. Those reputed to have been shared by the 2 regions are examined. There is some indication that *Cucurbita ficifolia, C. moschata,* maize and common beans originated in Mesoamerica and were carried to South America. The plants possibly showing a movement in the reverse direction include the lima bean, the peanut, cassava, tobacco (*Nicotiana tabacum* and *N. rustica)* and the pineapple. The possibility that some species shared by the 2 regions had separate origins as cultivated plants in the two areas is discussed. These include maize, lima beans, common beans, cassava, sweet potatoes and avocados. Although only a very small number of plants were exchanged between the 2 regions, it is pointed out that this does not necessarily imply limited cultural diffusion. The need for additional study of the origins of many of the cultivated plants of the Americas is emphasized. *(Author's summary)* A00

0036-4914 ROSS, H. B. **The diffusion of the manioc plant from South America to Africa; and essay in ethnobotanical culture history.** Ph. D. Thesis. New York, Columbia University, Faculty of Political Science. 1975. 135p. Engl., Sum. Engl., 171 Refs.

Cassava. History. Taxonomy. *Manihot esculenta.* Genetics. Cytology. Plant anatomy. Plant geography. Cassava products. Fermentation. Rasping. Peeling. Pressing. Cultivation. Detoxification processes. Chickwangue. Cassava flour. Cassava meal. Gari. Dumbol. FooFoo. Human nutrition. Africa. Brazil.

A notable result of the discovery of the New World has been the diffusion of more than a dozen food plants from the Americas to other continents. Among these foods is cassava *(Manihot esculenta),* a food apparently domesticated in northeastern South America. Although cassava contains varying levels of HCN, the tubers may be processed to yield flour, fermented drinks and other food products. Cassava was first spread throughout South America according to historical and archeological evidence. After the Portuguese conquered Brazil, they learned its cultivation and processing and evidently took this knowledge and planting materials to their West African colonies, from where cassava was diffused throughout tropical Africa. Linguistic data indicate that African names of the plant and its products are similar to Portuguese terminology. Cassava food products were very suitable as provisions on Portuguese ships sailing between South America and Africa, and it was probably in this way that the crop was introduced into Africa, where it is still a staple food in numerous areas. *(Summary by C.B.)* A00 H00

0037-3190 ROGERS, D. J. and FLEMING, H. S. **A monograph of *Manihot esculenta* with an explanation of the taximetrics methods used.** Economic Botany 27(1):1-113. 1973. Engl., 43 Refs., Illus.

Cassava. *Manihot esculenta.* Taxonomy. Identification. Cultivars. Plant anatomy. Roots. Leaves. Stems. Branching. Developmental stages. Foliage. Ecology. Protein content. Amino acids. Composition. Cyanides. Ash content. Carbohydrates content. Energy productivity. Productivity. Dry matter. Research. Analysis.

This work reports the classification of 228 samples of cassava (*Manihot esculenta* Crantz) according to 15 characteristics. The character groups include 3 root, 4 stem and 8 leaf characters. Plant samples including a longitudinal section of the root, a representative section of the stem, at least one mature vegetative leaf, a portion of the vegetative apex and, where available, portions of the flowers were collected in Jamaica, Costa Rica and Nicaragua; in the states of Amazonas, Pará, Pernambuco, Minas Gerais and São Paulo in Brazil; and on the eastern slopes of the Andes in Bolivia and Peru. The qualitative and quantitative judgments of the characters were computer-processed by the Graph Theory Clustering Program to group the samples by characters. This classification method should be most useful to workers in plant breeding or agronomy studies in contrast to purposes relating to plant naming. Detailed descriptions of cassava samples within the 15 groups are discussed and suggestions are given for identifying unknown cultivars. *(Summary by C.B.)* A00 B00 C00

0038-3466 RENVOIZE, B. S. **The area of origin of *Manihot esculenta* as a crop plant: a review of the evidence.** Economic Botany 26(4):352-360. 1973. Engl., 36 Refs., Illus.

Cassava. Manihot. Maps. History. Sweet cassava. Bitter cassava. *Manihot esculenta.* Plant geography. Ecology. Brazil. Paraguay. Venezuela. Colombia. Ecuador. Peru. Mexico.

Existing hypotheses on the origin of cassava as a crop plant were studied. Bitter and sweet cassavas, as they are arbitrarily divided on the basis of the degree of HCN toxicity of their roots, apparently represent a cultural as well as a chemical subdivision. The significance of this division is discussed on the basis of a separate and local history of cultivation. It is proposed that the sweet type was first domesticated in Mesoamerica, whereas the bitter type was most likely cultivated first in northern South America. Subsequent intercommunication and migrations of Amerindians evidently brought about the diffusion of both types, which were established as crops of major importance. Despite the many wild species of Manihot found in Brazil, it seems unlikely that the bitter type was domesticated there first. *(Summary by J.L.S.)* A00

0039-3212 SOBRIHO, V. **Consideraçoes geraes sobre o gênero Manihot.** *(General notes on the genus Manihot).* Boletim da Secretaria de Agricultura, Industria e Comercio, Pernambuco 4(1):54-58. 1939. Port., Illus.

Cassava. Manihot. Taxonomy. Identification. Leaves.

A key, based on leaf characteristics, of 8 sections of **Manihot** is presented. Cassava is in the section **Parvibracteatae,** which is divided into 11 subsections. **Utilissimae** is the subsection with contains cassava *(Manihot utilissima),* together with 5 other species. *M. utilissima, M. dulcis* and *M. palmata* are cited as different species. The taxonomic position of cassava species is discussed. *(Summary by H.J.S.)* A00

See also 0894 0895 0902 0920 1551

B00 PLANT ANATOMY AND MORPHOLOGY

0040-0363 CAPINPIN, J. M. and BRUCE, V. C. **Floral biology and cytology of** ***Manihot utilissima.*** Philippine Agriculturist 39(16):306-316. 1955. Engl., Sum. Engl., Illus.

Cassava. Cultivars. Cytology. Seed. ***Manihot esculenta.*** **Developmental stages. Inflorescences. Plant development. Chromosomes. Germination. Flowering. Philippines.**

The protogynous inflorescence of cassava contains both male and female flowers. The opening of the flowers is concentrated between 12m. and 1 p.m. The haploid number of chromosomes is 18 in the pollen mother cells of the varieties Gariasa, Vassourinha, Aipin Manteiga, Copeland, Berat and Kekabu. In the metaphase plants of somatic divisions in root tips, 36 chromosomes were found. Cuttings and seedlings of Manihot clones planted at the same time flowered simultaneously. *(Author's summary)* B00 C01

0041-1916 INDIRA, P. and KURIAN, T. **A comparative study of the anatomical changes in the tuberization of roots of cassava and sweet potato.** Trivandrum, India, Central Tuber Crops Research Institute, 1973. 7p. Engl., 8 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Plant development. Tuber development. Sweet-potatoes. Plant anatomy. Roots. Plant physiology. India.

Anatomical studies have been carried out on the tuber-forming roots of cassava and sweet potatoes. Though both belong to the group of root tubers, they differ from each other in the mode of anatomical differentiation leading to tuberization. In cassava, tuber differentiation is accomplished through rapid division of the secondary xylem, which is initiated 3 weeks after planting, followed by starch deposition. However, in sweet potatoes, deposition of starch occurs in the cortical region 1 week after planting, when anomalous cambia arise around individual vessels in the vascular region. Thus in cassava, starch deposition is confined mainly to the secondary xylem tissue, whereas in sweet potatoes, the cortical region is involved. *(Summary by D.H. and L.J.)* B00 C01

0042-0283 MONTOYA, L. A. *et al.* **Ensayo preliminar sobre problemas en la clasificación de las variedades de yuca,** *Manihot utilissima. (Preliminary examination of problems in the classification of varieties of cassava, Manihot utilissima).* Agricultura Técnica en México 2(10):457-463. 1969. Span., 8 Refs.

Cassava. Tubers. Cultivars. Identification. Cortex. Plant anatomy. Productivity. ***Manihot esculenta.*** **HCN content. Composition. Mexico.**

This is a preliminary attempt to classify varieties and species according to some of their morphological characteristics from a collection of cassava *(Manihot utilissima)* from Brazil, Costa Rica and Colombia. The concentration of HCN in the roots was also determined to see if there was a relationship between the morphological characteristics used in this classification and the HCN content of the roots. Adaptation and yields of the plants were also observed in order to select the best varieties for distribution in the tropical regions of Latin America. The epidermises of the mature roots were either dark brown in color with a rough texture or reddish-yellowish in color with a smooth texture; these characteristics served as a basis for classifying the cassava varieties into two groups. A secondary group of characteristics was also observed; this included size and number of lenticels, pigmentation directly below the epidermis, and the tendency of the root to peel. Varieties with high, medium and low yield were found in both groups. Based on the HCN content, none of the varieties in the collection could be considered sweet. Of the 30 varieties analyzed, 10 had an HCN content between 5 and 10 mg| 100 g fresh weight, while the other 20 had more than 10 mg HCN | 100 g fresh weight. No correlation was found between the morphological characteristics and the HCN content. *(Summary by P.A.C.)* B00

0043-0041 MILANEZ, F.R. **Segunda nota sôbre os laticíferos.** *(Second note on laticifers).* Lilloa 16: 193-211. 1949. Port., Sum. Engl., 18 Refs.

Manihot. *Manihot glaziovii.* **Plant anatomy**

The author presents new statements that complete the conclusions of a previous paper. These statements are (1) A nuclear extrusion was observed in the laticifers of the secondary structure of *Hevea brasiliensis* and *Manihot glaziovii.* (2)This extrusion was also observed in the sieve tube elements of the same species. (3) Based on microscopical observations, considerations were made upon the origin of the hypodermic laticiferous system. (4) The formation of corpuscles of rubber in *H. brasiliensis* by the plastidome of the laticiferous cell was verified by new observation. (5) The occurrence of elongated plastids, which are the cause of the presence of rods in the latex of *M. glaziovii,* was verified; and the behavior of the laticiferous cells during histogenesis is described. (6) Vital staining with neutral red made it possible to study the laticiferous cells in living condition. The contents of the laticiferous cells, always animated by Brownian movement, are not stained; the staining only appears when the movements stop. The latex is similar to protoplasm in this respect. (7) The same method was used with a **Podostemonacea;** viz., *Apinagia accorsii;* results were the same with material that was observed with a minimum of manipulation and therefore a minimum of possible alterations. *(Author's summary)* B00

0044-4328 SENERATNA, J. E. **Bisexual flowers in the manioc,** *Manihot esculenta* **Crantz (***M. utilissima* **Pohl).** Ceylon Journal of Science (Series A) 12(3):169. 1945. Engl., Illus.

Cassava. *Manihot esculenta.* **Plant anatomy. Flowers. Sri Lanka.**

In the manioc plant, so widely cultivated in Ceylon, at present the flowers are unisexual. I have been examining large numbers of manioc flowers in the field and found no exception. Nor have I been able to find any mention of bisexual flowers of the plant in literature. On 24th May, 1941, however, Mr. L.E.A. Fonseka of this Department called my attention to bisexual flowers of this species. The flowers occurred on a plant at Peradiniya, of the locally cultivated form designated AB 12 (now MU 11), grown, as usual, from a cutting. The plant appeared normal in other respects, and in only one inflorescence were bisexual flowers observed. Two bisexual flowers were found in the upper part of the position normally occupied by female flowers (the lower flowers had dropped off at the time, so that it was not possible to decide if they were female or bisexual). The male flowers were in the usual position. The bisexual flowers were of the same size as normal female flowers. The pistil was fully developed. The stamens were also fully developed, with pollen in the anthers: an outer whorl of 5 smaller stamens alternating with an inner whorl of 5 larger stamens. Here is a reversion to an ancestral condition: development of the primitive bisexual condition of the flower in place of the present, more advanced, unisexual (female) state; and perhaps (not ascertainable), the occurrence of bisexual flowers between the female flowers and the male flowers in an inflorescence where the basal flowers are female and the apical, male. A sketch of one flower with the sepals on the posterior side opened out and a floral diagram of the same accompany the original text. *(Full Text)* B00

0045-3804 STEYAERT, R. L. **Another pith for free-hand sections.** Science 103:695. 1946. Engl.

Cassava. *Manihot esculenta.* **Stems. Plant anatomy.**

Mention of a pith other than elder Science 1946, 103, 112) prompts the writer to communicate further information in this respect. Botanists or plant pathologists in tropical or equatorial regions will find an advantageous substitute for elder pith in cassava (*Manihot utilissima* Pohl). It is the writer's view that the latter is decidedly superior to the former in several respects. As in the case of *Tetrapanax papyriferum* Koch (above reference), cassava pith has no vascular bundles or hard tissues. Moreover, when used dry it cuts beautifully under the razor, leaving a sheeny surface very soft to the touch. It can be sectioned very thinly without disintegrating as the elder does. The reason for this can be found in comparing the texture of both piths. Dried cassava pith ready for use has cells (in cross section) measuring 160-250μ by 100-150 u. The cells are larger in the center than outwards and gradually decrease in size in that direction. In a longitudinal section the dimensions are contrariwise uniform and vary throughout from 25 to 60μ. Thus, if they were not organized in a tissue, the cells would be lenticular in shape, whereas elder pith cells are globular and of dimensions somewhat larger than the above. Extraction of the pith is quite simple and offers no difficulty whatsoever. Cassava stalks should be straight and cut when plants are fully mature. They are cut in lengths of about 30-40 cm. A stick of the diameter of the pith is inserted at one end of the fragment. Pushing the stick forces the pith out at the other end in a contorted rod. When straightened out, the rods are left to dry and are then ready for use. The rods can be obtained in diameters up to 1.5 cm, but they are more usually 1-1.2 cm, which is quite sufficient for sectioning with a hand microtome. For cutting small objects, the pith can be carved while in the hand microtome clamp, similarly to paraffin blocks. The writer has had such satisfactory results with cassava pith that elder pith has been totally discarded. *(Full text)* B00

0046-0373 CONTRERAS G., J. **Observación de las colecciones de yuca en la región tropical de Veracruz.** *(Observations on the cassava collections from the tropical region of Veracruz).* Proceedings of the Caribbean Region. American Society of Horticultural Science 7:60-64. 1963. Span., Sum. Engl., Span., 1 Ref.

Cassava. Plant height. Leaves. Roots. Productivity. Cultivars. Plant anatomy. Stems. *Manihot esculenta.* **Mexico.**

A collection of 38 cassava varieties established at Cotaxla, Veracruz, was studied for adaptation and productivity. Eight outstanding varieties have been selected for further work; description of plant.and root characters are given. *(Author's summary)* B00

0047-1825 PALIWAL, G. S. and KAVATHEKAR, A. K. **Anatomy of vegetative food storage organs.** Acta Agronomica Academiae Scientiarum Hungaricae 20(3-4):261-270. 1971. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. *Manihot esculenta.* **Plant anatomy. Tubers. Roots.**

The anatomy of specialized roots (modified for food storage) of the following plants were studied: *Brassica rapa, Dioscorea bulbifera, Ipomoea batatas, Manihot esculenta,* and *Raphanus sativus.* It was found that they (1) have a well-developed periderm which arises earlier in ontogeny (when the organs have just started to store food material); (2) possess mostly parenchymatous tissue, which is most suited for storage; (3) exhibit a relatively poor development of vascular elements; (4) are composed of cells rich in ergastic substances in the form of druses and raphides; and (5) show absence of intercellular spaces in the parenchyma. These roots, although they perform an identical function and possess a uniform ground plan, have variable organization depending upon whether the plant is a dicot or a monocot. The arrangement of vascular tissues, latex cells, mucilage ducts, the extent of periderm formation, the types and frequency of starch grains and ergastic substances, etc. also appear to be determined by the genetic make-up of the species. *(Author's summary)* B00

0048-0704 TEMPLETON, J. K. **Identification and naming of tapioca varieties in West Malaysia.** *In* Blencowe, E. K. and Blencowe, J. W., eds. Crop diversification in Malaysia. Kuala Lumpur, Malaysia, Incorporated Society of Planters, 1970. pp. 118-127. Engl., Sum. Engl., 2 Refs.

Cassava. Cultivars. Identification. Plant anatomy. Leaves. Stems. Tubers. Petioles. Malaysia.

In view of the lack of information and the confusion on the identification and naming of cassava varieties in West Malaysia, assessments of cassava as an intercrop of rubber cannot be made with confidence. An attempt has been made to identify and describe all principal cultivars in the country. More than 200 samples were collected throughout the country and planted in a nursery at the R.R.I.M. Experiment Station. More than 70 distinct varietal names were recorded. On the basis of differences in leaf shape and colorations of young leaves, leaf stalks, leaf veins, stems and tubers, 35 varieties were provisionally recognized, of which 32 were accorded specific names. Legitimate synonyms are noted. Where applicable, naming has been kept in close accord with that used in the collection at the Federal Experiment Station, Serdang. *(Author's summary)* B00

0049-0827 SOHMER, S. H. **Some cultivars of *Manihot esculenta* Crantz in Costa Rica.** Ceiba 13 (1):54-59. 1967. Engl., 13 Refs., Illus.

Cassava. *Manihot esculenta.* History. Taxonomy. Cultivars. Identification. Plant anatomy. Costa Rica.

A list is given of 10 morphological characteristics, which varied among 85 varieties of cassava maintained as a collection at the Instituto Interamericano de Ciencias Agrícolas, Turrialba. *(Summary by Plant Breeding Abstracts)* B00

0050-3165 MIEGE, J. **La staminodie chez le manioc en Côte d'Ivoire.** *(Staminody in cassava in the Ivory Coast).* Revue de Cytologie et de Biologie Végétales 20(3):161-185. 1959. Fr., Sum. Fr., 8 Refs., Illus.

Cassava. Stamens. Flowers. Plant anatomy. *Manihot esculenta. Manihot glaziovii.* Ivory Coast.

The occurrence of staminody was studied in Guebi, B7, *Manihot glaziovii, Manihot utilissima* and a population from Vassirounha, all with 2n=36. The respective percentages of female flowers with staminody were 56.47, 88.00, 78.52 and 85.56. The degree of development of the staminodes varied, with sammal-grained, partially functional pollen occurring more frequently in Guebi than in the other varieties. The number of staminodes varies according to the season and to the position of the flowers on the branch; early suppression of normal male flowers augmented the number of staminodes. *(Summary by Tropical Abstracts)* B00

0051-0389 SPENCER, R. **A rapid method for estimating the leaf area of cassava (*Manihot utilissima* Pohl) using linear measurements.** Tropical Agriculture (Trinidad) 39 (2):147-152. 1962. Engl., Sum. Engl., 7 Bibl.

Cassava. Leaf area. Leaves. Analysis.

The basic requirements for any method used to estimate leaf area are discussed. The object of the investigation was to find a routine method which could be used by relatively inexperienced staff to determine the area of large numbers of deeply lobed cassava leaves quickly and accurately. Several methods were rejected either on the grounds of practical difficulties or because of the errors involved. A rapid method, giving accurate results, for determining the leaf area of cassava using the regression of leaflet rectangular area on leaf area is described. *(Author's summary)* B00

0052-0152 ARRAUDEAU, M. **Anatomie florale male et meiose chez quelques clones du genre Manihot.** *(Anatomy of the male flower and meiosis of some clones of the genus Manihot).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1967. 61p. Fr.

Also available in Spanish, translated by T.E. Delgado.

Cassava. Manihot. Plant anatomy. Flowers. Clones.

Data on macro and micromorphology of the male flower of cassava are given. Outstandings results gathered deal with the optimal size of flower buds for observing developmental stages, staining techniques, main stages of meiosis, general aspects and structure of pollen. *(Summary by H.J.S.)* B00

0053-0749 SMITH, B. G. C. **Variation in cassava clones.** Trinidad, Imperial College of Tropical Agriculture, 1959. 40p. Engl., 23 Refs., Illus.

Cassava. Clones. Identification. Productivity. Storage. Plant anatomy. Trinidad and Tobago.

Twenty cassava clones from Trinidad and Dominica, collected by the Imperial College of Tropical Agriculture in 1956, are botanically described; and a key based on their morphological characteristics is developed. Yield and time-of-maturity trials, toxicity, storage and cooking tests performed on these clones are also described. *(Summary by L. A.)* B00

0054-1690 DOKU, E. V. **Cultivated cassava varieties in Ghana.** Ghana Journal of Science 6(3-4):74-86. 1966. Engl., 4 Refs., Illus.

Cassava. ***Manihot esculenta.*** **History. Plant geography. Cultivars. Identification. Stems. Flowers. Tubers. Petioles. Branching. Ghana. Developmental stages.**

Some 90 local cassava cultivars are classified into 4 primary groups on the basis of petiole color and the markings at the corners of pentagonal-shaped immature stems. Classification within these groups is further based on the type of stem branching. Synonymy of the same cultivars which occur in different localities under different names is given for 11 of the most important cultivars. *(Summary by Field Crop Abstracts)* B00

0055-1804 NOBRE, A. **Mandioca var. amarela de Amazonia.** *(Yellow cassava varieties from Amazonas).* Boletim Técnico do Centro de Tecnologia Agricola e Alimentar no. 5:9-13. 1973. Port., Sum. Port., Engl., 6 Refs.

Cassava. Cultivars. Plant anatomy. Roots. Identification. Composition. HCN content. Protein content. Productivity. Brazil.

Aspects of food value, botanical characteristics and field behavior of 5 yellow cassava varieties from Amazonas, grown at the Ministry of Agriculture's Experimental Station in the state of Rio de Janeiro (IPEACS), were investigated. Crude protein, HCN and flour yield were determined in 18-month-old plants. Crude protein was determined in the whole root (peel and pulp) with the following results: 1.18-2.07% in the fresh root; 1.93-2.80% in the peel; 0.96-2.36% in the pulp and 18.06-20.56% in the leaves. The average flour yield was 17.30%. The distribution of the HCN in the fresh root indicated that the variety Niple can be considered as sweet whereas Cachimbo, Xingu, Uapichuna and IAN-S-12 varieties can be considered as bitter. In the field, Xingu and Uapichuna showed resistance to bacteriosis, whereas Cachimbo, Niple and IAN-S-12 were attacked by this disease. *(Author's summary)* B00 C03

0056-0311 SARMIENTO, M., E. **Descripción morfológica y comparativa de rendimiento de 17 cultivares de yuca.** *(Morphological description and yield comparison of 17 cassava cultivars).* La Molina, Perú, Universidad Nacional Agraria, Programa de Agronomía, 1969. 22p. Span., 28 Refs.

Cassava. Cultivars. Branching. Tuber productivity. Tubers. Plant height. Plant anatomy. Productivity. Clones. Petioles. Stems. Developmental stages. Leaves. Flowers. Perú.

This study presents the results of a comparison of 17 cassava cultivars principally from Peru. A bibliographic review of the morphological, quality and yield characteristics of cassava is also included: (1) Norms for clonal variability as stated by León and others, confirm the existence of repeated clones such as Valenca, Costa Rica and Pico de Huacho 2 and Huaycán and between Blanca Mochera and Injerto. (2) The variety Negra Mochera showed significantly higher yields than all other varieties, with a yield of 18.894 kg| ha and appeared to be most resistant to nematode attack. (3) The variety Amarillo is best for cooking and has the best taste although its yield of 8,703 kg| ha is possibly due to its apparent susceptibility to nematode attack. (4) Plants of the variety Colorada and Huacho 2 (Huaycán) are highly fasciated, which appears to influence yield. (5) The varieties Colorada, Huacho 2, Pata de Paloma 1, Maleña, Valenca and Huacho 1 presented no significant yield differences, all being of second order. (6) It was found that there was a high statistical significance between varieties in the characteristics studied, such as stem diameter, length of internodes and plant height. *(Summary by P.A.C.)* B00 D03

0057-3147 MIEGE, J. **Variétés eburnéennes de manioc à lobes foliares arrondis et nervures présentant une excroissance.** *(Cassava varieties from the Ivory Coast with rounded leaf lobes and veins producing an excrescence).* Journal d'Agriculture Tropicale et de Botanique Appliquée 5:691-718. 1958. Fr., Sum. Fr., 6 Refs., Illus.

Cassava. Leaves. Plant anatomy. Cultivars. Identification. Plant physiology. Plant development. Branching. Inflorescences. Flowers. Stems. Maps. Chromosomes. Ivory Coast.

Seven varieties of cassava growing in the Ivory Coast have certain characters in common which distinguish them from other varieties grown in this region. They seem to be peculiar to West Africa, and their presence is thought to indicate the existence of a secondary center of variation of recent origin; cassava was only introduced into Africa 4 or 5 centuries ago. These varieties have rounded leaflets, which are fewer in number than those of most other varieties. The central leaflet of each leaf is also shorter than the outer leaflets. There is and outgrowth from the main vein on the underside of each leaflet. All these varieties are rather short and compact in form and very susceptible to virus diseases. A more detailed report of 2 of the varieties is presented. Both have a chromosome number of 36; one variety, which is male sterile, shows various meiotic abnormalities. *(Summary by Plant Breeding Abstracts)* B00

0058-0381 TOLEDO, A. P. DE. **Anatomía e desenvolvimento ontogenético da flor de mandioca.** *(Anatomy and ontogenetic development of the cassava flower).* Bragantia 22(37):465-476. 1963. Port., Sum. Port., Engl., 3 Refs., Illus.

Cassava. Flowers. Plant anatomy. Sepals. Carpels. Anthers. ***Manihot esculenta.*** **Plant vascular system. Pedicels. Stamens. Ovaries. Plant development. Flowering. Brazil.**

Flower development of cassava (*Manihot utilissima* Pohl) is acropetalous. The early phases of cellular differentiation of the floral appendages are similar. All organs develop by anticlinal divisions of the surface layer, accompanied by periclinal divisions in the second tunica layer and also in the outermost layer of the corpus, followed by the formation of an apical meristem. The carpels and sepals also originate from marginal initials. The vascular anatomy is described. The pedicel has a complete vascular cylinder from which 10 bundles branch out to constitute the sepal traces. Five of these bundles bifurcate alternately to form the lateral bundles of adjacent sepals. The stamen has one single trace and each carpel has 3 traces. Anatomically, the ovary is formed by an outer epidermis provided with stomata, a medium parenchymatous layer in which the vascular bundles and an inner epidermis develop. At maturity each anther exhibits 4 pollen sacs surrounded by a uniseriate epidermis and a specialized endothecium with secondary thickness. *(Author's summary)* B00

0059-3191 NINAN, C. A. and ABRAHAM, S. **Cassava varieties having hermaphrodite flowers.** Tropical Root and Tuber Crops Newsletter no. 6:14-16. 1972. Engl.

Cassava. Flowers. Stamens. Ovaries. Plant anatomy. Taxonomy. India.

During the course of extensive research on cassava collections at the University of Kerala, 4 varieties of *M. esculenta* were found producing unisexual and hermaphrodite flowers. Unlike normal plants that produce only unisexual flowers, these 4 varieties produced staminate, pestillate and hermaphrodite flowers. The hermaphrodite flowers were seen in very low frequencies compared to the other 2 types. Considerable variation has also been observed in the floral organs of the hermaphrodite flowers in these varieties. Descriptions of floral organs are given. *(Summary by H.J.S.)* B00

0060-3206 DECKER, J. S. **Variedades de mandioca cultivadas no Ceylao.** *(Cassava cultivars grown in Ceylon).* Boletim de Agricultura (Brazil) 46:305-312. 1945. Port.

Cassava. Identification. Taxonomy. Plant anatomy. Cultivars. Sri Lanka.

Comments are made on an article from the Tropical Agriculturist (Ceylon). A key is given for the identification of 75 cultivars. *(Summary by H.J.S.)* B00

0061-3060 SENE, D. and BIRIE - HABAS, J. **Etude des clones de manioc cultivés en Casamance.** *(Cassava clones cultivated at Casamance).* Bambey, Senegal, Institut de Recherches Agronomiques Tropicales, 1968. 19p. Fr.

Cassava. Plant anatomy. Leaves. Stems. Fruits. Identification. Cultivars. Senegal.

A botanical key is given for the identification of 45 varieties based on leaf, stem and fruit characteristics. These varieties were collected in different localities in Casamance (Senegal). *(Summary by J.L.S.)* B00

0062-3447 BAYMA, C. **Mandioca "Manipeba".** *("Manipeba" cassava).* Revista dos Criadores 38 (450):909-100. 1967. Port.

Cassava. Cultivars. Plant anatomy. Tubers. Brazil.

Manipeba,a bitter cassava variety cultivated in northeastern Brazil, is described. The plant reaches large dimensions; it resists dry seasons but grows well in wet soil conditions; it grows well in shade and in open sites. It is resistant to many diseases and pests affecting other common early-maturing cassavas. Tuber formation starts in the second year, thus harvesting is possible only in the third year and later. It is hard to peel. *(Summary by H.J.S.)* B00

0063-3303 **LE MANIOC de Madagascar dans l'Est africain allemand.** *(Cassava from Madagascar in German East Africa).* Bulletin Economique de Madagascar no. 1:42-43. 1907. Fr.

Cassava. Cultivars. Sweet cassava. Bitter cassava. Plant anatomy. Identification. Tanzania.

This is a commentary on a paper by professor Zimmermann (Der Pflanzer no. 16-17. 1906). Brief notes are given on cassava, mainly concerning characteristics of the so-called sweet and bitter varieties. *(Summary by H.J.S.)* B00

0064-0865 CRUZ, N. D. **Nova especie do gênero Manihot Adans no estado de Minas Gerais.** *(A new species of the genus Manihot Adans in Minas Gerais).* Bragantia 26(23):317-322. 1967. Port., Sum. Port., Engl., 11 Refs.

Cassava. Manihot. *Manihot jolyana.* **Taxonomy. Chromosomes. Cytology. Leaves. Petioles. Flowers. Pedicels. Anthers. Carpels. Plant anatomy. Ovaries. Seed. Stamens. Brazil.**

A new species of **Manihot**, named *M. handroana,* was originally collected in the state of Minas Gerais (Brazil). This new species is related to *M. jolyana* N. D. Cruz, but differs from the latter in vegetative and floral characters. The upper part of its branches has less pilosity, and the basal part is glabrate. The stipules are linear and smaller than *M. jolyana,* without glandulous teeth. The limb is deeply divided resulting in a more reduced disk, with cuspidae lobe apices and a more glabrate upper surface. Some lower leaves show lobulation of the lobes and are slightly peltate. This plant also has the same expasion of the petiole tip in unlobulated leaves as *M. jolyana* The perianth of masculine and feminine flowers is larger; the external part is yellowish green in color. The most evident character is the fleshy disk in féminine flowers, which increases in size during fruit development. The fruit shape is markedly triangulate while in *M. jolyana* it is circular. The chromosome number for *N, gabdriaba* is 2n = 36, as in *M. Jolyana (Author's summary)* B00

0065-3215 **VARIEDADES VULGARES (de mandioca) cultivadas na área de Icolo e Bengo (Angola).** *(Common cassava varieties cultivated in the Icolo and Bengo area, Angola).* Agronomia Angolana no. 2:217-220. 1949. Port.

Cassava. Cultivars. Identification. Leaves. Tubers. Petioles. Flowers. Inflorescence. Angola.

Nine varieties of cassava are described. Information refers to morphology, areas under cultivation, agronomic characteristics and diseases and pests. *(Summary by H.J.S.)* B00

0066-0535 TOLEDO, A. P. DE. **Anatomía e desembolvimento ontogenético do fruto e da semente de mandioca.** *(Anatomy and development of the manioc fruit and seed).* Bragantia 22:71-76. 1963. Port., Sum. Engl., 7 Refs., Illus.

Cassava. Fruits. Seed. Plant anatomy. Ovaries. Ovules. Plant development. Cytology.

The cassava fruit is a trilocular capsule with a seed in each locule. The epicarp is represented by a layer of polygonal cells and has many stomata. The mesocarp is formed by several layers of large polyhedral cells in the unripe fruit, which become compressed and flattened in the ripe fruit. The endocarp is constituted of sclereids which have simple pits. The seed coat (about 0.3 mm thick) is formed by an outermost colored layer originating from the epidermis of the outer integument and a sclerenchymatous layer formed by long sclereids bent obliquely and derived from the inner epidermal cells of the inner integument. Completing the seed coat structure, there are several layers of indistinct cells originated from the mesophyll and from the inner epidermal cells of the inner integument. *(Author's summary)* B00

0067-3342 CENOZ, H. M., HENAIN, A. E. and BERTINI, B. D. P. **Dos cultivares de mandiocas ornamentales Johgue Morada No. 1 y Johgue Morada No. 2).** *(Two varieties of ornamental cassava: Jhogue Morada No. 1 and Jhogue Morada No. 2).* Corrientes, Argentina. Universidad Nacional del Nordeste. Departamento de Producción Vegetal. Publicación no. 15. 1972. pp.15-17.

Cassava. Cultivars. Identification. Plant anatomy. Argentina.

Two new cultivars (clones) of garden cassava named Jhogue Morada No. 1 and Jhogue Morada No. 2 are described. *(Author's summary)* B00

0068-4643 MEDARD, R. **Morphogénèse du manioc, *Manihot esculenta* Crantz (Euphorbiacées-crotonoidées): étude descriptive.** *(Morphogenesis of cassava, Manihot esculenta Crantz; a descriptive study).* Adansonia (Serie 2) 13(4):483-494. 1973. Fr., Sum. Engl., Fr., 29 Refs., Illus.

Cassava. *Manihot esculenta.* Morphogenesis. Apical meristems. Branching. Flowering. Leaves. Roots. Inflorescences. Tuber development.

A descriptive study was made of cassava morphogenesis about which little is known. Cassava clones (especially of the variety *Manihot esculenta* Crantz) from the Brazzaville region were used. It describes in detail the aerial part of the plant and its formation, foliar characteristics and distribution, axillary buds, sexuality and the root system. *(Summary by S.S. de S.)* B00 C01

0069-5003 GRANER, E. A. **Tratamento da mandioca pela colchicina. I. Nota preliminar sobre poliplidia indicada pela diferenca de tamanho dos estomatos.** *(Cassava treated by colchicine. I. Polyploidy indicated by the difference of stomata size).* Journal de Agronomia (Brazil) no. 3:83-98. 1940. Port., Sum. Port., Engl., 3 Refs., Illus.

Cassava. stomata **Chromosomes. Polyploidy. Plant anatomy. Analysis. *Manihot esculenta.* Brazil.**

Plants of cassava (*Manihot utilissima* Pohl) obtained by colchicine treatment showed difference in stomata size when compared to the control. A statistical analysis of variance in 2 plants (control CA| 1 and treated plant 1| 5) showed significant difference between leaves of different ages in the same plant. The stomata size was then examined in old leaves, of 31 plants (including 9 controls. These plants could be separated into 3 groups: the controls, with a diameter of stomata v=29. 2μ; the plants with stomata as big as the control, $\bar{v}$= 30.6μ and plants with larger stomata $\bar{v}$=40.7μ. According to the correlation between chromosome number and stomata size observed in other plants, a group of polyploid cassava plants, probably tetraploid, may have been found. The cytological verification and the test of their economic value will be carried on. *(Author's summary)* B00 G00

See also 0008 0014 0016 0020 0025 0027 0037 0298 0306 0741 0894 0901 0936 0943 0977

C00 PLANT PHYSIOLOGY

0070-1807 CHITHARANJAN NAIR, N. and KURUP, P. A. **Phosphorylase inhibitor in the rind of tapioca tuber.** Naturwissenschaften 50(21):667. 1963. Engl.

Cassava. Tubers. Enzymes. Plant physiology.

The rind (69-100%) and, to a lesser extent the flesh (0-33%) of cassava tubers contained an inhibitor of phosphorylase activity. Phosphorylase activity was 50% less during the summer than at other times. *(Summary by Plant Breeding Abstracts)* C00

0071-3168 OFORI, C. S. **Absorption and translocation of phosphate through cassava tubers (*Manihot esculenta* Crantz).** Ghana Journal of Agricultural Science 3:203-205. 1970. Engl., 3 Refs.

Cassava. Tubers. P. Fertilizers. Absorption. Leaves. Plant assimilation. Plant physiology. Plant physiological processes. *Manihot esculenta.*

Radioactive fertilizer was used in a field experiment to show that after cassava roots have assumed the function of storage as cassava tubers, they do not take part in active nutrient absorption. Results also indicate differences in specific activity of various branches of the plant. Further research is needed in order to use the leaves of the branches at the jorquette (the point at which the stem forks into two or three limbs) as a diagnostic tool in determining the nutrient status of the cassava plant. *(Author's summary)* C00

0072-2307 SADASIVAM, K. V. **On the composition of leaf exudate and leaf leachate of tapioca (*Manihot utilissima* Pohl.) foliage.** Science and Culture 36(11):608-609. 1970. Engl., 10 Refs.

Cassava. *Manihot esculenta.* **Foliage. Leaves. Composition. Amino acids. Sugars. HCN content. Analysis. Transpiration. Plant physiological processes.** *Cercospora henningsii*

Reports indicate that mineral nutrients, amino acids, carbohydrates and other organic acids are leached and exuded from cassava foliage. Cassava leaf exudate collected in the early morning was found to contain amino acids and sugar. Presence of alanine, asparagine and an unidentified amino acid was noted. In the leaf leachate, HCN was obtained in detectable amounts. The presence of HCN in cassava leaves during the initial stages of growth and its exudation may serve as a defense mechanism against the invasion and establishment of leaf spot organism *Cercospora henningsii* Allesch. *(Summary by J.L.S.)* C00 C03 E03

0073-0127 DUNCAN, E. J. and McPHERSON, G. I. **Changes in the petiole of leaves of *Manihot esculenta* (Crantz) on rooting.** Annals of Botany 38(155):261-267. 1974. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. *Manihot esculenta.* **Petioles. Leaves. Plant physiology. Propagation. Rooting. Tuber development. Developmental stages. Plant anatomy. Plant vascular system. Plant-growth substances. Plant development. Morphogenesis.**

The effects of leaf age and the application of a synthetic rooting hormone were investigated in leaves of *Manihot esculenta.* The age of the leaf was not critical to the process, but the application of a hormone resulted in early, prolific root production. the anatomy of the rooted petiole was investigated and was found to differ from that of an unrooted petiole in three respects: in an increase in the amount of secondarily produced tissues; in the incomplete lignification of the secondary xylem; and in the production of adventitious roots from the interfascicular regions of the basal end. *(Author's summary)* C00 C01

0074-1848 SRIVASTAVA, L. M. and KRISHNAN, P. S. **Distribution of starch phosphorylase in the tapioca plant,** *Manihot utilissima.* Enzymologia 23(5):270-280. 1961. Engl., Sum. Engl., Germ., 14 Refs.

Cassava. *Manihot esculenta.* **Plant physiology. Plant physiological processes. Biochemistry. Enzymes. Proteins. Metabolism. Cassava starch. Tubers. Leaves. Stems. Analysis.** Amorphophallus. *Ipomoea batatas.* **Potatoes.**

All parts of the cassava plant studied possessed phosphorylase activity, except for the pith. On a unit dry weight basis, the tubers contained the maximum activity, with significant amounts present in the leaf stalk and to a lesser extent in leaf blades and the apical portion of the stem. When calculated on a unit protein basis, the specific phosphorylase activity was considerably high in the tubers and conspicuously low in the leaf blades. The absence of demonstrable phosphorylase activity in the pith of thecassava plant was not due to the occurrence of inhibitory material since experiments on mixed homogenates of pith and tuber enabled the quantitative recovery of the activity initially present in the latter. Very little phosphatase activity was present in the tubers of the cassava plant, whereas the phosphorylase activity of leaf homogenates was weak compared to their phosphatase activity. Assuming that M|50 sodium fluoride does not inhibit phosphorylase but completely inhibits phosphatase, about 2|3 of the orthophosphate mineralized in the system is actually due to the phosphatase activity of the leaves. Phosphorylase activity was also maximal in the storage tissue of other plants studied; namely, sweet potatoes, potatoes and **Amorphophallus** plants. Of all the tissues investigated, potato tubers had the highest enzyme activity. The leaves of the **Amorphophallus** plant were unique in that homogenates showed virtually no phosphatase activity against glucose-l-phosphate. *(Author's summary)* C00

0075-0347 MIEGE, J. and OBATON, M. **Comportement anormal de la tubérisation chez un clone de manioc.** *(Abnormal tuberization in a cassava clone).* Journal d'Agriculture Tropicale et de Botanique Apliquée 1(10-12):407-413. 1954. Fr., Illus.

Cassava. Tubers. Stems. Tuber development. Cuttings. Developmental stages. Plant physiology. Phenology. Plant development. Plant anatomy.

A detailed description is made of a cutting which presented a strange development after planting. The cutting itself and its branches became tubers (i.e., they thickened and produced abundant reserve substances). The anatomy of both a tuber derived from roots and from cuttings is described; transversal section drawings are presented. *(Summary by H.J.S.)* C00

0076-3354 MOGILNER, I., ORIOLI, G.A. and BLETTLER, C. M. **Ensayo de topofisis y fotoperiodismo en mandioca.** *(Experiment on cassava topophysis and photoperiodicity).* Bonplandia 2(15):265-272. 1967. Span., Sum. Span., Engl., 9 Refs., Illus.

Cassava. Cuttings. Photoperiod. Propagation. Flowers. Leaves. Stems. Roots. Tuber development. Developmental stages. Plant anatomy. Plant physiology.

Cassava stalks (from seedlings) in different stages of development, were planted. Results showed that plants proceeding from stalks that were in a very advanced development stage produced more weight of storage roots. To observe the influence of the photoperiod on storage root formation in cassava, stalks were planted in pots with soil in greenhouse conditions, receiving 6, 10, 12 and 14 light hours. All the variants received 6 h of sunlight; the 4, 6 and 8 h of supplementary light were supplied by incandescent lamps. The results show that cassava is a short-day plant in respect to storage root formation. The dry weight of roots, leaves and stems, the number of leaves, nodes and roots, and stem length were also determined. *(Author's summary)* C00

0077-1844 CAMPOS, H. DOS R. and SENA, Z.F. DE. **Profundidade do sistema radicular do aipim maragogipe (*Manihot esculenta* Crantz) em diferentes idades.** *(Distribution of the root system in Aipim maragogipe (Manihot esculenta Crantz) at different growing periods).* Cruz das Almas, Bahia, Brasil, Universidade Federal da Bahia, Escola de Agronomia, 1974. 9p. Port., Sum. Port., Engl., 10 Refs.

Cassava. *Manihot esculenta.* Root system. Root development. Morphogenesis. Roots. Plant development. Timing. Brazil.

A study of the root distribution in Aipim Maragogipe was made in oxisol (Série sêde) at the Escola de Agronomia) in Cruz das Almas, Bahia (Brazil). The root system reached depths of 90 and 140 cm after 210 days and 365 days of growth, respectively. In the upper layer, 95.30 and 96.40% of the roots were found from 0-30 cm deep; 65.6 and 85.75 % were found 0-10 cm deep. *(Author's summary)* C00

0078-1579 ESKES, A. B. *et al.* **Callus growth and rooting of cassava (*Manihot esculenta* Crantz) stem segments cultured in vitro.** Acta Botanica Neerlandica 23(3):315-320. 1974. Engl. Sum. Engl. 9 Refs.

Cassava. *Manihot esculenta.* Plant reproduction. Plant tissues. Tissue culture. Stems. Culture media. Laboratory experiments. Rooting. Plant growth substances. Developmental stages. Plant development. Roots. Growth.

With the in vitro culture of cassava tissue, the optimum sucrose level for callus growth is lower than that for the initiation and growth of roots. Auxin and cytokinin both promote callus growth, the latter by inducing cell division, the former also by stimulating cell elongation. In subcultures, cytokinins are obligatory for callus growth, the natural cytokinins (zeatin and 2iP) yielding green tissues. Organ development never occurred in these subcultures. Auxin (NAA) is required for the initiation and growth of roots on the callus. Different cytokinins reduce this rooting effect in various degrees without, however, inducing the initiation of shoot primordia. *(Author's summary)* C00 C01

0079-5331 MURTY, K.S. **The amylase activity of sweet cassava *(Manihot palmata).*** Journal of the Indian Chemical Society 17:578-580. 1940. Engl., Sum. Engl.

Cassava. Cassava starch. Enzymes. Metabolism. *Manihot esculenta.* Sweet cassava. Tubers. Leaves. Biochemistry. Plant physiology.

The amylase activity of sweet cassava was studied, using pure soluble starch as the substrate. Optimum temperature for enzyme activity was about 55° and optimum pH was about 6.5. *(Author's summary)* C00

0080-2453 ENYI, B. A. C. **Effect of shoot number and time of planting on growth, development and yield of cassava (*Manihot esculenta* Crantz).** Journal of Horticultural Science 47(4):457-466. 1972. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. *Manihot esculenta.* Shoots. Planting. Timing. Cultivation. Plant development. Leaf area. Productivity. Leaves. Tuber productivity. Field experiments. Plant assimilation. Plant physiological processes. Plant physiology.

Root tuber yield, weight of individual tubers, root tuber| stem weight ratio at harvest, mean bulking rate, portion of total dry matter diverted into the root tubers, and net assimilation and relative growth rates were greater in single-shoot than in multishoot plants. Multishoot plants, however, had greater leaf area and leaf area duration. Early planting encouraged the production of greater leaf area, root tuber number per plant, root tuber yield, individual tuber size and dry matter. Bulking rate was positively related to net assimilation rate. In single-shoot plants differences in leaf area duration accounted for 95% of the variation in yield between treatments; and in both single- and multishoot plants, differences in the product of leaf area duration and mean net assimilation rate accounted for 75% of the total variation in yield between treatments. *(Author's summary)* C00 D03

0081 3187 MOH, C. C. **Radiosensibil. ad de las especies de plantas tropicales:** *Carica papaya, Manihot dulcis y Swietenia humilis. (Radiosensitivity of tropical plant species: Carica papaya, Manihot dulcis, and Swietenia humilis).* Turrialba 13(3):180-181. 1963. Span., Sum. Engl., 1 Ref.

Cassava. *Manihot esculenta.* **Plant physiology. Research. Analysis.**

As regards cassava *(Manihot dulcis)*, it was found that nodes were rather sensitive to acute gamma radiation. The projected LD50 was in the vicinity of 3 kR. *(Summary by T.M.)* C00

0082-4774 CIFERRI, R. **Ricerche intorno al potere rizogeno delle talle di manioca.** *(Root formation of cassava cuttings).* Universita di Pavia, Istituto Botanico "Giovanni Briosi". 4(7):266-297. 1936. Ital., Sum. Engl., Lat., 41 Refs., Illus.

Cassava. *Manihot esculenta.* **Cuttings. Plant-growth substances. Shoots. Rooting. Plant physiology. Dominican Republic.**

Results of trials conducted with cassava (*Manihot esculenta* Crantz) cuttings confirm the conclusion of Went, Bouillenne *et al.* on the presence of substances(rhizocalines) capable of inducinghe neoformation of rootlets. A new technique has been employed, using physiologically "inactivated," but living cuttings immersed in solutions (plant extracts, liquid media of fungi cultures, autolytic products of yeast and bacteria, glucose, mineral nutritive solutions, etc.) or with physiologically active cuttings as "inductors" of root formation under different conditions. Rhizocalines are completely aspecific, widely diffuse in nature and also formed by micro-organisms. *(Author's summary)* C00

0083-4742 PRABHUDESAI, V. R. and NARAYANASWAMY, S. **A tissue culture from tapioca.** Plant Science letters 4(4):237-241. 1975. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. *Manihot esculenta.* **Tubers. Tissue culture. Morphogenesis. Culture media. Plant-growth substances. HCN content. India.**

A tissue culture from cassava tubers was successfully established on a Linsmaier-Skoog medium, supplemented with coconut milk, 2,4-dichlorophenoxyacetic acid (2,4-D), kinetin and adenine. The formation of roots was studied; it was found that size and age of the tuber at culture played a part in initiating callus induction and growth promotion. Chemical analysis of the primary explanted tissues of the intact root and the cultured callus showed the absense of HCN in the latter, indicating progressive loss of its biosynthetic potential. *(Summary by T.M.)* C00

0084-3260 MURTHY, H. B. N., RAO, G. R. and SWAMINATHAN, M. **Studies on the starch-synthesizing enzymes in tapioca** *(Manihot utilissima)* **roots.** Enzymologia 18(1):63-75. 1957. Engl., Sum. Engl., Fr., 21 Refs., Illus.

Cassava. Tubers. Enzymes. pH. Temperature. Metabolism. Starch productivity. Productivity. Cassava starch. Analysis.

A study has been made of the starch-synthesizing enzyme system in cassava roots. Phosphorylase and Q-enzyme have been found in the juice obtained from the fresh roots. Methods for the purification of the 2 enzymes are described. Some properties of the enzymes have been studied. The optimum pH and temperature for the action of the phosphorylase were 6.3 and 45°C, respectively. Phosphorylase synthesized an amylose-type polysaccharide from glucose-1-phosphate. The quantity of inorganic phosphate liberated during the action of phosphorylase on glucose-1-phosphate was found to be proportional to the quantity of amylose formed. The optimum pH and temperature for the action of Q-enzyme were 6.9 and 31°C, respectively. The Q-enzyme converted amylose into a polysaccharide with properties similar to that of amylopectin. A similar polysaccharide was also formed by the combined action of phosphorylase and Q-enzyme on glucose-1-phosphate. Q-enzyme was found to exert a marked accelerating effect on the rate of synthesis of the polysaccharide by phosphorylase from glucose-1-phosphate. *(Author's summary)* C00

0085-3041 COOPER, P. S. **Plant injections for diagnostic and curative purposes.** East African Agricultural Journal 13:37-53. 1947. Engl.,Sum. Engl., 13 Refs.

Cassava. Mineral deficiencies. Leaves. Minerals. N. Groundnut. Stems. Sweet potatoes. Plant physiology.

The use of a hypodermic syringe for plant injections in the diagnosis of mineral deficiencies is described. It is shown that patience and experience with relatively little technical skill is required and that highly accurate results are obtained rapidly. In practice few disadvantages occur in using a hypodermic syringe for plant injections on a large number of both temperate and tropical species of plants. The most useful types of syringes are described, and the additional equipment required is listed. Three principal methods of injection are described, two referring to leaf injections and one to stem injections. One method (the leaf veinal method) involves the permeation of all major and minor veins by the injected solution, while the other method involves the permeation of the tissue of an interveinal area of the leaf and is therefore called the leaf tissue method. The methods of injection most suitable to various common species of plants are discussed as a practical guide. It was found that the methods of injection, especially the leaf tissue method, for the diagnosis of mineral deficiencies give a degree of accuracy rarely attainable in either experimental or diagnostic work. The type and strength of chemical solutions used for injections are given, the effect of both chemical and mechanical damage is described. A brief outline of the symptoms attributed to deficiencies of some of the major and minor elements is given, and the results of typical injection experiments are given. As far as possible, all details relating to the physiological aspects of the injection methods are ommitted; this paper refers only to the type of injections as used solely in diagnostic work. Reference is made to the use of a hypodermic syringe for injection purposes in the control of mosaic virus on cassava. *(Author's summary)* C00

0086-2450 LONGMAN, K. A. **Effects of orientation and root position on apical dominance in a tropical woody plant.** Annals of Botany 32(127):553-566. 1968. Engl., Sum. Engl., 29 Refs., Illus.

Cassava. Cuttings. Rooting. Plant physiology. Shoots. Developmental stages. Plant reproduction. ***Manihot esculenta.***

Stem cuttings of cassava (*Manihot esculenta* Crantz), rooted at one of both ends, were grown at a range of orientations from the vertical. Basally rooted cuttings showed strong apical dominance only in upright or near-upright positions. Basal shoots generally dominated when the stem was horizontal, while completely inverted stems exhibited weak apical dominance or no dominance at all. Cuttings rooted at the apical end were little affected by changed orientation, apical dominance being present throughout. Effects of each system could be detected in cuttings rooted at both ends. The results are discussed in relation to current thinking on the mechanism of apical dominance, gravimorphic effects in woody plants and the role of the "root factor" in the control of shoot growth. *(Author's summary)* C00

0087-3365 MASON, T. G. **A note on growth and the transport of organic substances in bitter cassava** ***(Manihot utilissima).*** Scientific Proceedings of the Royal Dublin Society 17(13):105-112. 1922. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Growth. Tubers. Plant physiology. Stems. Plant development. Shoots. Apical meristems. Developmental stages. Tuber development.

A study was undertaken to ascertain whether there was any evidence for the presence of a factor correlating the activity of the cells of the apical meristem and the growth of the tuberous roots of bitter cassava. Measurements of stem height were made weekly over a period of 18 weeks and also at the end of the 27th week. Half the plants were ringed 15 weeks before the termination of the experiment. It was found that the rate of growth of the ringed plants was not affected by the operation for a period of about 3 weeks when it fell below that of the unringed plants. The weight of the tuberous roots of the ringed plants was approximately ¼ that of the unringed; the weight of the stem, on the other hand, was more than 12 times as heavy. It was concluded that the activity of the cells of the apical meristem was not controlled by the supply of organic substances available but was, on the contrary, determined by autogenous changes within the growing point.

No evidence was obtained of the presence of a factor correlating the activity of the apical meristem and the growth of the tuberous roots. The experimental results were in accord with the view that the rate of growth of the stem was conditiond by the catalytic activity of the cells of the apical meristem. *(Author's summary)* C00

0088-3463 VISWANATHAN, P. N. **Starch synthesis in chlorophyllous tissues.** Indian Journal of Biochemistry 5:188-189. 1968. Engl., Sum. Engl., 8 Refs.

Cassava. Maize. Plant physiology. Metabolism. Plant tissues. Leaves. Enzymes. Biochemistry. Cassava starch.

The relative efficiency with which particulate fractions from 5 different plant tissues utilize UDPG and ADPG as substrates for the elaboration of starch has been studied. Particulate fractions from the leaves of *Manihot utilissima* Pohl, and *Zea mays* Linn. failed to utilize UDPG, and those from *Dendrophthoe falcata* Ertingsh utilized UDPG with only 12% efficiency as compared to ADPG, the particulate fractions from the leaves of *Luffa cylindrica* Linn.,and phylloclades of *Nopalea dejecta* Dalm-Dyck utilized UDPG with an efficiency approaching that of ADPG. *(Author's summary)* C00

0089-2251 VISWANATHAN, P. N., SRIVASTAVA, L. M. and KRISHNAN, P.S. **Diurnal variations in some enzymes of carbohydrate metabolism in tapioca leaves.** Plant Physiology 37(3):283-287. 1962. Engl., Sum. Engl., 25 Refs.

Cassava. Leaves. Metabolism. Plant physiological processes. Carbohydrate content. Laboratory experiments. Plant physiology. Analysis. Proteins. Enzymes. Cytology. Photosynthesis. N.

A diurnal variation in fructose-1, 6-diphosphate aldolase and starch phosphorylase was observed in the leaves of the cassava plant; the activities were higher during the day than at night. The fluctuation in phosphorylase activity was not associated with a change in its intracellular distribution. Of the 3 fructose-diphosphatase activities (alkaline, neutral and acidic),only the alkaline enzyme showed a diurnal variation; the activity was maximum at noon and minimum at midnight. These results support the hypothesis that it is the alkaline enzyme that is directly involved in photosynthesis. Phosphoglucomutase activity did not show a prominent fluctuation, but there seemed to be a distinct tendency for higher activities at night. Glutamic-oxaloacetic transaminase activity seemed to be constant in all the samples collected during a 24-h period. Assays by the mixed homogenate technique eliminated the presence of activator or inhibitor as the cause of alterations in activity. The data can be interpreted in terms of variation in formation of enzymes. There was no significant change in the protein content or total and nonprotein N. It is likely that enzyme protein was being formed and removed by transformation occurring among the various proteins and not by fresh synthesis from nonprotein N. The significance of the observed diurnal activity in enzymes is discussed from the point of view of carbohydrate synthesis during the day and breakdown at night. *(Author's summary)* C00

0090-4534 TANG, P.S., TAI, Y.L. and LIANG, Y.L. **The effects of cyanide on the rate of oxygen-consumption and P^{32} uptake by cyanogenic tissues of the cassava *(Manihot esculenta)* tubers.** Scientia Sinica 14(11):1617-1623. 1965. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Cyanides. Plant respiration. Plan assimilation. Plant tissues. Tubers. Laboratory experiments. P.

The effects of cyanide on the rate of respiration(oxygen-consumption, Qo_2)and P^{32} uptake were studied in rind tissue discs from root tubers of cassava, *Manihot esculenta*. The following results were obtained: (1) Cyanide (10^{-3} M, buffered at pH 7) did not inhibit the rate of respiration but markedly stimulated (about 168% of control rate) the process. Within the range of concentration tested (10^{-5} to 10^{-2} M, pH 7), Qo2 increases with cyanide concentration in a manner indicative of rate| substrate relationship. This stimulation, as well as the ground rate, is heat labile. (2) Tissue extracts made with Sorensen phosphate buffer gave an easily measurable rate of Qo_2, which was stimulated by cyanide to the same extent (abouth 180% of control rate) as in tissue discs. The stimulated rate, as well as the ground rate of Qo_2 is heat labile It appears that at least the bulk of the cyanide-stimulated Qo_2 is located in the extractable parts of the cassava tissue and is therefore extramitochondrial. Azide (10^{-3} M,pH7) also stimulates tissue respiration, but to a slightly lower extent than cyanide. (3) Contrary to its stimulatory effect on the rate of respiration, cyanide (10^{-3} M,pH7) inhibits P^{32} uptake by the cassava rind tissue discs to 70% of the control rate. This inhibition is significantly weaker than that for the same process in wheat seedlings (about 10% of the control rate). On the other hand, P^{32} uptake by cassava and wheat seedlings are strongly inhibited to about the same degree (29 and 18%) by DNP, the uncoupling agent for phosphorylation. It was concluded that the respiration-dependent process of P^{32} uptake in the tissues of a cyanogenic plant (cassava), like that in other commonly investigated plant tissues, is also mediated largely through the process of oxidative phosphorylation. The bulk of the cyanide-stimulated Qo_2 is extramitochondrial. The physiological significance of this enzyme-mediated stimulatory effect by cyanide was considered in the light of a detoxication mechanism. *(Author's summary)* C00

0091-0175 MORAN, E.F. **Energy flow analysis and the study of *Manihot esculenta* Crantz.** Acta Amazonica (Brazil) 3(3):29-39. 1973. Engl., Sum. Engl., Port., 11 Refs., Illus.

Cassava. Ecology. Plant physiology. Plant physiological processes. Climatic requirements. Developmental research. *Manihot esculenta*. Brazil.

The task of cultural ecology is to trace energy flows (nature-man-ecosystem) and is the basis of the methodology used in this study. Energy flow language and diagrams are defined. The potential of cassava as a food of the future is outstanding for its rugged ecological adaptations. A general model for future study of cassava in context (experimental station, shifting cultivation, large commercial farm) is fully explained. A great deal of sociocultural data (agricultural patterns) must be collected to aid in this type of approach. *(Summary by T.M.)* C00 D00

0092-2303 PORTUGUEZ A., J. D. and MOGILNER, I. **Crecimiento *in vitro* de raices de *Manihot esculenta* en distintas condiciones de iluminacion y temperatura.** *(Growth in vitro of roots of Manihot esculenta under different conditions of light and temperature.* Bonplandia 2(7):113-120. 1967. Span., Sum. Span., Engl., 11 Refs.

Cassava. *Manihot esculenta*. Plant physiology. Roots. Laboratory experiments. Growth. Culture media. Temperature. Illumination. Growth-chamber experiments. Plant development. Argentina.

In vitro growing of *Manihot esculenta* roots was studied under different conditions of light and temperature. Roots obtained from apices cultivated in vitro in a solid Torrey medium were kept in rooms, greenhouses and stoves. There were 3 variants: (1) continuous light for 24 h, (2) natural day (11 h light and 13 h darkness), and (3) darkness for 24 h. Each variant had 2 subvariants: (a) high temperatures for 24 h and (b) high temperatures during the day and low temperatures at night. In variant (1) sunlight was used during the day and artificial light at night. It was found that composition of the nutrient medium affected apex growth and rhizogenesis. The Torrey medium was better than White's, and high temperatures for 24 h with continuous light or a natural day improved root growth. A green coloration was found in the roots, probably due to the presence of chlorophyll as a result of the light. *(Author's summary)* C00

See also 0037 0152 0406 0458 0498 0734 0737 0747 0748 0898

C01 Plant Development

0093-0017 MOGILNER, I., ORIOLI, G. A. and PORTUGUEZ A., J. D. **Influencia de la intensidad lumínica en el crecimiento "in-vitro" de ápices radiculares de mandioca.** *(The influence of light intensity on the in vitro growth of cassava root apexes).* Bonplandia 2(6):107-112. 1967. Span., Sum. Span., Engl., 18 Refs.

Cassava. *Manihot esculenta*. Root apex. Roots. Laboratory experiments. Culture media. Plant physiology. Illumination. Rooting. Developmental stages. Argentina.

Growth of *Manihot esculenta* roots in vitro was studied under different conditions of illumination. Roots obtained from a cultivation of apexes in vitro in a solid medium with 3 different carbohydrated sources (sucrose 3%, glucose 3%, and lactose 3%) were later cultivated in solid Torrey's medium with sucrose 3% under 5 different conditions of illumination: (a) 50,000 luxes (sunlight), 12 hours; (b) 3,000 luxes (artificial light), 24 hours. The temperature for all conditions was 31°C during the day and 21°C at night. After 2 months, it was found that the roots grew more under conditions "a" and "b" and the concentration of HCN decreased in almost all of them. The different carbohydrate sources where the apexes were growing influenced the later growth of roots. *(Author's summary)* C01

0094-0120 NARTEY, F., MOLLER, B. L. and ANDERSEN, M. R. **Changes in the major constituents of *Manihot esculenta* seeds during germination and growth.** Economic Botany 28(2):145-154. 1974. Engl., Sum. Engl., 35 Refs., Illus.

Cassava. *Manihot esculenta*. Seed. Composition. Fat content. Developmental stages. Germination. Starch content. Soluble carbohydrates. Timing. Plant physiology. Growth. Protein content.

An investigation was made of the changes in concentrations of the major storage reserves of cassava seeds that occur during germination and growth in the dark and in the light. Evidence supports the occurrence of exceptionally high levels of lipids and proteins, thus making cassava seeds a potential source of dietary and industrial fats and proteins. The massive mobilization and conversion of storage lipids into carbohydrates during germination and the activating influence of light on the lipolytic activities of seedlings are described. The relationship of these changes to the metabolic activities of other germinating oleaginous seeds is discussed. *(Author's summary)* C01 C03

0095-0096 WHOLEY, D. W. and COCK, J. H. **Onset and rate of root bulking in cassava.** Experimental Agriculture 10(3):193-198. 1974. Eng., Sum. Engl., 5 Refs., Illus.

Cassava. *Manihot esculenta*. Developmental stages. Tuber development. Roots. Production. Productivity. Cultivars. Composition. Dry matte Timing. Field experiments. Tuber productivity. Colombia.

Thirteen cultivars of cassava were planted with wide spacing and harvested after 2, 3, 5 and 7 months. Differences in root yield after 7 months were caused by variations in rate of root bulking and were not associated with differences in onset of root bulking, which occurred during the second month of growth in all varieties that produced thickened roots. *(Author's summary)* C01 D03

0096- 1541 SENA. Z. F. DE and CAMPOS, H. DOS R. **Studo do sistema radicular da mandioca (*Manihot esculenta* Crantz) submetidas a diferentes frecuencias de irrigação.** *(Study of the root system of cassava under different periods of irrigation).* Cruz das Almas, Brasii. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):41-52. 1973. Port., Sum. Port., Engl., 12 Refs., Illus.

Cassava. *Manihot esculenta.* **Roots. Plant development. Irrigation. Water requirements (plant). Brazil.**

A study was made of the root distribution of cassava (*Manihot esculentu* Crantz) under varying irrigation treatments in oxisol series Sede Escola de Agronomia, Cruz das Almas, Bahia, Brazil. The root system reached, respectively, depths of 0.60, 0.80, 0.60, and 1.40 m. The highest amount of roots was present in the upper 10 cm-layer; i.e., 97.56%, 90.96%, 98.41% and 28.81%, respectively. The last treatment did not receive any irrigation water. *(Author's summary)* C01

0097- 1829 SHANMUGHAM, A. and SRINIVASAN, C. **Influence of number of shoots per plant on the growth and yield of cassava (*Manihot esculenta* Crantz).** Farm Journal (India) 14 (7):17-19. 1973. Engl., Sum. Engl., 4 Refs.

Cassava. *Manihot esculenta.* **Propagation. Shoots. Propagation materials. Cuttings. Plant physiology. Plant height. Plant development. Tuber productivity. Productivity. Growth. India.**

Studies were undertaken during 1970-72 to investigate the influence of single and multishoots per plant on the growth and yield of cassava var. Malavella. Results revealed that plants with 2 shoots outyielded the single and multishooted plants, registering narrow tuber-shoot ratio. This practice is sure to increase the yield per unit area and could be commercially recommended. *(Author's summary)* C01 D03

0098- 1778 WILLIAMS, C. N. **Growth and productivity of tapioca (*Manihot utilissima*). IV. Development and yield of tubers.** Experimental Agriculture 10(1):9-16. 1974. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. *Manihot esculenta.* **Plant physiology. Plant anatomy. Growth. Roots. Tuber development. Tuber productivity. Developmental stages. Productivity.**

Root measurements on 3 Malayan varieties of cassava (high- medium- and low-yielding clones) showed that the onset of tuberization brings about a slowing down or cessation of growth in root length, but no changes in stem growth rate were associated with the onset of tuber growth. High yield was associated with high tuber weight rather than with tuber number, which could be related to the size of storage tissue cells formed by the root cambium. The process of tuberization in cassava is discussed generally. *(Author's summary)* C01 D03

0099-2476 SYKES, J. T. and HARNEY, P. M. **Cassava propagation: the effects of rooting medium and IBA on root initiation in hardwood cuttings.** Tropical Agriculture (Trinidad) 51(1):13-21. 1974. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Roots. Shoots. Propagation. Cultivation. Cuttings. Propagation materials. Developmental stages. Rooting. Plant-growth substances.

The beneficial effects of IBA at 8000 ppm in promoting rooting are described. Different types of fully mature, hardwood cuttings of 3 cassava clones were rooted in sphagnum peat and in perlite under mist. Treatment with IBA had an adverse effect on initial shoot development, especially on cuttings inserted in perlite. In peat, root length was stimulated particularly during the second week after insertion. Whether this was due to higher temperature or differences in the rooting medium characteristics as compared to perlite, requires further investigation. Shoot length increase in peat was also considerable, especially when cuttings were completely covered with peat. The presence of live, healthy buds was found to be essential for complete regeneration. With viable buds present, more than 90% of all the cuttings produced roots and shoots within 2 weeks. Young rooted plants established from multibud, single bud or eye cuttings could serve as stock plants to provide a lasting source of nonlignified shoots. As cuttings, these shoots may be readily rooted to give a rapid multiplication rate of selected cassava clones, either of new genotypes or virus-tested plants. *(Author's summary)* C01 D02

0100-1713 INDIRA, P. and SINHA, S. K. **Studies on the initiation and development of tubers in *Manihot esculenta* Crantz.** Indian Journal of Plant Physiology 13(1):24-39. 1970. Engl., Sum. Engl., 26 Refs., Illus.

Cassava. *Manihot esculenta*. Propagation. Plant physiology. Cuttings. Plant anatomy. Plant-growth substances. Roots. Tuber development. Developmental stages. India.

Studies on the mechanism of tuber differentiation and development in *Manihot esculenta* were undertaken. Morphologically speaking, tubers of this plant are roots. Stem cuttings used for propagation produce roots both from nodes and from callus. There is no anatomical difference in the roots originating from both regions, and both are capable of producing tubers. The excision of buds reduces the number of roots originating from callus. The application of glucose or sucrose to cuttings devoid of buds enhances root formation. The presence of leaves does not seem to be necessary for root formation and growth; however, the application of GA3 and CCC reduces the number of roots originating from callus, while NAA enhances it. Secondary growth starts 3 weeks after planting. This is followed by starch deposition in secondary xylem of roots and apparently represents the first stage of tuber differentiation. Secondary growth and starch deposition occur even in the absence of buds on stem cuttings but are considerably delayed. However, the application of glucose or sucrose hastens secondary growth and starch deposition. The application of GA3 inhibits starch deposition and tuber development. Tuber differentiation in **Manihot** seems to be associated with the initiation of secondary growth of roots. This is contrary to plants bearing stem tubers, where tuber differentiation is associated with the change of polarity in the apical bud. *(Author's summary)* C01

0101-1544 CONCEICAO, A. J. DA., CUNHA, H. M. P. DA. and SAMPAIO, C. V. **Germinação da semente da mandioca (*Manihot esculenta* Crantz).** *(Seed germination in cassava, Manihot esculenta Crantz).* Cruz das Almas, Brasil. Universidade Federal da Bahia. Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):21-24. 1973. Port., Sum. Port., Engl., 7 Refs.

Cassava. *Manihot esculenta*. Developmental stages. Germination. Seed. Brazil.

Germination of cassava seed was affected by the place of germination. The "ripado" (a semienclosed structure) was shown to be a very efficient place as observed in studies conducted over a three-year period. *(Author's summary)* C01

0102-1697 MAGOON, M. L., JOS, J. S. and BASUDEVAN, K. N. **Male sterile cassava.** Nucleus 11(1):1-6. 1968. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Plant fertility. Flowers. Pollen. Microsporogenesis. Plant physiology. Cytology. Developmental stages. *Manihot esculenta*.

Comparative developmental studies of 1 fertile male and 6 sterile male lines of *Manihot esculenta* were made with regard to the flower, microsporogenesis and development of the male gametophyte. In the 5 sterile male lines, degeneration of individual microspores is probably due to the failure of the microspores to separate from the tetrad, which leads to the formation of empty anthers. However, in the sterile male line, CTCRI-1417, pollen abortion has been attributed to the persistent nature, abnormal behavior and development of tapetum. The nutritive relationship between the developing microspores and the tapetum has also been stressed. Based on cytological data, it has been suggested that meiotic abnormality is not the cause of pollen degeneration in the material studied. *(Author's summary)* C01

0103-0392 BOLHUIS, G. G. **Influence of length of the illumination period on root formation in cassava** (*Manihot utilissima* **Pohl**). Netherlands Journal of Agricultural Science 14(4):251-254. 1966. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Plant physiology. Rooting. Development stages. Photoperiod. ***Manihot esculenta.*** **Cultivars. Plant development.**

Sprouted cuttings of 6 cassava cultivars were subjected to treatments with different light periods (10 h daylight, 10 h daylight plus 2 h weak light, 10 h daylight plus 4 h weak light, and 10 h daylight plus 6 h weak artificial light, respectively) in order to study root formation under these conditions. The results make it evident that the optimal light period is about 12 h; longer light periods inhibit root formation. In this respect cassava must be considered as a short-day plant. *(Author's summary)* C01

0104-2083 NORMANHA, E. S. **Acido 4- cloro-2-metilfenoxibutírico (CMPB) como hormônio estimulante do enraizamento.** *(The chemical 4-chloro, 2-methylphenoxybutyric acid (CMPB) as a root-inducing hormone).* Bragantia 17:41-44. 1958. Port., Sum. Engl., Illus.

Cassava. Plant-growth substances. Propagation materials. Rooting. Cuttings. Herbicides. Developmental stages. Brazil.

Field studies on the herbicidal properties of the commercial product known under the trade name Tropotox, which contains the sodium salt of the 4-chloro, 2-methylphenoxybutyric acid (CMPB), have indicated that this chemical may act as a hormone-like substance, inducing adventitious root formation on the stems of certain weeds. Preliminary tests with cassava (*Manihot utilissima* Pohl) cuttings have confirmed that Tropotox has a stimulating effect on root formation. *(Author's summary)* C01

0105-2082 SRINIVASAN, K. **The effect of hormone application on root formation and yield in tapioca.** Agricultural Research Journal of Kerala 3(1):1-4. 1965. Engl., Sum. Engl., 8 Refs.

Cassava. Rooting. Cuttings. Tubers. Processing. Plant-growth substances. Productivity. Propagation materials. Cultivars. Tuber productivity. Plant development. India. Developmental stages.

Treatment of cassava cuttings with a root-inducing hormone results in an increase in the number as well as the total length of roots. The number of tubers per plant is not altered as a result of hormone treatment, which may be a varietal character. Inducing better initial root formation in cassava is found to result in higher tuber weight. *(Author's summary)* C01 D03

0106-1925 ENYI, B. A. C. **Growth, development and yield of some tropical root crops.** Papua, New Guinea, University of Papua, 1973. 36p. Engl., Sum. Wnfl., 27 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Root crops. Plant development. Growth. Developmental stages. Tuber development. Productivity. Fertilizers. N. P. K. Ca. Leaf area. Leaves. Tuber productivity. Planting. Timing. Plant physiology. Developmental stages.

The main factors affecting the yield of tropical root crops are rate and period of bulking and where light is not a limiting factor, leaf area duration. The effect of seed size on tuber yield is due mainly to its effect on rate of bulking and leaf area duration. The difference in root tuber yield between varieties of root crops is due mainly to the differences in their rate of bulking and in some cases to the duration of bulking and leaf area duration. The effect of planting and mulching time on root tuber yield is due mainly to leaf area duration. The spacing effect on root tuber yield is due to leaf area duration and rate of bulking per unit area of land surface. The effect of staking on root tuber yield is due to its effect on leaf area duration, rate and duration of bulking. The age of sett effect on tuber yield is brought about by the differences in leaf area duration due to the differences in leaf area indices of different-aged setts. In breeding for high yield, one has to bear in mind these factors which contribute to the final yield of the plants and the morphological attributes of the plants which affect these factors. The ideal tropical root crop then will be the one with high rate of bulking, greater duration of bulking and greater leaf area duration. Greater leaf area duration can be achieved by a combination of high leaf area index with a short period of leaf growth or low leaf area index with longer period of leaf growth. The latter combination is a better one, provided that the leaf area index does not remain below the optimum for maximum production for a long period. In most root crops, leaf area duration between the time of tuber initiation and final harvest is very important, and in some the number of tubers initiated depends on the leaf area of the plant at the time of tuber initiation. It is essential, therefore, that breeders produce plants with rapid leaf development between the time of planting and tuber initiation; after tuber initiation, such plants should maintain an optimum leaf area index for maximum dry matter production for a long period. The partition of the assimilates between the aerial and underground portion of cassava varieties is very important, and plant breeders should select only those cassava varieties in which a greater portion of the assimilates is diverted into the root tubers rather than into the stems; also agronomic practices should be geared towards the encouragement of greater diversion of the assimilates into the root tubers. *(Author's summary)* C01 D03

0107-5203 IBN-MOHAMED TAMIN, M. S. **Toward production of virus-free manioc plants (*Manihot esculenta* Crantz).** Serdang, Malaysia, Malaysian Agricultural Research and Development Institute (MARDI), 1975. 5p. Engl., Sum. Engl., 3 Refs.

Paper presented at the National Plant Tissue Culture Symposium, Kuala Lumpur, 1975.

Cassava. *Manihot esculenta.* Tissue culture. Plant development. Culture media. Rooting. Plant-growth substances. Leaves. Petioles. Stems. Malaysia.

Stem internodal sections about 2 mm long, excised from the 2nd to 5th nodes from the apex, were grown on a synthetic agar medium containing a known ratio of auxin to cytokinin. Two types of callus were observed on the explants: (1) the "surrounding callus," which originated from the epidermal or subepidermal region and developed around the sides and lower region of the explants and (2) the "central callus" which originated from the pith region and developed on the upper surface of the explants. High levels of auxin appeared to stimulate greater root formation. It was observed that younger explants (excised nearer the apex) formed more roots. The roots appeared to originate from the cambial region of the stem; their development appeared to be arrested after a stage, probably due to the formation of an abscission layer at the base of the roots. Shoot formation was not observed even at relatively high levels of cytokinin. Gibberellic acid did not initiate organogenesis. Current work is centered on developing a hormonal treatment capable of initiating balanced organogenesis (i.e., both shoot and root initiation) from the callus. *(Author's summary)* C01

0108-3092 ENYI, B. A. C. **Growth rates of three cassava varieties (*Manihot esculenta* Crantz) under varying population densities.** Journal of Agricultural Science 81(1):15-28. 1973. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. *Manihot esculenta.* Spacing. Growth. Plant development. Productivity. Cultivars. Rainfall data. Dry matter. Composition. Tubers. Leaf area. Plant assimilation. Plant physiological processes. Leaves. Analysis. Field experiments. Research. Tuber productivity. Tuber development.

The effect of variety and spacing on growth, development and yield and the relationship between growth, development and yield in 3 cassava varieties were investigated during the 1971-72 growing seasons. Msitu Zanzibar outyielded Aipin Valenca, and these 2 varieties in turn outyielded Amani 4026|16. The varietal effect was associated with differences in the rate of bulking. Increase in plant density led to an increase in the yield of tubers per hectare, the mean increase being greater in Aipin Valenca than in either Amani 4026|16 or Msitu Zanzibar. Increase in plant density from 12,000 to 18,000 plants|ha led to a decrease in tuber yield in Amani 4026|16. The calculated optimum density for maximum yield was 6.7, 6.4 and 5.6 plants|m^2, respectively, for Msitu Zanzibar, Aipin Valenca and Amani 4026|16. The spacing effect on tuber yield was associated with differences in the rate of bulking. Aipin Valenca was usually taller than the other varieties; and in general, increase in plant density increased plant height. Final total dry matter|m^2 was greater in

Aipin Valenca and Msitu Zanzibar than in Amani 4026|16; and with the exception of the last variety, TDM|m^2 increased with increasing plant density. TDM|plant was greater in Msitu Zanzibar than in Aipin Valenca, and these two varieties had greater dry weight|plant than Amani 4026|16. In the 3 cassava varieties, the dry weight|plant increased with decreasing plant density. A greater proportion of the TDM was diverted into the root tubers of Aipin Valenca and Msitu Zanzibar than in Amani 4026|16. Generally, increase in plant density decreased the proportion of TDM diverted into the root tubers. Mean crop growth rate increased with increasing plant density whereas mean net assimilation rate and relative growth rate decreased with increasing plant density. Amani 4026|16 and Aipin Valenca had a greater mean crop growth rate and a greater net assimilation rate than Msitu Zanzibar. Mean relative growth rate was greater in the last than in the first 2 varieties. Leaf area index and leaf area duration were greater in Msitu Zanzibar than in the other 2 varieties and tended to increase with increasing plant density. There was a close and positive relationship between rate of bulking and root tuber yields; the lack of a positive relationship between leaf area duration and tuber yield is also discussed. *(Author's summary)* C01 D02 D03

0109-3441 KARTHA, K. K. *et al.* **Regeneration of cassava plants from apical meristems.** Plant Science Letters 2:107-113. 1974. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Cultivars. Apical meristems. Morphogenesis. Plant development. Research. Growth-chamber experiments. Laboratory experiments. Plant-growth substances. Culture media. Propagation. Plant reproduction. Rooting. Tuber development.

Cassava plants were regenerated from meristems of 5 cultivars: Colombia no. 800, Llanera, Venezuela no. 255, Ecuador no. 133 and Mexico no. 35. Using benzyladenine (BA), gibberellic acid (GA3) and naphthaleneacetic acid (NAA) at molar concentrations of $5 \cdot 10^{-7}$, 10^{-7} and 10^{-6}, respectively, resulted in complete plant development on Murashige-Skoog (MS) medium, supplemented with vitamins as in B5. GA in combination with NAA resulted in root formation whereas BA with NAA produced callus and storage roots. The meristems were cultured in a growth cabinet at 26°, 60% RH, and exposed to a light intensity of 4,000 l from cool, white fluorescent lamps using a light and dark cycle of 18|6 h. *(Author's summary)* C01

0110-0538 GRANER, E. A. **Notas sôbre florescimento e fructificação da mandioca.** *(Notes on the flowering and fructification of cassava).* Bragantia 2(1):1-12. 1942. Port., Sum. Engl., 6 Refs., Illus.

Cassava. Flowering. ***Anastrepha pickelli. Teleocoma crassipes.*** **Entomology. Pests. Fruiting. Injurious insects. Noxious animals. Pollination. Plant reproduction. Developmental stages. Plant development.**

The flowering habits and the fructification of cassava (*M. utilissima* Pohl) are described. Mention is made of the small production of flowers per plant, the attack on male flowers by the fly *Teleocoma crassipes* Aldrich, and the attack on the fruit by the fly *Anastrepha pickelli* C. Lima. The difficulties of controlled pollination is emphasized, and a practical method of obtaining F_1 seeds is discussed. *(Author's summary)* C01

0111-3498 SENA, Z. F. DE and CAMPOS, H. DOS R. **Estudo do sistema radicular da mandioca,** ***Manihot esculenta*** **Crantz, submetida a diferentes frequencias de irrigação.** *(Study of the root system of cassava, Manihot esculenta Crantz, under different irrigation treatments)* Cruz das Almas, Bahia, Brasil, Universidade Federal da Bahia, Escola de Agronomia, 1973. 15p. Port., Sum. Port., Engl., 12 Refs.

Cassava. ***Manihot esculenta.*** **Roots. Irrigation. Water requirements (plant). Soil requirements. Cultivation. Research. Field experiments. Rooting. Developmental stages. Brazil.**

A study was made of root growth and distribution in cassava (*Manihot esculenta* Crantz) in a latosol at the Escola de Agronomia in Cruz das Almas, Bahia (Brazil). The 210-day-old plants were given the following treatments: A, irrigated every 10 days; B, every 14 days; C, every 18 days; and D (control), no irrigation. In order of treatments, 97.56, 90.96, 98.41 and 28.81% of the roots were located in the upper layer of soil, 0-10 cm deep. Maximum depth reached by the root systems were 0.70, 0.80, 0.60 and 1.40 m, respectively. *(Summary by S.S. de S.)* C01

0112-0394 SINHA, S.K. and NAIR, T. V.R. **Leaf area during growth and yielding capacity of cassava.** Indian Journal of Genetics and Plant Breeding 31(1):16-20. 1971. Engl., 3 Refs.

Cassava. Leaf area. Productivity. Plant development. Rainfall data. Photosynthesis. Plant physiology. Growth. Tubers productivity. India.

Photosynthetic efficiency is one of the most important characteristics of a plant, partly determining its economic yield; it is controlled by a number of factors including number, shape, orientation and area of leaves, and plant geometry. In an experiment to discover the role that leaf retention might play in the yield capacity of cassava, leaf number, leaf area and tuber yield were recorded monthly for 7 months. Results indicate that cassava strains differ considerably in their leaf area and yield. Strains of cassava have a tendency to shed leaves as they grow, resulting in a reduced leaf area. It appears, therefore, that the leaf characters are important factors contributing to yield in cassava. These characters can be evaluated and employed in breeding programs for obtaining desirable plant types. *(Summary by P.A.C.)* C01

See also 0040 0041 0068 0073 0078 0113 0350 0363 0389 0424 0486 0508 0544 0547 0570

C02 Cyanogenesis

0113-1788 INDIRA, P., MAINI, S. B. and MANDAL, R. C. **Effect of growth on the cyanoglucoside content in *Manihot esculenta* Crantz.** Current Science 41(9):339-340. 1972. Engl., 7 Refs.

Cassava. *Manihot esculenta.* HCN content. Plant physiology. Plant-growth substances. Cuttings. Rooting. Growth. India.

Stem cuttings of cassava *(M. esculenta)* H-57, a hybrid having 6-8 buds, were given a presoaking treatment for 16 h with various growth regulators like NAA, IAA, indole-3-butyric acid, and IPA at 10-50 ppm. The treated cuttings were planted in pots containing sawdust and were watered. On day 30, the HCN in roots was established by a colorimetric method. The HCN content in roots was considerably reduced by the various growth regulators tested, and the effect of these regulators was more pronounced at higher concentrations (50 ppm). Although the maximum effect on reducing HCN content was noted at 75 ppm concentration, the optimum concentration for these growth regulators in invariably all the treatments, was 25-50 ppm. *(Summary by Chemical Abstracts)* C02 C01 C03

0114-0613 BRUIJN, G. H. DE. **Etude du caracter cyanogenetique du manioc (*Manihot esculenta* Crantz).** *(A study of the cyanogenic character of cassava).* Mededelingen Landbouwhogeschool 71(13):1-140. 1971. Fr. Sum. Fr., Engl., Dutch., 135 Refs., Illus.

Cassava. *Manihot esculenta.* Cyanogenesis. Cyanogenic glucosides. Amygdalin. Linamarin. Lotaustralin. HCN. Analysis. Tubers. Plant physiology. Cortex. Pulp. Leaves. Clones. Fertilizers. Climatic requirements. Drought. Plant development. Soil fertility. Enzymes. Linamarase. Detoxification. Detoxification processes. Drying. Rasping. Pulping. Boiling. Glucose. Timing. Metabolism. Toxicity. Dry matter.

Among the 67 Ivory Coast clones analyzed for cyanogenetic glucoside content, Tabouca and A 13 were chosen as examples of less toxic and Ta25 and 461 of more toxic forms. The difference between the higher concentration of the glucosides in the tuber bark and the lower concentration in the inner part of the tuber was more marked in the less toxic clones than in the more toxic. The less toxic differed from the more toxic mainly in the glucoside concentration of the inner tuber. It is suggested that the less toxic clones can metabolize glucoside more than the more toxic, the conversion probably taking place in the cortical zone of the tuber. Within clones, glucoside content was correlated with average root weight ($r = +0.35$). Between clones, the glucoside content of the leaves was correlated with the glucoside content of the peeled tubers ($r = +0.55$) and with the dry-matter content of the roots ($r = +0.34$). The glucoside content of the peeled tubers was correlated with the dry matter content of the leaves ($r = -0.33$) and the dry matter content of tubers ($r = -0.40$). *(Summary by Plant Breeding Abstracts)* C02

0115-0717 CONN, E. E. **Cyanogenic glycosides.** Agricultural Food and Chemistry 17(3):519-526. 1969. Engl., Sum. Engl., 73 Refs.

Cassava. HCN. Cyanogenic glycosides. Plant tissues. Amino acids. Tyrosine. Toxicity. Hydrolysis. Analysis. Enzymes. Detoxification processes. Drying. Cyanogenesis. Linamarin.

Approximately 1000 plant species representing 90 families and at least 250 genera have been reported to be cyanogenic. Several dozen species have been studied in greater detail (in some instances because of their economic significance), and 11 cyanogenic glycosides have been identified. The majority of these are formed by the plant from one of four amino acids (valine, isoleucine, phenylalanine and tyrosine) by means of a biosynthetic pathway involving oximes, nitriles and α-hydroxynitriles (cyanohydrins). The cyanogenic glycosides are toxic because they yield hydrogen cyanide (HCN) when enzymically degraded. Enzymatic hydrolysis results when the plant tissue is crushed or otherwise disrupted, but hydrolysis by the digestive enzymes of an animal feeding on cyanophoric plants may also occur. Plant tissues containing cyanogens may be rendered less toxic by extraction or by maceration and dehydration to remove the volatile HCN. *(Author's summary)* C02

0116-0300 CLAPP, R. C. *et al.* **Cyanogenesis in manioc: Linamarin and isolinamarin.** Phytochemistry 5:1323-1326. 1966. Engl., Sum. Engl., 12 Refs.

Cassava. HCN. Cyanogenic glycosides. Linamarin. Analysis. Laboratory experiments. Cyanogenesis.

Good yields of the cyanogenetic glucoside linamarin were obtained from tubers of cassava *(Manihot esculenta* Crantz*)* by a chromatographic procedure. From the reaction of acetobromoglucose and acetone cyanohydrin, both the α- and β-anomers of the glucoside of acetone cyanohydrin were obtained, and comparison of the properties of natural linamarin with those of the synthetic samples established the identity of the natural glucoside as the β-anomer. The spectroscopic properties of the α- and β-anomers are consistent with the configurational assignments. *(Author's summary)* C02

0117-3401 BUTLER, G. W., REAY, P. F. and TAPPER, B. A. **Physiological and genetic aspects of cyanogenesis in cassava and other plants.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp.65-71. Engl., Sum. Engl., Fr. 38 Refs.

Cassava. Plant physiology. Genetics. HCN. Cyanogenesis.

Available data on the pathways for degradation of cyanoglucosides and subsequent fate of the breakdown products in cassava (**Manihot** spp) and other plants are discussed. Also considered is the degradation of cyanoglucosides after ingestion by animals and parasitic organisms. The physiological and genetic factors which give rise to variations in cyanoglucoside content in plants are also discussed. *(Author's summary)* C02

0118-0481 NARTEY, F. **Studies on cassava,** ***Manihot utilissima;*** **Biosynthesis of asparagine-^{14}C from ^{14}C-labelled hydrogen cyanide and its relations with cyanogenesis.** Physiologia Plantarum 22:1085-1096. 1969. Engl., Sum. Engl., 25 Refs.

Cassava. ***Manihot esculenta.*** **Seed. Composition. Analysis. Cyanogenic glycosides. Metabolism. Plant physiology. Cyanogenesis. Enzymes. Biochemistry. Proteins. Amino acids. Linamarin. Linamarase. HCN. Isolation.**

Seeds and seedlings of *Manihot utilissima* were analyzed for cyanogenic glycosides and free amino acids, with special reference to valine and isoleucine, which serve as precursors of the aglycone moieties of linamarin and lotaustralin. Seeds contained traces of valine and isoleucine but no glycosides, whereas seedlings contained high concentrations of these. Illumination of seedlings led to a steep increase in the concentration of glycosides, followed by a decrease without excretion of detectable HCN. Seeds accumulated asparagine, while seedlings accumulated both asparagine and glutamine in the storage and transport of N. Seedlings incorporated 13.2% of label from valine-^{14}C(U) and 2.4% of label from isoleucine-^{14}C(U) into linamarin and lotaustralin, respectively. In both cases, appreciable amounts of label were also incorporated into asparagine: 49% of label from $H^{14}CN$ was incorporated into asparagine in which about 98% of total radioactivity was located —in the amide-carbon atom. The different patterns of labeling which occurred during the assimilation of $H^{14}CN$ and $^{14}CO_2$ showed that cyanide metabolism did not proceed via

CO_2 and that *M. utilissima* contains an efficient enzyme system which catalyzes the conversion on high concentrations of HCN into asparagine, which subsequently enters different metabolic pools involved with respiration, protein and carbohydrate syntheses. Cyanogenesis in *M. utilissima* appears to be directly influenced by available pools of valine and isoleucine, and the metabolism of HCN released from linamarin and lotaustralin by the action of linamarase may be directly related to respiratory and synthetic processes by way of the incorporation of HCN as a unit into asparagine. *(Author's summary)* C02

0119-0446 BUTLER, G. W. **The distribution of the cyanoglucosides, linamarin and lotaustralin, in higher plants.** Phytochemistry 4:127-131. 1965. Engl., Sum. Engl., 20 Refs.

Cassava. HCN. Linamarin. Lotaustralin. Glucose. ***Manihot carthagenensis.*** **Cyanogenic glycosides. Cyanogenesis. Linamarase.**

In a survey of plants which had previously been reported to contain either linamarin or lotaustralin it was found that both cyanoglucosides were generally present. Seeds of *Hevea brasiliensis* were exceptional in that only linamarin could be detected. The two cyanoglucosides were found to be present in a number of additional species drawn from genera containing species already known to contain either linamarin or lotaustralin. Implications of the similar distribution of the two cyanoglucosides are discussed with respect to their biosynthesis. *Manihot carthagenensis* Muell. Arg. contained 96% linamarin and 4% lot australin. *(Author's summary)* C02

0120-3402 CONN, E. E. **Cyanogenic glycosides: their occurrence, biosynthesis and function.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp. 55-63. Engl., Sum. Engl., Fr., 38 Refs., Illus.

Cassava. HCN. Cyanogenic glycosides. Linamarin. Human health. Ataxic neuropathy. Endemic goitre. Hydrolysis. Plant physiology. Cyanogenesis.

Cyanogenic glycosides are widely distributed among plants and in 2 classes of animals (Myripoda and Insecta). The structure and distribution of some cyanogenic glycosides are discussed, in particular the structure of linamarin and lotaustralin, which occur in cassava (Manihot spp). The biosynthesis and functions of these compounds are discussed, as well as their possible role in the etiology of tropical ataxic neuropathy and goiter. *(Author's summary)* C02 H02

0121-0607 NARTEY, F. **Studies on cassava,** ***Manihot utilissima*** **Pohl; I: Cyanogenesis: The biosynthesis of linamarin and lotaustralin in etiolated seedlings.** Phytochemistry 7:1307-1312. 1963. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. HCN. Germination. Linamarin. Linamarase. Amino acids. Leaves. Photoperiod. ***Manihot esculenta.*** **Seed. Cultivars. Cyanogenesis. Analysis. Laboratory experiments. Plant physiology. Plant development.**

No HCN could be detected in seeds of one cultivar of *Manihot utilissima* Pohl, whereas seeds of two other cultivars contained 5.2-8.5 μg HCN/g fresh weight. However, 10-14-day-old seedlings of all 3 cultivars contained 156-200 μg HCN/g fresh weight. Thus a rapid biosynthesis of cyanogenic material occurred during germination. Chromatographic analysis showed that linamarin, 2(β-D-glucopyranosyloxy)isobutyronitrile, accounted for 93%, while lotaustralin, 2(β-D-glucopyranosyloxy)2-methylbutyronitrile, accounted for 7% of the total HCN evolved by autolyzing etiolated seedlings. L-Valine $^{14}C(U)$ and L-isoleucine $^{14}C(U)$ were incorporated by etiolated seedlings into the aglycone moieties of linamarin and lotaustralin, respectively, indicating that amino acids are effective precursors of these glucosides in *M. utilissima.* Seedlings of all 3 cultivars contained linamarase, the β-glucosidase which catalyzes the hydrolysis of both glucosides. A crude preparation of the enzyme from leaves showed strong activity against linamarin and lotaustralin, mild activity against salicin and weak activity against β-methyl glucoside and amygdalin. *(Author's summary)* C02

0122-3399 NARTEY, F. **Biosynthesis of cyanogenic glucosides in cassava, Manihot spp.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp.73-87. Engl., Sum. Engl., Fr., 28 Refs., Illus.

Cassava. Manihot. HCN. Biochemistry. Seed. Leaves. Roots. Germination. Linamarin. Amino acids. Linamarase. Enzymes. Plant respiration. Cytology. Cultivars. Cyanogenic glucosides. Developmental stages. Composition. Analysis. Plant respiration. Plant physiological processes. Plant tissues. Cyanogenesis.

Cyanogenic materials could not be detected in seeds of sweet cassava (*Manihot* spp.) cultivars, whereas low levels of these materials were found in seeds of bitter cultivars. However, both types of seeds synthesized high cyanogen levels during germination and growth. Linamarin, 2(β-D-glucopyranosyloxy) isobutyronitrile, accounted for 93%, while lotaustralin, 2(β-D-glucopyranosyloxy) 2-methylbutyronitrile, accounted for 7% of the total cyanogenic glucosides in cassava. Seedlings efficiently incorporated L-valine-^{14}C (U) and L-isoleucine-^{14}C (U) into the aglycone moieties of linamarin and lotaustralin, respectively. Appreciable radioactivity from these amino acids were also incorporated into asparagine. Linamarase, the β-glucosidase which catalyzes the hydrolysis of linamarin and lotaustralin, was identified and isolated in crude form from seedlings and leaves of both sweet and bitter cultivars. Thus both cultivars contained the enzymes which catalyze the biosynthesis and degradation of the glucosides. The free amino acid profiles of seeds and seedlings indicated that during germination, the action of proteolytic enzymes on seed storage proteins resulted in the rapid accumulation of valine and isoleucine, from which the glucosides were rapidly synthesized. During seedling growth, the concentration of cyanogenic glucosides increased and then fluctuated without the release of HCN. Studies with $H^{14}CN$ showed that HCN released intracellularly from the glucosides was rapidly incorporated in asparagine and subsequently into metabolic pools involved with respiration and protein and carbohydrate synthesis. Cassava plants assimilated $H^{14}CN$ as efficiently as $^{14}CO_2$ in the light. The pathway of $H^{14}CN$ assimilation was found to proceed by the ration of cyanide with serine and cysteine, which resulted in the formation of asparagine. Seedling homogenates showed the presence of equally high activities of β-cyanoalanine synthase and rhodanese, the enzymes which catalyze cyanide detoxification. Both enzyme activities were found to be localized in cassava mitochondria, which showed very low sensitivity toward cyanide during respiration. Electron microscopic studies on cassava seed tissues showed the presence of large amounts of fat and protein bodies in all cells. Organelles were little differentiated. At the onset of active cyanogen synthesis, the cytoplasmic organelles were well developed, especially in the roots. *(Author's summary)* C02

0123-1616 SINHA, S. K., MAGOON, M. L. and INDIRA, P. **Note on the possibility of controlling increased cyanoglucoside content in cassava tubers caused by higher application of nitrogen.** Indian Journal of Agricultural Sciences 40(6):573-575. 1970. Engl., 5 Refs.

Cassava. *Manihot esculenta.* **Tubers. Cyanogenic glycosides. HCN. Fertilizers. N. Cyanogenesis. Sweet cassava. Bitter cassava. Field experiments. India.**

A bitter and a sweet cultivar of cassava were given a basal dressing of PK and 100 kg N| ha as urea applied by (a) incorporation into the soil, (b) foliar spray, or (c) 50 kg by (a) and 50 kg by (b). In both cultivars, the HCN content of the tubers was higher at 9 than at 10 months after planting and was higher in the bitter than in the sweet cultivar. At 10 months after planting, the HCN content in both cultivars was in the order (a) > (c) > (b); in the bitter cultivars the contents were 176.1, 91.0 and 73.0 mg HCN| kg tubers with (a), (c) and (b), respectively. The method of N application had no effect on the number or weight of tubers| plant. *(Summary by Field Crop Abstracts)* C02 C03 D01

0124-0423 EGGUM, B. O. **The protein quality of cassava leaves.** British Journal of Nutrition 24:761-768. 1970. Engl., Sum. Engl., 21 Refs.

Cassava. Leaves. Dry matter. Amino acids. Methionine. Lysine. Cystine. Ca. P. Composition. Protein content. Dietary value. Mineral content. Sodium. Magnesium. Digestibility.

A chemical and biological evaluation was made of the protein content of some leaves and leaf extracts from the eastern region of Nigeria (Biafra); most were from cassava *(Manihot utilissima).* The protein content of the leaves was from 30-40% (expressed as percentage of leaf dry matter). The concentrations of essential amino acids were adequate, except for methionine. The biological criteria, true digestibility (TD) and biological value (BV), showed that TD varied from 70-80%, whereas BV varied from 44-57%, depending on the methionine content. Adding methionine to a diet of cassava leaves raised BV from 49% (for the leaves alone) to 80% (for the mixture). This relationship clearly shows that cassava leaves contain too little available methionine. An investigation into the true availability of the amino acids showed that this is somewhat variable, and only 60% of the methionine is available. The BV of cassava leaves combined with Norwegian dried cod showed a mutual supplementation effect. *(Author's summary)* C02 H01

0125-0489 BISSET, F. H. *et al.* **Cyanogenesis in manioc concerning lotaustralin.** Phytochemistry 8:2235-2247. 1969. Engl., Sum. Engl., 63 Refs.

Cassava. *Manihot esculenta.* **Lotaustralin. Linamarin. Cyanides. Cyanogenic glycosides. Analysis. Cyanogenesis. Metabolism. Plant physiology.**

A glucoside of 2-hydroxy-2-methylbutyronitrile was shown to be present, in low concentration compared with linamarin, in 3 samples of relatively bitter tubers of cassava (*Manihot esculenta* Crantz). The glucoside was separated, as the trimethylsilyl derivative, by gas chromatography and identified by mass spectrometry. The B-D-glucopyranosides of the enantiomeric hydroxy nitriles were synthesized from acetobromoglucose and methyl ethyl ketone cyanohydrin, being separated by chromatography of the acetates. The less levorotatory of the synthetic glucosides, having the "R" configuration at the asymetric center of the glucone, was shown to be identical to the compound which occurs naturally in white clover (lotaustralin). *(Author's summary)* C02

0126-0491 WILLIAMS, C. N. **Growth and productivity of tapioca** *(Manihot utilissima)* **II. Stomatal functioning and yield.** Experimental Agriculture 7:49-62. 1971. Engl., Sum. Engl, 13 Refs. Illus.

Cassava. Growth. Productivity. Leaves. Stomata. Canopy. Plant development.

The stomatal functioning of high-, medium- and low-yielding cassava clones was examined to see whether yield could be associated with conductivity and/or resistance to moisture stress. A sensitive falling pressure porometer was used to measure stomatal conductivity to the viscous flow of air at small pressure differences. No marked differences were observed that could account for the large range in yields shown by the varieties, but stomatal functioning could be related to canopy type and to planting conditions. In general the conductivity values of all 3 varieties were very low compared to many other crop species, which suggests that increases in canopy efficiency and yield could be obtained in certain environments by an increase in leaf conductivity. *(Author's summary)* C02

0127-3392 BRUIJN, G. H. DE. **The cyanogenic character of cassava,** *Manihot esculenta. In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp. 43-48. Engl., Sum. Engl., Fr., 10 Refs.

Cassava. HCN. Toxicity. Tubers. Leaves. Cortex. Cyanogenesis. Ecology. Enzymes. Linamarase. Cyanogenic glycosides. Amygdalin. Lotaustralin.

Results are given of a study on cassava toxicity carried out in the Ivory Coast. The distribution of the cyanogenic glucosides in the plant has been studied. It is concluded that classifying clones for toxicity according to the glucoside content of the tuberous roots is not strictly correct for other parts of the plant. Glucoside concentration of the leaves and of the peel of tuberous roots of less toxic clones tends to be, on the average, only slightly lower than in the same organs of very toxic clones. Environmental conditions have a very important influence on the cyanogenic glucoside content of the tuberous roots. Different clones do not react in the same way to changing ecological conditions. Nitrogen fertilization increases the glucoside content whereas the supply of potassium and farmyard manure decreases. The influence of phosphate, calcium, and magnesium does not seem to be important. Drought increases glucoside content. Shading young plants increased the glucoside content of the leaves but decreased that in the roots. No relation was found between the glucoside content of tuberous roots and plant age. Glucoside concentration of a clone appears to be positively correlated with the water content of leaves and tuberous roots; slight positive correlation with productivity was found. There may be transportation of the glucoside in the plant. Ringing of stems caused a considerable increase in the glucoside content in the bark above the incision; this was not found when the leaves had been removed first. Distribution of the enzyme linamarase was studied. Activity was highest in the very young expanding leaves. In the peel of tuberous roots, the activity was relatively high; but in the inner part of the roots, activity offers possibilities for developing more effective methods for elimination of the toxicity of cassava products. The process of breaking down the glucosides of the grated inner part of the tuberous roots can be accelerated considerably by the addition of leaves or peel of tuberous roots, after which the HCN can be driven off. *(Author's summary)* C02

0128-0016 MOGILNER, I., ORIOLI, G. A. and PORTUGUEZ ARIAS, J. D. **Influencia de distintas fuentes hidrocarbonadas en la rizogénesis, en el crecimiento radicular y en la biogénesis del ácido cianhídrico en mandioca.** *(The influence of different sources of carbohydrates on rhizogenesis and HCN synthesis in cassava).* Bonplandia 2(8):121-125. 1967. Span., Sum. Span., Engl., 20 Refs.

Cassava. *Manihot esculenta.* **Developmental stages. Rooting. Culture media. Growth-chamber experiments. Laboratory experiments. Cyanogenesis. Plant physiological processes. Roots. HCN. Metabolism. Argentina.**

The influence of different sources of carbohydrates on rhizogenesis and HCN synthesis in the apex of *Manihot esculenta* (Crantz) cultivated in vitro was studied. Results are presented in a table. *(Author's summary)* C02

See also 0518 1042

C03 Chemical Composition, Methodology and Analyses

0129-0042 MARTINO, G. and KNALLINSKY, A. **Sul contenuto in fattore E della radice di mandioca.** *(Vitamin E content in the cassava root).* Bolletino della Societá Italiana di Biologia Sperimentale 8:819-821. 1933. Ital.

Cassava. Tubers. Composition. Vitamin content. Laboratory animals. Nutritive value.

The cassava root is poor in vitamin E as judged from fecundity of female rats fed a synthetic diet containing various amounts of this substance. Male rats, on the contrary, were always capable of impregnating normal females. *(Summary by Chemical Abstracts)* C03

0130-0060 MUTHUSWAMY, P., KRISHNAMOORTHY, K. K. and RAJU, G. S. N. **Investigations on the hydrocyanic acid content of tapioca (*Manihot esculenta* Crantz) tubers.** Madras Agricultural Journal 60(8):1009-1010. 1973. Engl., Sum. Engl., 5 Refs.

Cassava. *Manihot esculenta.* **Tubers. Composition. HCN content. Water content. Cultivars. India.**

The moisture and HCN content of promising types of cassava tubers are reported. The average moisture content from 30 varieties was 65.40% and the HCN content in the tuber was 41.21 ppm on a fresh weight basis. Varietal differences ranged from 5 to 125 ppm. *(Author's summary)* C03

0131-0061 MUTHUSWAMY, P. *et al.* **Hydrocyanic acid content of cassava (*Manihot esculenta* Crantz) peel as affected by fertilizer application.** Current Science 43(10): 312. 1974. Engl., 5 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Cortex. Composition. HCN content. Fertilizers. N. P. K. India.**

Peels of 30 promising cultivars were separated from the flesh and analyzed for their HCN content. These cultivars were grown to maturity. The effects of N, P and K fertilizer application on the HCN content of peels of 3 varieties of cassava were also studied. Nitrogen application increased the HCN content of the peel (756 ppm) significantly at 150 kg N| ha. Application of P and K did not have any significant effect on HCN content. *(Summary by J. L. S.)* C03

0132-2366 RICHARDS, M.B. **The colorimetric determination of manganese in biological material.** Analyst 55:554-560. 1930. Engl., Sum. Engl., 6 Refs.

Cassava. Analysis. Manganese. Composition. Potatoes.

The periodate method of Willard and Greathouse for the colorimetric determination of manganese can be applied to the estimation of very small amounts of manganese, such as occur in biological material, if due care is taken to drive off all chlorides before oxidation and to see that the acidity of the solution does not exceed 15 cc of sulfuric acid per 100 cc of solution. It is recommended that the acidity be kept at about 5 to 6%, unless it is found that very considerable amounts of manganese are present. It has been shown that the method gives satisfactory results, both for agreement of parallel determinations and regarding recovery of added manganese from the samples analyzed. Results for different classes of substances such as grass, cassava, potatoes, liver of different species, etc, are given as tables. *(Author's summary)* C03

0133-2306 FILHO, J.C. and AZEVEDO, E. **Determinacão colorimetrica de ácido cianidrico em mandioca.** *(Cotorimetric determination of hydrocyanic acid in cassava).* Brazil. Instituto de Pesquisas Agronômicas de Pernambuco. Boletim Técnico no.9. 1964. 9p. Port., Sum. Port., Engl., 10 Refs., Illus.

Cassava. HCN content. Composition. Analysis.

This paper describes a modification in the colorimetric method for HCN determination in cassava. The modified method is quicker than the conventional one and avoids confusion with some other substances which give similar reactions. *(Author's summary)* C03

0134-0018 JANSZ, E. R. and NETHSINGHA, C. **Manioc: selected topics.** Journal of the National Science Council of Sri Lanka 1(2): 83-96. 1973. Engl., 102 Refs.

Cassava. *Manihot esculenta.* **Cyanogenic glycosides. Linamarin. Linamarase. Enzymes. Hydrolysis. Metabolism. HCN. Toxicity. Sri Lanka.**

The following aspects are discussed: the cyanogenic glucosides in cassava and the factors affecting their concentration; the ingestion of toxic factors from cassava; cassava products and the elimination of cyanogenic compounds from them; and pollution caused by the cassava starch industry. *(Summary by Chemical Abstracts)* C03 H01

0135-2422 VOISIN, J.C. **Teneurs en acide cyanhydrique des maniocs de Cote d'Ivoire** *(HCN contents of cassava from the Ivory Coast).* Revue Generale de Botanique no. 724: 386-388. 1954. Fr., Sum. Fr., 3 *Refs.*

Cassava. HCN content. Composition. Sweet cassava. Bitter cassava. Ivory Coast.

Results are given of studies on the HCN content in several varieties of cassava from West Africa. Differences were significant; percentage of HCN ranged from less than 10 mg| 100 g, fresh weight, for sweet varieties to more than 25 mg| 100g for the bitter varieties. *(Summary by H.J.S.)* C03

0136-0045 VISWANATAN, P. N. and SRIVASTAVA, L. M. **Search for uridine diphosphate glucose-starch synthetase and phosphorylase activity in polyfructosan-bearing tissues.** Indian Journal of Biochemistry 1(3):133-136. 1964. Engl., Sum. Engl., 19 Refs.

Cassava. Cassava starch. Biochemistry. Enzymes. Tubers. Laboratory experiments. India.

The activities of UDPG-starch synthetase and starch phosphorylase have been studied in different parts of two typical polyfructosan-bearing plants: dahlia *(Dahlia spectabilis)* and asparagus *(Asparagus crispus).* They are compared with those of two starch-bearing plants: cassava *(Manihot utilissima)* and amorphophallus *(Amorphophallus campanulatus).* Both enzymes are absent in the tubers of polyfructosan-bearing plants, whereas the leaves show appreciable phosphorylase activity. UDPG-starch synthetase activity is not demonstrable in the leaves of either cassava or dahlia plants. *(Author's summary)* C03.

0137-0002 SRIVASTAVA, L. M. and KRISHNAN, P. S. **Localization of starch phosphorylase in the leaves of tapioca plant.** Journal of Scientific and Industrial Research (Section C) 20(11):306-311. 1961. Engl., Sum. Engl., 20 Refs.

Cassava. *Manihot esculenta.* **Biochemistry. Plant physiology. Leaves. Cassava starch. Enzymes. Analysis. Laboratory experiments.**

A significant proportion of the total phosphorylase activity in the leaves of the cassava *(Manihot utilissima)* plant is found to be associated with the plastid fraction sedimenting at centrifugal forces of 1,600 x g from homogenates prepared in aqueous media. As regards the activity found in the supernatant, it is difficult to decide whether a soluble enzyme is present along with the particle-bound enzyme or whether the soluble enzyme is an artifact arising from plastid rupture during homogenization and centrifugation. When the chloroplast fraction is separated into stroma and grana, the greater part of the enzymic activity is found in the former. Dialysis of the whole homogenate leads to a change in the distribution pattern in the direction of increased activity in the supernatant, but an appreciable part of the total activity is still associated with the particulate fraction. Dialysis of the separated plastid fraction leads to very little solubilization of the enzyme. *(Author's summary)* C03

0138-0015 MUTHUSWAMY, P. *et al.* **A study of the micronutrient content in tubers of some cassava cultivars (*Manihot esculenta* Crantz).** South Indian Horticulture 22(1-2): 65-66. 1974. Engl., 1 Ref.

Cassava. *Manihot esculenta.* Cultivars. Tubers. Composition. Analysis. Mineral content. Copper. Iron. Manganese. Zn. India.

A total of 35 cultivars of cassava were analyzed for micronutrient contents. The copper status of cassava tubers ranged from 2.1 to 8.4 ppm with a mean of 3.3 ± 0.2. Tubers of different types had Mn levels from 4.2 to 10.0 ppm with a mean of 6.1 ± 0.5 ppm. Similarly, iron (13.2 to 74.2 ppm) and zinc (10.5 to 63.2 ppm) had the mean values of 34.2 and 28.2 ppm, respectively. Among the micronutrients analyzed, the greatest variation in the tuber was observed for iron (55.4%) and the least for copper (36.3%). *(Summary by J. L. S.)* C03

0139-0150 PEREIRA, A.S. and PINTO, M. R. G. **Informações sobre as mandiocas de mesa, macaxeiras ou aipins.** *(Information about sweet cassava varieties).* Agronômico 14:9-10. 1962. Port.

Cassava. Cultivars. Sweet cassava. HCN content. Human nutrition. Toxicity. Brazil.

Selection of cassava varieties for human and animal nutrition was carried out at the Instituto Agronômico de Campinas. The HCN content of the fresh roots of cassava varieties has been determined. The HCN content lethal for humans ranges from 30-60 mg | 100 g. An HCN content of 10mg | 100g in the roots is considered a safe limit to avoid toxicity. *(Summary by A.N.)* C03

0140-0450 MONTALDO, A., BARRIOS, J. R. and GUILLEN, R.D. **Evaluación agronómica de la yuca** *(Manihot esculenta). (Agronomical evaluation of cassava, Manihot esculenta).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1969. 10p. Span., Sum. Span., 4 Refs.

Cassava. Toxicity. Dry matter. Temperature. Cultivars. Productivity. HCN content. Analysis. Composition. Sweet cassava. Bitter cassava. *Manihot esculenta.* Leaves. Tubers. Venezuela.

The behavior of 77 cultivars of cassava *(Manihot esculenta)* brought from Central America in 1966 to the Experimental Station of Saman Mocho, Carabobo (Venezuela) is presented. From the total material, 19 cultivars (16 sweet and 3 bitter) yielded more than 30 tons | ha. A quality evaluation method for the toxicity of cassava leaves and roots is described in detail; the evaluation was based on Guignard quantitative methods. *(Author's summary)* C03 D03

0141-2214 CAMPOS, F.A. DE M. **A presenca do complexo vitaminico B na raiz tuberosa da mandioca.** *(Vitamin B complex in cassava roots).* Annaes da Facultade de Medicina de Sao Paulo 11:27-31. 1935. Port., Sum. Engl., 5 Refs., Illus.

Cassava. *Manihot esculenta.* Vitamin B. Tubers. Laboratory animals. Laboratory experiments. Cassava meal. Nutritive value. Vitamin content. Composition. Brazil.

Cassava meal prepared from the tuber *Manihot utilissima* and used as food in Brazil (especially in the northeastern part of the country), was tested for the vitamin B complex. Good growth curves were obtained in white rats when scraped tubers were added to the Hawk-Bergein diet. With the dry meal, the growth curves were not so good, but vitamin B deficiency was prevented in 80% of the cases. *(Author's summary)* C03

0142-2216 MUÑOZ, G., A. and CASAS P., I. **Contenido de ácido cianhídrico en raíces y hojas de clones "amargos" de yuca** *(Manihot esculenta). (Hydrocyanic acid content from roots and leaves of bitter cassava clones).* Turrialba 22(2):221-223. 1972. Span., Sum. Engl., 13 Refs.

Cassava. Tubers. Leaves. Clones. Cultivars. Cyanogenic glycosides. Linamarin. Detoxification. HCN content. Composition. *Manihot esculenta.* **Bitter cassava. Costa Rica.**

Ten clones of bitter cassava *(Manihot esculenta)* were analysed for the HCN content in their roots and leaves. In general, the acid content in roots was higher than in leaves. The values of HCN found in the samples ranged from 0.112 to 1.327 mg|g DM for roots and from 0.262 to 0.772 mg|g DM for leaves. No correlation was found between the HCN content in roots and leaves. The time required for the complete digestion of the cyanogenic glucoside linamarin is crucial for maximal HCN liberation, a fact that should be kept in mind when parts of this plant (roots and|or leaves) are to be detoxified for direct animal consumption. *(Author's summary)* C03

0143-0104 CHEW, M. Y. **Rhodanese in higher plants.** Phytochemistry 12(10):2365-2367. 1973. Engl., Sum. Engl., 6 Refs.

Cassava. *Manihot esculenta.* **Rhodanese. Enzymes. Biochemistry. Analysis. Laboratory experiments. Leaves.**

Rhodanese activity was detected in crude leaf extracts of 12 randomly selected plant species (including *Manihot utilissima*), consisting of 9 noncyanophoric and 3 cyanophoric species in each case; the enzyme exhibited high activity at pH 10.4 and 55°. There appeared to be no correlation between rhodanese activity and the cyanophoric nature of the plant. *(Author's summary)* C03

0144-0729 BARRIOS, E. A. and BRESSANI, R. **Composición química de la raíz y de la hoja de algunas variedades de yuca, Manihot.** *(Root and leaf chemical composition of some varieties of cassava, Manihot).* Turrialba 17(3):314-320. 1967. Span., Sum. Span., Engl., 13 Refs.

Cassava. Leaves. Ca. P. Cultivars. Composition. Iron. Ash content. Fibre content. Protein content. Carbohydrate content. HCN content. Tubers. Costa Rica.

Eight varieties of cassava tubers (**Manihot**), as well as their dehydrated leaves, were studied to obtain information regarding their use in animal nutrition and in the industrial production of starch. The varieties were grown in Guatemala:5 of them in a dry subtropical area and the remaining 3 in a dry tropical area. The tubers of each variety were weighed and the quantity of peel was determined. The analysis of both roots and leaves included determinations of moisture, ether extract, crude fiber, protein, ash, and carbohydrate, as well as Ca, P, Fe and HCN. The percentage of peel in the tuber varied between 11.1 and 20.3%, averaging 16.1 for all varieties. By simple extraction with water, the roots yielded 70% starch. The chemical composition analyses showed that cassava contains small amounts of protein but is rich in carbohydrates, especially starch; thus it is a good caloric concentrate that can be used in animal feeding, provided all the HCN contained in the root is eliminated. The root could be also used with certain economic advantages in the feeding of dairy cattle and also in rations for beef cattle and swine. The peel is relatively rich in the chemical components studied, and it could be an important by-product in the starch industry, provided it is detoxified. It could also be used as ensilage in the feeding of ruminants. However, it is recommended that a study be made to determine the nutritive value of this product by digestibility assays and to determine whether the minerals it contains are biologically available for animals. The cassava leaf is relatively rich in protein, ash, calcium and ether extract; it is considered of good nutritive value; but, as indicated before, it must be detoxified. Hydrogen cyanide concentration was highest in the peel and lowest in the leaf. There was a large range in HCN concentration between varieties. *(Author's summary)* C03

0145-2950 JOACHIM, A.W.R. and PANDITTESEKERE, D. G. **Investigations of the hydrocyanic acid content of manioc** *(Manihot utilissima).* Tropical Agriculturist 100:150-163. 1944. Engl., Sum. Engl., 5 Refs.

Cassava. *Manihot esculenta.* **Composition. Analysis. HCN content. Tubers. Leaves. Boiling. Washing. Detoxification processes. Detoxification. Drying. Steeping. Cortex. Pulp. Cooking. Processed products. Fresh products. Cassava chips. Cassava flour. Temperature. Cultivars. Timing. Sri Lanka.**

Fundamental and practical research relating to HCN in cassava has shown that (1) the standard method for estimating HCN in materials containing cyanogenetic glucosides gives low results with cassava and its products. A combination of the auto-enzyme and acid hydrolysis methods has proved very satisfactory. A correct sampling technique is also of primary importance as the HCN content of cassava varies from tuber to tuber in the same clump and within the tuber itself. There is a fall in HCN in the tuber from the end nearest the stem (proximal) to that furthest from it (distal); the central section is generally intermediate in this respect. A suitable sampling method has accordingly been adopted. (2) Variety and environmental conditions (climate and soil) are the major determining factors of HCN in cassava. Age is of less importance athough the data indicate that the flesh of the sweet or low HCN-containing varieties tends to develop slightly more HCN with age, while that of the bitter or high HCN-containing varieties tends to become less bitter with age. In the case of the peel, which has a much higher HCN content than the flesh in both bitter and sweet varieties, there appears to be slight rise with age up to the 9th or 10th month and a steady fall, thereafter. (3) Variable, but generally high losses of HCN occur on drying the flesh and peel of tubers at temperatures below 72°C, above which temperature the enzyme is destroyed. Washing the slices or rasped material before drying, further reduces the HCN content of the dried material. (4) On cooking, the HCN content of cassava tubers or flour is reduced appreciably. Occasionally, cases do occur in which, even after cooking, cassava tubers or flour preparations contain sufficient HCN in a combined or slowly available form to render their consumption dangerous. Cassava peel flour contains HCN in amounts which render it unsafe for use, unless mixed with 3-4 times its weight of wheat or other non-HCN containing flour. (5) Cassava leaves contain high amounts of HCN; the younger the leaves, the higher the acid content. On steeping the leaves in boiling water for periods of 3 - 15 minutes, from 80 - 95 % of the original HCN is removed. Steaming the treated material, as in the normal cooking process, reduces the HCN content still further. *(Author's summary)* C03 H04

0146-0872 BOLHUIS, G. G. **L'emploi de la réaction par la couleur de Guignard dans la sélection du manioc.** *(The use of the Guignard color test in the selection of cassava).* Revue Internationale de Botanique Appliquée et d'Agriculture Tropicale 32(361-362):559-564. 1952. Fr., 5 Refs.

Cassava. Tubers. HCN content. Analysis. Toxicity. Laboratory experiments. Java.

Guignard's color reaction test is a rapid and simple method of determining roughly the degre of toxicity of the roots of different cassava varieties. It appears that varieties classified as fairly poisonous and poisonous are influenced by external conditions more than by any other factor. The wide variation in toxicity make a botanical classification impossible. *(Summary by Tropical Abstracts)* C03

0147-2232 COURS, G. **Le manioc.** *(Cassava).* Recherche Agronomique de Madagascar. Compte rendu no. 2:78-88. 1953. Fr., 3 Refs., Illus.

Cassava. Analysis. Leaves. Zn. Ca. Manganese. N. P. K. Iron. Boron. Fertilizers. Manures. Cultivation. Soil fertility. Nutritional requirements. Minerals. Malagasy Republic.

A review is presented of plant leaf diagnosis. Leaf analysis permits detection of physiological disturbances, element deficiencies in the soil, etc. Data concern selection of the proper leaves, deficiencies of K, B, Mn, Fe and Zn. The paper also deals with cassava fertilization and manuring trials, using organic matter, minerals, or a mixture of the two. Leaf diagnosis and fertilization trials will be carried out jointly in the future. *(Summary by H.J.S.)* C03

0148-0302 JOHNSON, R. N. and RAYMOND, W. D. **The chemical composition of some tropical food plants. IV. Manioc.** Tropical Science 7(3):109-115. 1965. Engl., Sum. Engl., 37 Refs., Illus

Cassava. Enzymes. Amino acids. Leaves. Composition. Fat content. Vitamin content. Protein content. Fibre content. HCN content. Tubers. *Manihot esculenta.*

Cassava *(Manihot utilissima* Pohl) is widely grown for its edible tubers which serve as a staple food in many tropical countries and are also the source of a valuable starch. The paper lists botanical sources and examines the chemical composition of the plant. *(Author's summary)* C03

0149-2196 BUSSON, F. and BERGERET, B. **Contribution à l'etude chimique des feuilles de manioc,** *Manihot utilissima* **Pohl., Euphorbiacées.***(A contribution to the chemical study of cassava, Manihot utilissima Pohl. Euphorbia).* Medicine Tropicale 18(1):142-144. 1958. Fr., 7 Refs.

Cassava. Leaves. Amino acids. Cassava flour. Eggs. Nutritive value. Composition. Cameroon.

Samples of cassava leaves from Cameroon were chemically analyzed to determine protein amino acids. Amino acid composition of cassava leaves is compared with that of eggs, and cassava flour, which were taken as a reference pattern. From a nutritional standpoint, cassava leaves are superior to cassava flour. *(Summary by J.L.S.)* C03 H01

0150-0361 CRUZ M., H. E. **Investigations on the root of** *Manihot utilissima* **Pohl.** Journal of Agriculture of the University of Puerto Rico 20:649-654. 1936. Engl., 3 Refs.

Cassava. Tubers. Composition. HCN content. Starch content. Fibre content. Water content. Cultivars. Identification. Growth. Puerto Rico.

The study includes methods for analyzing the HCN content. The HCN content of the roots of cassava varieties under study were compared, and the HCN content of the roots at different stages of growth was determined. Determination of starch and fiber content was also included. Some of the characteristics of 25 of the 44 varieties studied are given, grouped according to color, size, type and thickness of the peel, underskin, rind and pulp. *(Summary by J.L.S.)* C03

0151-3683 SEIGLER, D. S. **Isolation and characterization of naturally occurring cyanogenic compounds.** Phytochemistry 14(1):9-29. 1975. Engl., Sum. Engl., 109 Refs., Illus.

Cassava. Cyanogenic glycosides. Isolation. Analysis. Laboratory experiments.

The literature dealing with the detection, isolation, purification and characterization of cyanogenic glycosides has been integrated with spectral and chemical data, as well as other techniques from our laboratory, to establish a method for the positive identification of glycosides of this type. The compounds are arranged into biosynthetically related groups (those derived from L-phenylalanine; L-tyrosine; L-leucine, L-valine; L-isoleucine; those with cyclopentene rings and pseudocyanogenic glycosides). Features of each of the above procedures are critically reviewed and spectral data for each group presented (IR, MS, UV and NMR). The NMR spectra of TMS ethers of cyanogenic glycosides have proven especially useful in chemical structure determination. This information is sufficient to permit identification of any of the 26 known glycosides as well as certain uncharacterized ones. *(Author's summary)* C03

0152-3169 ORIOLI, G. A. *et al.* **Acumulación de materia seca, N, P, K y Ca en** *Manihot esculenta.* *(Accumulation of dry matter, N, P, K and Ca in Manihot esculenta).* Bonplandia 2(13):175-182. 1967. Span., Sum. Span., Engl., 2 Refs., Illus.

Cassava. Dry matter. Analysis. N. P. Ca. K. Leaves. Stems. Plant assimilation. Soil fertility. Plant physiology. Plant physiological processes. Minerals. *Manihot esculenta.*

Monthly accumulations of N, P. K, Ca and dry weight were determined during the vegetative period of cassava planted in fertilized and in unfertilized soils. The bimonthly levels of accumulation during a 6-month period are given. While greater soil fertility increased the absolute accumulation of measured factors, the tendency of the accumulation curve did not vary substantially. *(Author's summary)* C03 C00

0153-3638 HUDSON, B. J. F. and OGUNSA, A. O. **Lipids of cassava tubers (*Manihot esculenta* Crantz).** Journal of the Science of Food and Agriculture 25(12):1503-1508. 1974. Engl., Sum. Engl., 18 Refs.

Cassava. *Manihot esculenta*. Tubers. Composition. Fat content. Cassava flour. Water content. Potato flour. Analysis. Nigeria.

The flour from cassava tubers contains about 2.5% lipids, only half of which is extractable with conventional solvent systems. Extractable lipids are mainly polar in character, the principal group of components being galactosyl diglycerides. A new galactolipid (tetragalactosyl diglyceride) is described for the first time. The component fatty acids are relatively saturated in character, in comparison with those of other structural lipids, such as those of the potato. *(Author's summary)* C03

0154-0384 ADRIANO, F. T. and YNALVEZ, L.. **A rapid modified method of detecting and estimating hydrocyanic acid suitable for field tests.** Philippine Journal of Agriculture 3(2):105-109. 1932. Engl., 6 Refs., Illus.

Cassava. Starch crops. HCN content. Composition. Analysis. Tubers. Yams. Field experiments. Philippines.

This method of detecting and estimating HCN in the field uses the intensity and length of coloration that a given amount of HCN will give on specially prepared picric acid paper. Instructions are included. A table of average weights of cylindrical strips of fresh yams and cassava tubers used in this process is included, together with a comparison of results of determining HCN in yam and cassava tubers with the modified and traditional methods. *(Summary by P.A.C.)* C03

0155-0830 COURS, G., FRITZ, J. and RAMAHADIMBY, G. **El diagnóstico felodérmico de la mandioca.** *(Phellodermic diagnosis of the nutritional status of cassava).* Fertilité no. 12:3-20. 1961. Span., Illus.

Cassava. Nutritional requirements. Composition. Mineral content. Stems. Boron. Copper. Manganese. Molybdenum. Zn. N. P. K. Manganesium. Plant physiology. Fertilizers. Plant tissues. Roots. Productivity. Leaves. Fruits. Ovules. Dry matter. Petioles. Malagasy Republic.

In view of certain difficulties encountered in the foliar diagnosis of cassava plants in Madagascar, a method of phellodermic diagnosis has been developed which facilitates sampling. In a series of experiments, the effects were studied of various fertilizers on the nutrient levels in the phelloderm of the main stem. Application of N had a positive, though nonsignificant effect on the N content of the phelloderm. Phosphate had no effect, whereas application of K had a highly significant, positive effect on the K content of the phelloderm and a highly significant, negative effect on both the N and P content of the phelloderm. Manurial experiments and tissue analyses are being continued. *(Summary by Tropical Abstracts)* C03 D01

0156-1686 NARTEY, F. and MØLLER, B. L. **Fatty acid profiles in germinating *Manihot esculenta*.** Phytochemistry 12(2):2909-2911. 1973. Engl., Sum. Engl., 10 Refs.

Cassava. *Manihot esculenta*. Seed. Composition. Laboratory experiments. Fatty acid.

The fatty acid composition of the storage lipids of cassava seeds was analyzed by GLC. Linoleate (61.6%), oleate (22.4%) and palmitate (10.3%) occurred as major components, with myristate, palmitoleate, stearate and linolenate as minor components. A trace of arachidate occurred during early germination. The overall fatty acid composition of total lipids in dark- and light-grown seedlings remained relatively constant and indicated that no specific fatty acids were preferentially metabolized during seed germination and growth. *(Author's summary)* C03

0157-0656 UMANAH, E. E. **A note on the variation of dry matter content (DMC) along the length of cassava *(Manihot utilissima* Pohl) tubers.** Tropical Root and Tuber Crops Newsletter no. 4:34-37. 1971. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Tubers. Dry matter. Composition. *Manihot esculenta.*

DMC is highest (40-45%) at the proximal portion of cassava tubers; over 40% of the varieties sampled gave this range. Highest DMC of the middle and distal portions fell within the 35-40% range; 35 and 30%, respectively, of the varieties sampled fell within this range. Distribution of the DMC was most uniform at the proximal portion. If a representative DMC of a cassava tuber is to be determined, the sample should not therefore be taken at only one portion—proximal, middle, or distal—but rather from each of these portions and pooled for the determinations. *(Author's summary)* C03

0158-2047 AIYER, R. S. and VIJAYAN, M. R. **A sampling technique for foliar diagnosis of the nitrogen and phosphorus status of cassava (*Manihot utilissima* Pohl) plants.** Science and Culture 35 (5):214-216. 1969. Engl., 2 Refs.

Cassava. Leaves. Petioles. N. P. K. Ca. Magnesium. Mineral content. Composition. Analysis.

Results gathered point to the suitability of the petioles from the middle one third of the total leaves for foliar diagnosis of the N and P status of cassava plants. The unique features of the area selected are ease of handling and sampling, homogeneity of the sample minimizing sampling errors, and existence of a definite relationship between the concentration of the nutrient in the petioles and the variation of these in the soil. The suitability of the petioles from the middle group of leaves for foliar diagnosis of other nutrients like K, Ca and Mg and its suitability for predicting the yield of cassava from an analysis of its nutrient content are currently under investigation. *(Author's summary)* C03

0159-0836 PRUDHOMME, E. **Manioc du Cambodge.** *(Cassava from Cambodia).* Agronomie Coloniale (France) no.31:1-8. 1920. Fr.

Cassava. Cultivars. Composition. N. Analysis. Cambodia.

The author discusses results of a chemical and physical analysis performed by other researchers on several cassava varieties from Cambodia. There are remarkable differences of composition, especially in the content of materials containing N. The author recommends one variety for further testing. *(Summary by H.J.S.)* C03

0160-0079 RAMIREZ, J. H. **El contenido de ácido cianhídrico y almidón en variedades de yuca** *(Manihot utilissima)* **de recién importación.** *(Hydrocyanic acid and starch content of recently introduced cassava (Manihot utilissima) varieties).* Revista de Agricultura de Puerto Rico 28(2):239-244. 1936. Span., Sum. Span., Illus.

Cassava. *Manihot esculenta.* **Cultivars. Composition. HCNcontent. Starch content. Timing. Puerto Rico.**

The varieties Itaparica, Peralta, X no. 2, Basioras and X no. 6 recently introduced into Puerto Rico, and the native varieties Amarilla and Pata de Paloma, showed the highest starch contents. Starch yield decreases when the plant has exceeded maturity and harvesting. Plant age affects the determination of HCN; the older the plant, the lower its HCN content. *(Author's summary)* C03

0161-0781 FLOCH, H. **Sur la richesse exceptionnelle en vitamine C de feuilles de plantes Guyanaises.** *(Notes on the exceptional richness of vitamin C in leaves of Guiana plants).* Journal d'Agriculture Tropicale et de Botanique Appliquée 4(9-10):385-391. 1957. Fr., 10 Refs.

Cassava. Human nutrition. Nutritive value. Leaves. Vitamin content. Ascorbic acid.

Ascorbic acid analysis of Guiana plants is presented. For the quantification of vitamin C, the authors have used the iodometric method and dichlorophenol-indophenol. Studies on cultivars of **Euphorbiaceae, Liliaceae** and **Amaryllidaceae** are presented. The amount of vitamin C for the cultivar studies ranges from 9.6 to 1,538 mg| 100 mg, the higher values being for the **Amaryllidaceae** group. *(Summary by A.P.)* C03

0162-0329 ROGERS, D. J. and MILNER, M. **Amino acid profile of manioc leaf protein in relation to nutritive value.** Economic Botany 17(3):211-216. 1963. Engl., Sum. Engl., 19 Refs.

Cassava. Leaves. Amino acids. Protein content. HCN content. Composition. ***Manihot esculenta.*** **Cultivars.**

Leaves of 20 cassava *(Manihot esculenta)* cultivars from Jamaica and Brazil were analyzed for 18 amino acids. The essential amino acid profile indicated a definite deficiency in methionine only, while the high lysine value suggested that this protein might be a useful supplement to certain cereal diets. Rats rejected diets containing the lyophilized, uncooked leaf at protein levels as low as 10%, but this rejection was apparently not related to the cyanide content of the leaf. *(Author's summary)* C03 H01

0163-0351 WOOD, T. **The isolation, properties, and enzymic breakdown of linamarin from cassava.** Journal of the Science of Food and Agriculture 17:85-90. 1966. Engl., Sum. Engl., 19 Bibl.

Cassava. Isolation. Enzymes. Linamarin. Linamarase. Cyanogenic glycosides. Analysis. Laboratory experiments. Biochemistry.

A new method is described for isolating linamarin from cassava. Using the pure glucoside, its properties and assay were investigated; and a number of modifications to the previous assay procedure were introduced. The paper chromatography of the glucoside and means of detecting it on chromatograms are described. A procedure is given for preparing and assaying a crude preparation of linamarase. The variation in activity with pH, the stability of the enzyme, and its inhibition by buffers and by (1-5)-gluconolactone are described. A suggestion is made as to the role of linamarin and linamarase in the plant. *(Author's summary)* C03

0164-2280 HENRY, C. **La vitamine C dans les plantes alimentaires malgaches.** *(Vitamin C in the food plants from Madagascar).* Naturaliste Malgache 8(1):31-45. 1956. Fr., 25 Refs., Illus.

Cassava. Ascorbic acid. Composition. HCN content. Vitamin content. Malagasy Republic.

Vitamin C quantity determination was investigated for 19 vegetables and starch crops and for 6 fruits usually eaten in Madagascar. Several extraction methods were tested to assure the minimum oxidation of ascorbic acid in the sample. Finally, methaphosphoric acid was used for this purpose. For titration, the reduction reaction of 2-6 dichlorophenol-indophenol by ascorbic acid was used until obtaining a pink coloration persisting for 15 seconds. For cassava leaves and tubers, it was impossible to perform the determination because HCN present in the plant tissues led to a strong and very rapid discoloration. *(Summary by H.J.S.)* C03

0165-0416 OYENUGA, V. A. and AMAZIGO, E. O. **A note on the hydrocyanic acid content of cassava** (*Manihot utilissima* **Pohl).** West African Journal of Biological Chemistry 1(2):39-43. 1957. Engl., Sum. Engl., 9 Refs.

Cassava. Toxicity. Composition. HCN content. Water content. Cortex. Tubers. Pulp. Cultivars. *Manihot esculenta.*

In the estimation of the HCN and the moisture content of 6 cassava varieties grown in Nigeria, it was found (1) that all the varieties contain sufficient amount of HCN in their roots to make them toxic to livestock; (2) the peel contains from 5-10 times the concentration of HCN in the pulp; this makes it safe to eat most of the cassava varieties raw since the bulk of the HCN is removed upon peeling; (3) the flesh of the Nigerian Local 37, 5 and 75 contains enough HCN to make them poisonous, particularly under wet conditions; (4) cassava roots are more wholesome if harvested from wet than from dry soil; and (5) the peels of these varieties constitute 18% of the whole root. *(Author's summary)* C03

0166-0663 CHITHARANJAN NAIR, N. and KURUP, P. A. **Phosphorylase inhibitor in the rind of tapioca tuber.** Naturwissenschaften 50:667. 1963. Engl.

Cassava. Tubers. Analysis. Enzymes. Biochemistry. Pulp. Cortex.

It was found that alcoholic extract of the cassava tuber pulp and also the fleshy portion of the tuber contain and inhibitor of phosphorylase activity. Brief notes are given on this subject. Detailed investigation of the isolation and nature of the inhibitor in cassava peel is in progress. *(Summary by H.J.S.)* C03

0167-1847 AGRAWAL, M. and KRISHNAN, P. S. **An unspecific metaphosphatase from the leaves of the tapioca plant** *(Manihot utilissima).* Enzimologia 21(1):18-22. 1959. Engl., Sum. Engl., Germ., 9 Refs.

Cassava. *Manihot esculenta.* **Biochemistry. Enzymes. Leaves. Cassava starch. Analysis. Laboratory experiments.**

An unspecific phosphatase has been purified partially, starting from the leaves of the cassava plant. The enzyme acts on a wide variety of condensed phosphates— the lower linear, the cyclic and the higher linear phosphates. The Michaelis constants have been determined for the various substrates. *(Author's summary)* C03

0168-1800 FIGUEIREDO, A. DE A. and REGO, M. M. DO. **Teor proteico e mineral em raizes e folhas de mandioca.** *(Protein and mineral content of cassava roots and leaves).* Boletim Técnico do Centro de Tecnologia Agricola e Alimentar no. 5:23-25. 1973. Port., Sum. Port., Engl., 6 Refs.

Cassava. Tubers. Leaves. Composition. Protein content. Mineral content. Sodium. Iron. Copper. Zn. Manganese. Brazil.

Results are given of the protein content,as well as the level of essential minerals, in cassava roots and leaves. Sodium, iron, copper, zinc, manganese and the crude protein content of roots and leaves of 7 varieties were determined. The roots have a higher mineral content than the leaves. The level of protein found in the roots was about 8 times lower than in the leaves. *(Author's summary)* C03

0169-1803 NOBRE, A., CONSTANTINO, E. and NUNES, W. DE O. **Seleção de variedades e clones de mandioca visando un melhoramento proteico.** *(Selection of cassava varieties and clones to obtain a higher protein content).* Boletim Técnico do Centro de Tecnologia Agricola e Alimentar no. 5:15-21. 1973. Port., Sum. Port., Engl., 11 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Clones. Selection. Composition. Tubers. Leaves. Protein content. Dry matter. HCN content. Brazil.**

The protein content was determined in roots and leaves of 121 varieties and 38 clones of cassava grown at the Ministry of Agriculture Experiment Station in the state of Rio de Janeiro. The analyses were carried out on the peel, pulp, whole root, and the leaves of twelve-month-old plants. The average protein content of all varieties was as follows: Peel, 2.20%; pulp, 1.23%; whole root, 1.45%; and leaves 22.10%. The varieties

Mulatinha, Xingu, IAN-S-12, Cenoura, Cacau, Manteiga, Ponta de Lanceta, Amazonia, Saracura, Amazonia Branca, Bahia Preto and Pão de Ouro and the clones 418-64-2 and 438-54-1 presented a protein content above 2.0%. These varieties and clones were selected with the purpose of increasing protein content through intervarietal breeding. The variety Saracura-696, containing 2.84% protein in the roots and 28.40% in the leaves, crossed with **Manihot** sp. 2399, containing 3.72% protein in the roots and 28.70% in the leaves, gave a hybrid (F_1) with 3.63% protein in the roots and 33% in the leaves. The variety Saracura-696 crossed with **Manihot** sp. 2401 containing 3.17% protein in the roots and 21.30% in the leaves, gave a hybrid (F_1) with 3.01% in the roots and 34.20% in the leaves. The protein content of the leaves in the hybrid was thus significantly increased. The HCN content in the hybrid roots was twice as high as in the parents. *(Author's summary)* C03 G01

0170-3391 ROGERS, D. J. **Cassava leaf protein.** Economic Botany 13(3):261-263. 1959. Engl., 2 Refs.

Cassava. Leaves. Protein content. Cultivars. Composition. Jamaica.

Sixty-one cassava cultivars from Jamaica were grown and their leaves were analyzed. Samples were taken from plants 11-12 months old. Leaves of varying size (from just mature to small ones underdeveloped at the stem apex) were included in the samples for each plant. Petioles were not included. Crude protein content (dry weight) ranged from 20.6-36.4%. It is not known whether cassava protein is nutritionally complete, but the high content of crude protein indicates that there is a possibility for cassava leaves to be used in protein-rich diets. *(Summary by H.J.S.)* C03

T-898

0171-0940 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. **HCN content of cassava.** *In* ______. Quarterly Research Bulletin no. 15. 1966. pp. 15-16. Engl.

Cassava. HCN content. Gari. Water content. Analysis. Composition. Food products.

Brief notes are presented on two items: HCN content of cassava and moisture content of gari. Methods to analyze HCN content were studied because the traditional methods of preparing cassava in Nigeria eliminate the HCN in the process. Two methods were tested to measure the moisture content of gari; results obtained with these methods were in reasonable agreement. *(Summary by H.J.S.)* C03 I02

0172-1802 JOIA, J. **Aparelho para dosagem do acido cianhidrico em mandioca e seus produtos.** *(Apparatus to determine hydrocyanic acid in cassava roots and its products).* Boletim Técnico do Centro de Tecnologia Agricola e Alimentar 5:27-30. 1973. Port., Sum. Port., Engl., 7 Refs., Illus.

Cassava. HCN. Analysis. Laboratory experiments.

A description is given of an apparatus that distills the HCN resulting from the autolysis of the cyanogenetic glucoside (linamarin) found in cassava and in some of the products obtained from it. This distillation is accomplished with the help of a stream of nitrogen. The apparatus is advantageous because the whole process can be carried out without having to dismount it, thereby avoiding the loss of the HCN that is liberated. After distillation, the HCN is determined by measuring the color intensity of the reaction with picric acid in an alkaline medium. *(Author's summary)* C03

0173-3403 NARTEY, F., MOLLER, B. L. and ANDERSON, M. R. **The major constituents of cassava seeds.** Tropical Science 15(3):273-277. 1973. Engl., Sum. Engl., 20 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Seed. Composition. Fat content. Protein content. Uses.**

In a general study of *Manihot esculenta* Crantz (syn. *M. utilissima* Pohl), the major constituents of the seeds were investigated. This paper, the third in the study series, is a preliminary report. Seed kernels were found to constitute 57% of the dry seeds and to be very rich in lipid materials which accounted for 47% of the kernel dry weight. Chromatographic resolution of the total lipids into lipid classes showed that 98% were triglycerides. Di- and monoglycerides, phospholipids and glycolipids occurred in trace amounts and constituted 2% of the total lipids. No free fatty acids could be detected. Protein accounted for 34% of the kernel dry weight, whereas the soluble nitrogenous component accounted for only 0.13%. The starch content was found to be very low, accounting for only 0.3% kernel dry weight, as compared with a relatively high concentration of soluble carbohydrates, which accounted for 3.8%. Organic-bound phosphate was found to be present at a relatively high level and accounted for 1.36% as compared with inorganic phosphate, which occurred to the extent of only 0.08%. The endosperm constituted 96% of the dry kernel. Electron microscope studies showed that both the endosperm and embryo contained large amounts of lipid globules and protein bodies. It was concluded that the occurrence of 47% lipids (composed mainly of triglycerides) as the major storage reserve in the seed of *M. esculenta* makes the seed a potential source of dietary and industrial fats. Similarly, the occurrence of protein to the extent of 34% makes the seed a potential source of dietary protein in the developing countries where the plant is extensively cultivated for its starchy root tubers. *(Author's summary).* C03.

0174-0330 WOOD, T. **The cyanogenic glucoside content of cassava and cassava products.** Journal of the Science of Food and Agriculture 16:300-305. 1965. Engl., Sum. Engl.

Cassava. Cyanogenic glycosides. Tubers. Cortex. Gari. HCN content. Dried tubers. Processed products. Cassava flour. Cassava products. Leaves. Analysis. Composition. *Manihot esculenta.*

A simple and rapid procedure has been developed for assaying the cyanogenic glucoside in cassava preparations. The HCN was liberated from the ground tissue by autolysis, followed by treatment with acid. It was distilled in a sodium carbonate solution and later reacted with picric acid to yield orange-colored isopurpuric acid. The reproducibility and reliability of the assay were evaluated using plant material and aqueous extracts of the glucoside. Values were obtained for the HCN content of peeled cassava roots, leaves, peels, konkonte flour and gari. More than 100% variation was found in the content of neighboring sectors of the same tuber. It was confirmed that the peel is a rich source of glucoside. *(Author's summary)* C03 H01

0175-0280 OYENUGA, V. A. **The composition and nutritive value of certain feedingstuffs in Nigeria. I. Roots, tubers, and green leaves.** Empire Journal of Experimental Agriculture 23(90):81-95. 1955. Engl., Sum. Engl., 16 Refs.

Cassava. *Manihot esculenta.* **Tubers. Fresh products. Composition. Dry matter. Protein content. Fibre content. Carbohydrate content. N. Human nutrition. Animal nutrition. Nutritive value. Starch content. Yams. Sweet potatoes. Cassava leaves (vegetable). Nigeria.**

The chemical composition and the calculated nutritive values of the commonly grown roots and tubers and certain leaves used as fodder in Nigeria were examined. They were found to be valuable sources of carbohydrate, cassava being one of the richest in this nutrient. The least popular of the yam varieties, *Dioscorea dumetorum*, contained more proten, while water yam *(D. alata)* was somewhat richer in ash than any of the other roots. The peels of these roots and tubers were relatively rich in protein oil and ash, as well as crude fiber. They should therefore provide a valuable addition to the nutrition of rumiants in those parts of Nigeria that grow roots and tubers in quantity. *(Author's summary)* C03 H01

0176-1859 JOSEPH, A. **Influence de la technologie traditionnelle du manioc sur les teneurs en éléments mineraux et en phosphore phytique.** *(The effect of traditional cassava processing on minerals and phytin-phosphorus contents).* Annales de la Nutrition et de l'Alimentation 27(3):125-139. 1973. Fr., 11 Refs.

Cassava. Processing. Drying. Storage. Steeping. Cooking. Human nutrition. Tubers. Processed products. Cassava flour. Cassava pastes. Foofoo. Chickwange. Nutrient loss. Mineral content. Composition. Gari. Phyticphosphorus. P.K. Ca. Na. Ash content. Cameroon.

Changes in minerals and in phytic acid P of cassava roots during preparation of the following traditional foods were studied: (1) peeled, cooked and washed tubers, (2) sticks or balls of cooked paste, (3) smoke-dried flour, and (4) sun-dried flour. Effects of cooking, soaking, method of drying and storage on ash, total P, phytin-P, Ca, K and Na contents are shown in tables. Considerable fluctuations were observed, with total ash losses of up to 83.7% in (1): When peeled tubers for (2) were soaked before cooling, phytin-P was completely degraded by enzymic hydrolysis. Except for (1), methods of preparations did not cause demineralization, and the Ca| P ratio of all products was in the range 0.51-0.79. *(Summary by Food Science and Technological Abstracts)* C03 102

0177-3167 MOTA, T. P. **Caraterísticas quimico-analiticas de algumas mandiocas em ensaio.** *(Chemical-analytical characteristics of some cassava).* Agronomia Moçambicana 4(1):21-29. 1970. Port., Sum. Port., Engl., Fr. 8 Refs., Illus.

Cassava. *Manihot esculenta.* **Analysis. HCN content. Fat content. Productivity. Pulp. Composition. Cultivars. Starch content. Fibre content. Mineral content. N. Cortex. Ash content. Sweet cassava. Bitter cassava. Mozambique.**

Samples of 6 cassava cultivars being tested at the Agricultural Station of Nhacoongo were analyzed physically and chemically. Peel and pulp fractions were separated by hand. Peel fractions ranged from 14.06 to 20.64; pulp ranged from 77.94 to 85.94% of the fresh root. The resulting fractions were analyzed for moisture, ash, nitrogen, crude fat, starch, crude fiber and hydrocyanic acid. From analyses of HCN the cultivars Cerigano, Gangassol and Sabuarara were classified as nonpoisonous and those of Maquela, Eng. Valente and H-35 as highly poisonous. Comparing the results of this study with analyses required in Holland and Belgium for cassava imported from Thailand, Tanzania and other countries, the good quality of the experimented cultivars was verified. *(Author's summary)* C03.

0178-3684 THAKUR, M.L., SOMAROO, B. H. and GRANT, W. F. **The phenolic constituents from leaves of** *Manihot esculenta.* Canadian Journal of Botany 52(11):2381-2386. 1974. Engl., Sum. Engl., Fr., 15 Refs., Illus.

Cassava. *Manihot esculenta.* **Leaves. Analysis. Composition. Phenolic constituents. Laboratory experiments.**

Fifty-five phenolic constituents were extracted with methanol (1% HCl) at room temperature from dried leaves of cassava (*Manihot esculenta* Crantz). By means of thin-layer chromatographic and spectrophotometric techniques, the 20 main phenolic constituents were identified as quercetin and luteolin glycosides, chlorogenic acid esters of π-coumaric, caffeic, ferulic and sinapic acids, and the glycosides of caffeic and ferulic acids. Benzoic acid derivatives were also confirmed. Acid and alkaline hydrolysis of the major compounds was carried out to determine their aglycones. Ultraviolet (UV) spectral data, Rf values, fluorescence in UV light, and color reactions with chromogenic spray reagents of the phenolic compounds and the aglycones are presented. The sugar residues of the major flavonoid compounds were identified as glucose. *(Author's summary)* C03

0179-1576 BASSLER, R. and PUTZKA, H. A. **Der Blausaurereglykosidgehalt von Maniokprodukten, seine Lokalisation und Veranderung beim Trocknen.** *(The cyanogenic glucoside content of cassava products, its location and modification in drying).* Landwirschaftliche Forschung. 27(3|4):211-221. 1974. Germ., Sum. Germ., Engl., Fr., 11 Refs., Illus.

Cassava. Cassava products. Pellets. Tubers. Composition. HCN content. Temperature. Drying. Cortex. Pulp. Analysis. Storage. Cyanogenic glycosides. Detoxification. Detoxification processes. Sweet cassava. Bitter cassava. Germany.

On the basis of a frequency distribution, a survey was made on the separable content HCN of 1971-73 cassava samples from Thailand. Fresh cassava roots from Angola were tested for the accuracy of their designation as sweet or bitter, both the total content in separable HCN and the distribution of the cyanogenic glucosides in the cortex and pith were ascertained. By model test, the extent to which the separable HCN content of the fresh roots can be reduced by drying, was verified, especially by brief heat treatment. In relation to deep-frozen base material subsequently dried (45°C) for preservation, the reduction of the initial HCN content in cortex and pith was separately ascertained. The very much greater reduction with the first texture during the drying makes it understandable that the pronouncements enabled by microscopic examination with fresh roots, concerning the distribution of separable HCN, cannot be assigned to dried material. *(Author's summary)* C03 H04.

0180-3398 ZITNAK, A. **Assay methods for hydrocyanic acid in plant tissues and their applications in studies of cyanogenic glycosides in *Manihot esculenta*.** *In* Chronic Cassava Toxicity;proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp.89-96. Engl., Sum. Engl., Fr., 31 Refs.

Cassava. Roots. HCN. Cyanogenesis. Enzymes. Analysis. Linamarin. Toxicology. Linamarase. Plant tissues. Cyanogenic glycosides. Cyanides. *Manihot esculenta*. Toxicity.

A survey of cyanide assay methodology is presented with particular reference to the determination of linamarin, the cyanogenic glucoside of cassava, *Manihot esculenta* Crantz, and some of the problems in obtaining reliable estimates and reproducible data on potentialcyanide yield. The measurement of potential cyanide output from plant tissues is a convenient method for medical and toxicological studies as it represents an index of health hazard; therefore, the actual glucoside content receives little attention even in agronomic studies. Linamarin is unusual in that it is not readily hydrolyzed by acid; therefore, endogenous or added linamarase must be employed in the release of cyanide. Since the activity of this enzyme in cassava tissues was only recently elucidated, many of the earlier reports on cyanide yield from these tissues are of dubious value. The peculiarities of the cyanide assay are reviewed in respect to the principal phases of analytical procedure; namely, the release of cyanide from the glucoside, the isolation or recovery of cyanide, and finally, its analytical determination. Because of the reactivity of the cyanide ion, its volatility and the lengthy incubation for enzymic hydrolysis, the crucial point of a reproducible technique is the total release and isolation of cyanide from the substrate and prevention of losses due to the secondary reactions or to the escape of cyanide from analytical train. It is unfortunate that few research papers have concerned themselves with the reproducibility of given methods and their analytical data, particularly regarding the recovery of cyanide added to plant tissue homogenates. The errors arising from sampling bulky plant materials, such as cassava roots, and their preparation for analysis – the two aspects of analytical work which in the past have received little attention or are only superficially covered in published reports – are also discussed. *(Author's summary)* C03

0181-0471 PACHECO, J. A. DE C. and CONAGIN, A. **Amostragem de raizes de mandioca para determinação de amido.** *(Sampling methods for determining the starch content in cassava roots).* Bragantia 14:25-26. 1955. Port., Sum. Port., Engl., 1 Ref.

Cassava. Starch content. Analysis. Composition. Tubers. Brazil.

Four sampling methods were compared for determining the starch content in roots of individual cassava plants or in mixed roots from 5 plants chosen at random. The methods were as follows: (A) A lengthwise section (⅛ of the diameter) was taken from every root in the sample. (B) A section was taken from every root in the sample, as in A; each of these sections was then divided into 3 parts (botton, middle and top). A 5-cm-long cross section was taken from the middle of each of the 3 parts to compose the sample. (C) The roots were divided into 2 groups (thick and thin) and then ordered according to size. The median root was selected from each group, and a lengthwise sector (¼ of the diameter) was taken from the 2 roots and used for analysis. (D) From each root selected as in C, a ¼ lengthwise section was taken; 5-cm-long cross sections were used from the bottom, middle and top. Method A was used as a parameter since it included a proportional part of every root in the sample, thus eliminating the variation between roots and between parts of the same root. Sampling method C gave the results closest to the parameter, followed by B and D. Since samples obtained using method C were small and easy to prepare, this method is recommended as satisfactory. The results concerning the number of plants in the samples were not conclusive. Preliminary evidence indicated that variation in starch content is greater between parts of the root (top, middle and bottom) than between the roots themselves. *(Author's summary)* C03.

0182-0388 RAMOS-LEDON, L. J. and POPENOE, J. **Comparative chemical composition of cultivars of *Manihot esculenta* Crantz and some related species.** Proceedings of the Tropical Region. American Society for Horticultural Science 14:232-234. 1970. Engl., Sum., Engl., Span., 19 Refs.

Cassava. Ash content. N. Cultivars. *Manihot esculenta.* Leaves. Analysis. Roots. Composition. Protein content. *Manihot tweedicana. Manihot glaziovii. Manihot dichotoma.* Petioles. Plant anatomy. Carbohydrate content. Water content. *Manihot angustiloba.* Tubers.

A survey of several species of **Manihot** revealed protein levels in the leaves ranging from 2.92—7.76 g| 100 g on a fresh weight basis. The protein levels in the leaves of *M. tweedicana* and *M. glaziovii* were similar to cassava, but were lower in *M. dichotoma* and *M. angustilova.* Additional species should be surveyed. Four-month-old cassava (*Manihot esculenta* Crantz) cultivars, contained levels of protein in the range of 6.29—8.30 g| 100 g in their leaf blades. The concentration of nitrogen and protein in cassava leaves decreased after root enlargement and seed formation but tended to remain constant during the year for those cultivars in a vegetative stage. Protein in the roots was in the range of 0.59 — 1.95 g| 100 g, the lowest level of protein in the whole plant. The cultivars studied showed remarkable phenotypic differences in leaf morphology, root color and growth habits. In an effort to find some relation between phenotype and high protein, several cultivars were compared, but no correlation could be established. Additional cassava clones should be studied. The high level of protein in cassava leaves grown in low-fertility soil indicates the plant's high capacity for N uptake and protein synthesis. It seems reasonable to suggest that this capacity is determined by phylogenetic factors developed by this species during its evolutionary history. *(Author's summary)* C03

0183-0596 FOO, L. C. and CHEW, M. Y. **Determination of water-soluble protein in tapioca (*Manihot utilissima*) leaf.** Malaysian Agricultural Journal 48(4):347-353. 1972. Engl., Sum. Engl., 20 Refs.

Cassava. *Manihot esculenta.* Leaves. Protein content. N. Composition. Analysis.

The crude protein of a cassava (Kekabu variety) leaf calculated from its N content (N x 6.25) was 6.2 g| 100 g leaf fresh weight. The presence of phenolics in tapioca leaf extract interfered in the colorimetric determinations of protein. Polyclar AT removed about 76% of the phenolics in the leaf extract. The modified Lowry's method afforded a water-soluble protein content of 0.22 g| 100 g leaf fresh weight for the Polyclor AT-treated leaf extract. On the other hand, the value calculated from the N content of the protein precipitate (N x 6.25) was only 0.043| 100 g leaf fresh weight. *(Author's summary)* C03

0184-0468 CORREIA, F. A. **Acido cianídrico em algunas variedades de mandioca.** *(Hydrocyanic acid in some varieties of cassava).* Bragantia 7:15-22. 1947. Port., 4 Refs.

Cassava. HCN content. Laboratory experiments. *Manihot esculenta.* Composition. Cultivars. Analysis. Tubers. Brazil.

Depending on the variety, the amount of HCN in the entire root of *Manihot utilissima* varies from 0.065 to 0.015%. When the roots are grated and dried, 54 to 87% of the HCN disappears. The peel, which is 17.06% of the fresh root, contains 60% of the acid, practically all of which is destroyed when the root is cooked. *(Summary by Chemical Abstracts)* C03 H04.

0185-0598 MARCANO L., J. **Determinación del rendimiento y contenido de ácido cianhídrico en algunas variedades de yuca (*Manihot utilissima* Pohl).** *(Determination of yields and hydrocyanic acid content in some cassava varieties).* Agr. Eng. Thesis. Jusepin, Monagas, Venezuela, Universidad de Oriente, Escuela de Ingeniería Agronómica, 1965. 13p. Span., Sum. Span., 12 Refs.

Cassava. Composition. HCN content. oductivity. Cultivars. Analysis. Venezuela.

A study was conducted to determine the yields and HCN content of 12 local varieties of cassava. The yields of these varieties varied between 23,200 and 56,000 kg| ha. Obviously, the adoption of the highest yielding varieties will permit a much greater output per unit area. As concerns HCN content, these varieties may be classified as sweet or bitter. The bitter types have a HCN content between 1.162 and 1.672 mg| 10 g of cassava, whereas in sweet types it ranges between 0.259 and 0.510 mg| 10 g of cassava. *(Author's summary. Trans. by N. U.)* C03

0186-2347 MARVALHAS, N. **Carotenoldes de** ***Manihot esculenta*** **Crantz.** *(Carotenoids of Manihot esculenta Crantz). In* ________. Cinco estudos sobre a farinha de mandioca. Brasil. Instituto Nacional de Pesquisas da Amazonia. Publicação no. 6. 1964. pp. 35-38. Port., Sum. Engl., 6 Refs.

Cassava. Analysis. Proteins. Cultivars.

The yellow varieties of cassava (*Manihot esculenta* Crantz) are only cultivated in certain parts of the Amazon Valley. In previous work the author identified the pigments as carotenoids. In the present paper the relative amounts of α and β-carotene and 2 hydroxycarotenes (probably xanthophyll and cryptoxanthin), are determined. The pigments are separated from the roots in a very original way as a mass precipitate of protein and carotene complex. This mass is extracted with appropriate solvent and chromatographed on an alumine column. The relative amounts found for 100 g of fresh material were α-carotene 1.35 mg; β-carotene 0.5 mg and hydroxycarotenes 0.5 mg. The proportion of α-carotene is higher than that of β-carotene and hydroxycarotenes. The occurrence of a relatively high amount of carotenes in reserve organs of **Euphorbiaceae** is reported for the first time. *(Author's summary)* C03

0187-3270 VISWANATHAN, P. N. **Metabolic activity of starch granules from the tapioca** ***(Manihot utilissima)*** **plant: IV - Further studies on the enzymes make-up of starch granules.** Indian Journal of Biochemistry 4(1):6-8. 1967. Engl., 20 Refs.

Cassava. Tubers. Enzymes. Laboratory experiments. Sugars. Cassava starch. Analysis. Research. Biochemistry.

Additional studies with starch granules isolated from cassava tubers revealed that the starch synthesizing activity of the granules with ADPG (adenosine diphosphate α-D-glucose) as the substrate was not significantly different from that with UDPG (uridine diphosphate α-D-glucose). About 55% of total nucleoside diphosphate kinase activity present in the whole tuber homogenate was also present in the granules. ADPG-pyrophosphatase and ADPG-(UDPG-) phosphorylase activities were absent. Soluble starch synthetase was apparently absent in the tuber. *(Author's summary)* C03

0188- 4644 *BYERS, M. **Extraction of protein from the leaves of some plants growing in Ghana.** Journal of the Science of Food and Agriculture 12:20-30. 1961. Engl, Sum. Engl, 11 Refs.

Cassava. Leaves. Protein content. Analysis. Ghana.

Extracts were made from the fresh leaves of 60 tropical species by mincing them and squeezing the resultant pulp through cotton cloth. Total N and protein N determinations were made on the extracted juice, and the percentages of total N and protein N extracted and total N remaining in the fiber were calculated. Small samples of crude protein were precipitated from the sap at 80° and analyzed for total N. Results were classified according to the extractability of protein N from the leaf and to the protein content of the product isolated. As regards cassava, pH levels of extracts were not adjusted during N and protein analyses. Two samples of bitter cassava *(Manihot utilissima)* were extracted from leaves 6- and 7-weeks-old. Six-week-old leaves (pH 5.9) yielded 18.2% total N, 11.6% protein N and crude protein with 7.67% N. Seven-week-old leaves (pH 6.0) yielded 13.9% total N, 9.5% protein N and 7.01% crude protein N. The cassava samples were among the lowest yielders of crude protein N. *(Author's summary)* C03

0189-3334 ESQUIVEL, T. F. **Rapid field method for evaluating hydrocyanic toxicity of cassava root tubers.** Journal of Agricultural and Food Chemistry 21(2):321-322. 1973. Engl., 4 Refs.

Cassava. HCN. HCN content. Composition. Analysis.

A simple and rapid method is described for evaluating the HCN content of cassava roots in the field. This method uses the benzidine-blue test, is reliable and can be performed in a few minutes. *(Author's summary)* C03

0190-0542 SPLITTSTOESSER, W. E. and RHODES, A. M. **Protein and amino acid values of some tropical root crops.** Illinois Research 15(4):6-7. 1973. Engl. Illus.

Cassava. *Manihot esculenta.* **Starch crops. Composition. Protein content. Yams. Amino acids. Taro.**

Protein (dry weight basis) and amino acid values were studied in yams, cassava, sweet potatoes and some aroids at the Federal Experimental Station in Mayagüez (Puerto Rico). Results of the analyses were compared to the FAO Reference Protein. Tryptophane could not be measured because it was destroyed during analysis. Upon hydrolysis, cystine yielded cysteine, reported here as half cystine. *(Summary by J.L.S.)* C03

0191-0503 CHEW, M. Y. and BOEY, C. G. **Rhodanese of tapioca leaf.** Phytochemistry 11(1):167-169. 1972. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. Leaves. Rhodanese. *Manihot esculenta.* **Enzymes. Thiocyanates. Cyanides. Biochemistry.**

Rhodanese activity was detected in a crude extract of cassava *(Manihot utilissima)* leaves. Optimal activity was found at a high pH (10.2-11.0) and temperature (57-50°F). Under these conditions, rhodanese from 0-5 ml of the crude extract (75 mg leaf fresh weight) catalyzed the formation of 10.2 μmoles thiocyanate per 15 min. *(Author's summary)* C03

0192-0527 KETIKU, A. O. and OYENUGA, V. A. **Preliminary report on the carbohydrate constituents of cassava root and yam tuber.** Nigerian Journal of Science 4(1):25-30. 1970. Engl., 18 Refs.

Cassava. Cellulose. Sugars. Sucrose. Maltose. Glucose. Fructose. Yams. Soluble carbohydrates. Composition. Starch content. *Manihot esculenta.* **Tubers.**

Cassava root *(Manihot utilissima)* and yam tuber *(Dioscorea rotundata)* contain sucrose, maltose, glucose and fructose. Sucrose is the major moiety. Starch constitutes the bulk of soluble carbohydrates in both yam and cassava. Processing of yams into "clubo" increases the total and reducing sugars and leads to the hydrolysis of suc ose and maltose to glucose and fructose. Peeling may activate hydrolytic enzymes which degrade disaccharides during processing. *(Summary by Biological Abstracts)* C03

0193-3810 COLLENS, A. E. **Bitter and sweet cassava; hydrocyanic acid contents.** Trinidad and Tobago Bulletin 14(2):54-56. 1915. Engl.

Cassava. Sweet cassava. Bitter cassava. HCN content. Laboratory experiments. Stems. Tubers. Detoxification processes.

This experiment determines the yield of HCN by hydrolysis on distillation of a portion of the stem of bitter cassava plant. Since the sample had been partially dried before the analysis, it was thought advisable to repeat the experiment, determining the yield of HCN obtained from different parts of freshly dug cassava. The experiments were also designed to ascertain whether the percentage of HCN was constant throughout the roots or variable. The yield of HCN was also determined in roots 3 days after harvest. The HCN content increased due to loss of water in the roots during the drying process. *(Summary by L.C. Trans. by T.M.)* C03

0194-3865 **CASSAVA FROM COLOMBIA.** West Indies Bulletin 4:74-78. n.d. Engl.

Cassava. Cultivars. HCN content. Toxicity. Water content. Starch content. Jamaica.

In 1901 some 17 new varieties of cassava were introduced to the West Indies from Colombia, where there are few poisonous varieties. Chemical analyses show that Colombian cassava is high in starch content and practically free of HCN. Studies should be made to see whether this will increase with acclimatization Results of the analyses of the introduced varieties are given in tables. The distribution of HCN and starch content in both sweet and bitter cassava is also given. *(Summary by L. C. Trans. by T.M.)* C03

0195-0782 GREENSTREET, V. R. **Studies on tapioca. III. Further notes on the determination of phosphoric acid in tapioca material by the coeruleo-molybdate method.** Malaysian Agricultural Journal 17:210-212. 1928. Engl.

Cassava. Deficiencies. Analysis. Tubers. Fertilizers. Farmyard manure. Soil impoverishment. Soil fertility. Petioles.

To determine soil impoverishment by cassava,the levels of phosphoric acid were determined in various samples of cassava material and fertilizers. Results were compared to the molybdate-magnesia gravimetric method. The amounts of phosphoric acid determined by both methods are given in a table. *(Summary by H.J.S.)* C03

0196-4855 LAVOLLAY, J. and BUI—XUAN—NHUAN. **La technique colorimétrique de contrôle rapide de la teneur en acide cyanhydrique des produits alimentaires d'origine végétale.** *(Colorimetric technique for the rapid control of the hydrocyanic acid content of food products of vegetable origin).* Annales de Chimie Analytique 25:212:214. 1943. Fr. Illus.,.

Cassava. HCN. Analysis. Laboratory experiments. Toxicity.

The toxicity of some species of **Manihot** is due to the presence of a glucoside containing HCN. The method here proposed depends upon the evolution of HCN by diastic fermentation in a buffered solution of pH 6, removal of the HCN after an hour's digestion at 32-34° by a current of air, absorption of the HCN in a solution of sodium picrate and colorimetric determination by comparing the reddish tint produced in the yellow picrate solution with standards. *(Summary by Chemnical Abstracts)* C03

0197-4391 HOWELL, D. D. **Symptoms of nutrient deficiency of cassava (*Manihot esculenta* Crantz).** M. Sc. Thesis. Guelph, Ontario, University of Guelph, 1974. 13p. Engl., Sum. Engl., 2! Refs., Illus.

Cassava. *Manihot esculenta*. Deficiencies. Mineral defiencies. Minerals. Iron. Copper. Zn. Boron. N. S. P. K. Manganese. Laboratory experiments.

Cassava (*Manihot esculenta* Crantz) was grown in sand cultures using nutrient solutions to produce color photographs of the macro- and micronutrient deficiency symptoms of boron and manganese. Potassium deficiency symptoms appeared as a browning of the tips of the leaflets; Mg deficiency symptoms appeared as a chlorosis of the leaf margins which extended inward as the deficiency progressed. Manganese and iron deficiencies appeared on expanding leaves as an interveinal chlorosis. Symptoms of the 2 deficiencies were similar except that severe Fe deficiency produced leaves totally devoid of chlorophyll. Copper deficiency produced severe curling and twisting of expanding leaves, together with a distinctive interveinal chlorosis. Zinc deficiency produced necrotic spotting, interveinal chlorosis and apical dieback. Plants with a N, P or S, deficiency were similar in appearance. Symptoms were pale green bottom leaves and the yellowing and browning of the leaflet tips. Toxic Mn concentrations produced daytime wilting but recovery occurred at night. Boron toxicity produced necrotic spots and browning of the leaf margins on lower leaves. It was concluded that N, P, S and B deficiencies could not readily be diagnosed by deficiency symptoms. Iron, Mn, Cu and Zn deficiencies may be diagnosed if all other growing conditions are good. Boron and Mn toxicity symptoms can probably aid in identifying excessive amounts of these elements. *(Author's summary)* C03

0198-3423 PERISSE, J. and LE BERRE, S. **Etude de la valeur alimentaire de variétés de manioc récemment introduites au Togo.** *(Study on the nutritive value of cassava varieties recently introduced into Togo).* Lame, Institut de Recherches du Togo, 1958. 11p. Fr. 5 Refs.

Cassava. Cultivars. Cultivation. Productivity. Analysis. Composition. Water content. N. Fat content. Ash content. Ca. HCN content. Energy productivity. Starch content. Nutritive value. Mineral content. Togo.

The varieties B39, B17, B8, B25, B50, B54, B53 and Tabouka were introduced from the Ivory Coast to compare them with the local varieties, Goula and Kataoli. The aim of this trial was to select the highest starch-yielding varieties. Methods for the evaluation of water, N, lipid, ash, Ca and HCN content, as well as the energy value of the above varieties, are presented. *(Summary by J.L.S.)* C03

T-1511

0199-3468 CHEW, M. Y. **Cyanide content of tapioca** *(Manihot utilissima)* **leaf.** Malaysian Agricultural Journal 48(4):354-356. 1972. Engl., Sum. Engl., 7 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Leaves. HCN content. Composition. Analysis. Malaysia.**

The cyanide content of the cassava (*Manihot utilissima)* leaf was determined. The average value from 18 varieties was 379 ppm (0.0379%) in a fresh, young leaf. Varietal differences ranged from 174-622 ppm. The average moisture content of the leaf was 69.9%. *(Author's summary)* C03

0200-3037 SADIK, S., OKERERE, O. U. and HAHN, S. K. **Screening for acyanogenesis in cassava.** International Institute of Tropical Agriculture. Technical Bulletin no. 4. n.d. 4p. Engl., Sum. Engl., 9 Refs.

Cassava. *Manihot esculenta.* **Cyanogenesis. HCN. Analysis. Leaves. Selection.**

The sodium picrate test for HCN was used to evaluate 88,510 cassava plants for their cyanogenic content. No acyanogenic plants were found. A small number of plants exhibited a low to medium degree of cyanogenesis while the rest of the plants showed a high degree of cyanogenesis. The screening method is simple and sensitive and lends itself to large-scale field screening. *(Author's summary)* C03

0201-0297 OBREGON B., R. **Variación del ácido cianhídrico en 118 clones de yuca** *Manihot utilissima* **Pohl.** *(Variation in hydrocyanic acid of 118 clones of cassava, Manihot utilissima Pohl).* Agricultura Tropical. (Colombia) 24(6):330-334. 1968. Span., 3 Refs.

Cassava. Clones. Dry matter. Alfalfa. HCN content. Protein content. Fat content. Ash content. Water content. Carbohydrate content. Composition.

The proportion of HCN was analyzed in 118 clones of cassava, immediately after harvest and 9 days later. With only air drying, the proportion of HCN was found to decrease notably in all varieties, with the exception of 8. Fifteen clones showed weak HCN reactions and could thus be used immediately after harvest. Sweet varieties showed no great differences in HCN content. Analyses of protein, fat, fiber, ash, moisture, carbohydrates and dry matter are given, based on the average of 16 varieties, and compared to alfalfa. *(Summary by P.A.C.)* C03

0202-3194 MOH, C. C. and ALAN, J. J. **The use of Guignard test for screening cassava cultivars of low hydrocyanic acid content.** Tropical Root and Tuber Crops Newsletter no. 6:29-31. 1973. Engl.

Cassava. HCN content. Analysis. Cultivars. Composition.

The poisonous nature of cassava due to HCN might cause medical problems when people use it as main dietary material. The fundamental solution to this problem is to cultivate cassava free of HCN. To select the planting material, it is neccessary to screen a large population of cultivars. Quantitative methods for determining the HCN released from the glucosides give accurate results, but the methods are usually tedious and time consuming. The Guignard test, a qualitative method, is more practical for the screening process. Ninety-five cultivars were tested. It was found that (1) no cultivar had an HCN content low enough to be undetectable by the Guignard test (once a cultivar gives a negative reaction, a more precise quantitative determination of the HCN can follow). (2) The leaves and the inner peel had the highest concentration of HCN in almost all the cultivar tested; the core (edible portion) had the second highest, and the outer cork layer of the peel and the central pith had the lowest. *(Summary by H.J.S.)* C03

0203-2096 LE BERRE, S., GALLON, G. and TABI, B. **Teneur en vitamine C dans les tubercules et le plantain du Cameroun avant et apres cuisson.** *(Vitamin C content of Cameroon tubers and plantains before and after cooking .* Annales de la Nutrition et de L'Alimentation 23(1):31-45. 1968. Fr.

Cassava. Yams. Taro. Sweet-potatoes. Human nutrition. Cooking. Starch crops. Cocoyams. Ascorbic acid. Composition. Protein content. Carbohydrate content. Ash content. Mineral content. Tubers. Banana-plantains. Cameroon.

The article has two sections: the first is devoted to tubers and the second to plantains. The Cameroon tubers are cassava *(Manihot utilissima)*, yam (**Dioscorea** sp.), taro (**Colocasia** sp.), sweet potatoes *(Ipomoea batatas)* and macabo (or cocoyam) (**Xanthosoma** sp.). The cassava was freshly dug or kept for up to 78 h, but the storage period of the others was not known. Tables give the value for the total ascorbic acid estimated with 2,4-dinitrophenylhydrazine before and after the tubers were boiled for a long time in 3-12 samples at each of 4 times of storage for cassava, in 12-14 samples of each of the other species, and the overall average for each time and species. Average values were for proximate composition, Ca, Fe, P, the calculated energy in the edible part, and the proportion of inedible waste. Ascorbic acid ranged from 0.4-2 mg| 100 g of the cooked tuber; and the loss averaged 91% for all species. Cassava cooked when fresh has 3.4 mg| 100 g; after being stored for 78 h, it has 0.5 mg| 100 g. Ranges between species were as follows: protein, 0.8-2.4 g; fat, 0.16-1.0 g; carbohydrates, 21.7-43 g; ash, 0.8-1.2 g; Ca, 21-85 mg; Fe, 1.0-2.0 mg; and P, 28-54 mg| 100 g wet matter. *(Summary by Nutrition Abstracts and Reviews)* C03

0204-2226 SAINT-AMAND, J.D. DE. **Etude de la teneur eh hétéroside cyanogénétique des variétiés de manioc cultivées sur les Hauts-Plateaux de Madagascar.** *(Study on the cyanogenic heteroside content of the cassava varieties grown in the High-Plateaus in Madagascar).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1960. 59p. Fr., 19 Refs., Illus.

Cassava. Climatic requirements. Water requirements (plant). Timing. HCN content. Dry matter Composition. Laboratory experiments. Tubers. Leaves. Petioles. Cultivars. Identification. Analysis. Malagasy Republic.

The cyanogenic heteroside content of 17 cassava hybrids were studied. Two maximum concentration periods of cyanogenic glucoside were established in the tubers. Both periods coincided with the local annual dry season (May-Sep), which was also the period of higher concentration of starch in the tubers. Plants were grown for 2 or 3 years. The same variety showed variable HCN content according to climate, soil, plant age and other factors. HCN concentration was higher during the first year of growth and in plants growing on soils with a high N content. Leaf analysis indicated that HCN content is about 25-55% higher at the end of the day than at the end of the night. There was a possible correlation between results gathered through analysis of N content and HCN content. Varieties were classified according to the percentage of HCN contained in fresh tuber pulp as follows: very sweet (10 mg| 100 g), sweet to slightly bitter (12 mg| 100 g), bitter (12-14 mg| 100 g) and very bitter (more than 14 mg| 100 g). No correlation was found between HCN and starch content in the tubers, but the bitter varieties contained less HCN in the leaves than the sweet varieties. Observations made during the dry season led to the following preliminary classification: very dark red-violet petiole, very sweet varieties; red-violet petioles, sweet varieties; green, more or less mottled red petiole, sweet to bitter varieties, green, more or less tinted red petiole, bitter to very bitter varieties. *(Summary by H.J.S.)* C03

0205-5330 TURNOCK, B.J.W. **An investigation of the poisonous constituents of sweet cassava** ***(Manihot utilissima)*** **and the occurrence of hydrocyanic acid in foods prepared from cassava.** Journal of Tropical Medicine and Hygiene 40(6):65-66. 1937. Engl., Sum. Engl.

Cassava. ***Manihot esculenta.*** **HCN content. Toxicity. Gari. Animal physiology. Cyanogenic glycosides. Sweet cassava. Nigeria.**

The toxic principle of sweet cassava causing fatty degeneration of the liver was due to an extract containing the cyanogenetic glucoside. The processes in use for the preparation of cassava foods do not eliminate the HCN. There is a seasonal variation in the amount of mannitol present in cassava, reaching its maximum from the middle to the end of the rainy season. *(Author's summary)* C03 H04

0206-3367 OKE, O. L. **Leaf protein research in Nigeria: a review.** Tropical Science 15(2):139-155. 1973. Engl., Sum. Engl., 22 Refs.

Cassava. Leaves. Composition. Amino acids. Protein content. Vegetable crops. Human nutrition. Nigeria.

Progress made on leaf protein research in Nigeria is reviewed. The percentage of protein that can be extracted from the green leaves of legumes increases to a maximum of 70% and up to 90% from green vegetables in the first 8 weeks after planting; these levels then decrease to low values (20-40%) after 11 weeks. As much as 3,000 kg protein/ha/yr can be obtained from these leaves, which is about 3 times the amount of protein that would be obtained if the plants were grown for seeds only. The amino acid pattern of leaves is similar to that of animal protein except for the marginal content of methionine. Experiments with rats, rabbits and chicks have shown that the protein is highly digestible (81%) and that it is better than fish meal as a protein supplement for chick rations. For rabbits the best supplementation level was found to be 10%, and it was as good as milk powder for rats. Clinical trials with children on a diet supplemented with leaf protein showed that edema disappeared within 10 days, appetite improved, and the children became mentally alert. Diarrhea spontaneously subsided, there was a good weight gain and a marked increase in serum proteins and albumins. Incorporation of leaf protein into Nigerian diets for adults showed that it was readily acceptable culturally, blending well with most of the dishes and causing no significant change in taste or color. *(Author's summary)* C03

0207-4744 GRAMACHO, D. **Contribuição ao estudo químico das raizes da mandioca.** *(A chemical study of cassava roots).* Anais da Associacão Química do Brasil 6:123-132. 1947. Port., 4 Refs., Illus.

Cassava. Cultivars. Tubers. HCN content. Protein content. Fibre content. Starch content. Fat content. Timing. Toxicity. Analysis. Brazil.

The HCH, starch protein, fiber and fat contents were determined in 54 samples of cassava roots from different varieties from Bahia (Brazil) between 11-14 mo old, and ranged from 0.0043-0.0282; 18.4-35.4; 0.13-3.15; 0.16-2.30%. The morphology of the starch, the toxicity of the roots (HCN), the determination of HCN by hydrolysis, distillation, and volumetric determination with $AgNO_3$ are described in detail. *(Summary by Chemical Abstracts)* C03

0208-2094 FAVIER, J. C., CHEVASSUS-AGNES, S. and GALLON, G. **La technologie traditionnelle du manioc au Cameroun; influence sur la valeur nutritive.** *(Traditional technology of cassava in the Cameroons; its influence on the nutritive value).* Annales de la Nutrition et de l'Alimentation 25(1):1-59. 1971. Fr., 41 Refs., Illus.

Cassava. Analysis. Nutritive value. Cassava pastes. Gari. Nutrient loss. Fermentation. Vitamin content. Protein content. Composition. Food products. Human nutrition. Cameroon.

Chemical composition and nutritive values of cassava and traditional cassava products are reviewed. The proximate composition of raw tubers and derived products, peeled tubers, inner cortex, leaves, boiled tubers, smoke-dried and sun-dried flour, sticks of cooked paste and gari, and loss of nutrients at various stages of preparation is shown in 24 tables. In vitro digestibility is shown graphically. Large losses of nutrients occurred, especially during the soaking of peeled tubers, which affected mainly vitamin and mineral contents. Ascorbic acid content was almost completely lost by most treatments. Riboflavin was sometimes increased by fermentation and Fe by contamination. For the majority of nutrients, plain boiled cassava and gari were the most valuable products. *(Summary by Food Science and Technology Abstracts)* C03 H01

0209-2242 KETIKU, A. O. and OYENUGA, V. A. **Changes in the carbohydrate constituents of cassava root-tuber (*Manihot utilissima* Pohl) during growth.** Journal of the Science of Food and Agriculture 23(12):1451-1456. 1972. Engl., Sum. Engl., 21 Refs.

Cassava. Growth. Tubers. Sugars. Glucose. Fructose. Maltose. Sucrose. Planting. Harvesting. Hydrolysis. Soluble carbohydrates. Carbohydrate content. Plant development. Cultivation. Cassava starch. Analysis. Composition. Timing.

Sucrose formed the bulk of the sugars in cassava root-tubers, accounting for more than 69% of the total sugars. Other sugars included fructose, glucose and maltose. Maltose was consistently present as the lowest amount. The highest concentration of sugars (5.7%) was attained 9 months after planting. Starch accounted for the highest proportion of the carbohydrates. A peak value of 81% was observed 8 months after planting. The decrease to 78% at 9 months was accompanied by an increase in sugar concentration from 3.5% to 5.7%. The sum of cellulose and hemicellulose constituted the nonavailable carbohydrate fraction to nonruminants. This was less than 7% of total carbohydrates. Paper chromatography of the neutralized hydrolysate of the extracted hemicellulose revealed the presence of glucose and xylose only. The amylose content of cassava starch varied between 16.2% and 17.4% during growth. This variation was significant at 1% level. The separated amylose had an iodine affinity of 17.0% while amylopectin had 0.1%. *(Author's summary)* C03

0210-0548 PEREIRA, A. S., NERY, J. P. and CONAGIN, A. **Teor de acido cianídrico na polpa das raizes dos aipins.** *(Hydrocyanic acid content in the core of cassava).* Bragantia 19(17):247-259. 1960. Port., Sum. Port., Engl., 6 Refs.

Cassava. HCN content. Cultivars. Sweet cassava. Composition. Tubers.

Studies were made to evaluate the content of HCN in the pulp of cassava roots. Seven varieties of the sweet cassava group and two varieties of the bitter type were analyzed in order to evaluate the differences between plant root size and plant age. There were significant differences between the two groups. Among the edible varieties, Vassourinha, Tatu and Branca do Pomar presented a high amount of HCN; nevertheless, they can he safely used as humand food, after cooking. Since no statistical differences were found between plant root size and age, the sampling technique will be much easier in the future. *(Author's summary)* C03

0211-3305 PILAC, L.M., ABDON, I.C. and MANDAP, E.P. **Oxalic acid content and its relation to the calcium present in some Philippine plant foods.** Philippine Journal of Nutrition 24(1):21-36. 1971. Engl., Sum., Engl., 14 Refs.

Cassava. Cereals. Nutritive value. Oxalic acid. Composition. Water content. Vegetable crops. Leaves. Tubers. Philippines.

An analysis was made of the oxalic acid, calcium and moisture content of 129 plant foods of local origin. The Ca:oxalate ratio and available Ca (expressed as percentage of total Ca) were calculated for each food. Only 21 foods have a Ca:oxalate ratio of 2 and above, with a corresponding available Ca of 80% and above. Oxalic acid in excess of Ca was obtained for 59 foods, 24 of which were leafy vegetables. Although the remaining 49 foods had a Ca:oxalate ratio below 2, some had over 50% available Ca, which could still be utilized by the body. The consumption of vegetables with oxalic acid in excess of Ca should not be discouraged because they are good sources of other nutrients. However, information should be given that more Ca-rich foods would be needed in the diet and that these should preferably not be eaten for therapeutic purposes. As regards cassava, leaves (used as a vegetable) and tubers had Ca:oxalate rations of 1.04 and 0.21, respectively. Leaves contained 57.2% available Ca whereas tubers had an excess of oxalic acid. *(Author's summary)* C03

0212-1746 SINGMASTER, J. A. **A modification of the AOAC extraction procedures for parathion residues on tropical root crops.** Journal of Agriculture of the University of Puerto Rico 54(1):189-191. 1970. Engl.

Cassava. Insecticides. Analysis.

Edible parts of the roots of yams, sweet potatoes, cassava, and taniers from plants grown in soil treated with parathion granules at the time of planting were analyzed for parathion residues at harvest, following the official AOAC method. Some samples of cassava, taniers and sweet potato required the addition of anyhydrous sodium sulfate to free more extract from the mud left after centrifugation. Analyses of the aforementioned root crops treated with parathion revealed that neither 2 nor 4 lbs of active parathion| acre left residues of parathion above 0.2 ppm in any of the 4 root crops at harvest. However, studies on the effectiveness of parathion were worthless as the checks proved as free of soil insects as the treated plots. *(Summary by R.O.D.)* C03

0213-1727 AMMANN, P. **Sur la grande richesse e matieres azotées de certains maniocs du Cambodge.** *(On the high nitrogenous content of certain Cambodian cassava varieties).* Compte Rendu Hebdomadaire des Séances de l'Academie des Sciences 170:1333-1334. 1920. Fr.

Cassava. Composition. Analysis. Protein content. Tubers. N. Cambodia.

Analyses of 10 samples representing 6 French colonies, made in the Colonial Garden laboratory, indicated a water content of 12.16-16.05% in the decorticated roots; protein content ranged from 0.74-1.49% after the elimination of HCN. Analyses of 6 samples from the Cambodia region gave results within the following ranges: water, 10.72-11.58%; protein 2.95-7.43%; sugars, 70.0-77-6%; fiber, 2.10-2.88%. These roots were from plants which had been bred by selection for the purpose of obtaining improved varieties. The protein in the remaining 4 samples was 4.33% in 3 of them and 6.93% in the fourth. The highest figures nearly correspond to rice in protein content. These varieties contain only traces of HCN (2.2-7.8 mg| 100 g). *(Summary by Tropical Abstracts)* C03

0214-5008 OELSLIGLE, D. D. **Accumulation of dry matter, nitrogen, phosphorus, and potassium in cassava (*Manihot esculenta* Crantz).** Turrialba 25(1):85-87. 1975. Engl., Sum. Span., 5 Refs., Illus.

Cassava. *Manihot esculenta*. Dry matter. N. P. K. Fertilizers. Absorption. Tuber productivity. Timing. Analysis. Costa Rica.

In cassava (*Manihot esculenta* Crantz cv. Guaxupe 454), the accumulation of dry matter, N, P and K during the period of rapid growth, was rather similar. The concentration of the 3 nutrients in top and roots decreased with time. Root yields of 43 tons| ha removed 174, 21 and 125 kg| ha of N, P, and K, respectively. *(Author's summary. Trans. by J.L.S.)* C03

0215-4810 JANSZ, E. R. *et al.* **Cyanide liberation from linamarin.** Journal of the National Science Council of Sri Lanka 2(1):57-65. 1974. Engl., Sum. Engl., 12 Refs.

Cassava. Cyanides. Linamarin. Hydrolisis. HCN. Linamarase. Biochemistry. Toxicity. Laboratory experiments. Sri Lanka.

Several plant materials were tested for their cyanide liberating capacity. Two of these materials were able to liberate cyanide from purified linamarin; however, the mechanism of liberation appears to be different from that of the cassava linamarase. Although ginger cannot liberate significant amounts of cyanide from purified linamarin, some samples have been found to release it from boiled cassava. In this case also, this effect does not appear to be due to a "cassava-type" linamarase. Coliforms cannot liberate HCN from linamarin. A reputed antidote for cassava poisoning, guava leaf extract, contains a potent linamarase inhibitor. Further details on acid and enzymic hydrolysis of linamarin are also reported. *(Author's summary)* C03

0216-2371 SUBRAMANIAN, S.A., NAGARAJAN, S. and SULOCHANA, N. Euphorbiaceae; **flavonoids of some Euphorbiaceous plants.** Phytochemistry 10(10):2548-2549. 1971. Engl., Sum. Engl., 8 Refs.

Cassava. Analysis. Laboratory experiments. Leaves.

Vitexin and isovitexin have been isolated from the leaves of *Jatropha. curcas* and *J. heynii* and *Hevea brasiliensis*, while the leaves of *Croton sparsiflorus* and *Manihot utilissima* contain significant amounts of rutin. *(Author's summary)* C03

See also 0004 0055 0072 0094 0113 0123 0289 0388 0391 0488 0543 0647 0936 0954 0974 0985 1004 1053 1109 1372 1377 1393 1439 1509 1522 1573 1638 1666

D00 CULTIVATION

0217-0652 ESTRADA R., N. **Colombian studies for the improvement of *Manihot esculenta* Culture.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd, Honolulu and Kapaa, Kauai, Hawaii, 1970. Tropical Root and tuber Crops Tomorrow, Honolulu, University of Hawaii, 1970. v.1., pp. 83. Engl.

Cassava. Productivity. Cultivars. Germplasm. Protein content. Starch content. Composition. Colombia.

A brief description is made of the cassava projects carried out by ICA, Palmira, (Colombia). Reference is made to cassava collections, yields, early-maturing characteristics, protein content, starch content and cultural practices. *(Summary by H.J.S.)* D00

0218-2322 TOLEDO, F.F. DE. **Estudo do aproveitamento integral da planta mandioca.** *(Study on the utilization of the whole cassava plant).* Anais da Escola Superior de Agricultura "Luis de Queiroz" 19:151-175. 1962. Port., Sum. Engl., 6 Refs.

Cassava. *Manihot esculenta.* Cultivars. Cultivation. Production. Roots. Stems. Leaves. Productivity. Field experiments. Animal nutrition. Brazil.

This paper deals with cassava leaf, stem and root production. Field competition trials showed that production of leaves and stems are the same as that of roots. Leaves and stems can be used in animal feeding while roots may be processed to obtain various products. *(Author's summary).* D00 H03

0219-2248 DAVESNE, A. **Le manioc.** *(cassava). In* Manuel d'agriculture a l'usage des écoles primaires de l'Afrique Equatoriale et Tropicale. Paris, Librairie Istra, 1954. pp. 151-154. Fr., Sum. Fr., Illus.

Cassava. Uses. Planting. Cuttings. Food products. Cultivation. Human nutrition. Soil fertility. Cassava products. Malagasy Republic. Gari. Cassava flour. Tapiocas.

Cassava plays an important role in African nutrition. Its cultivation and preparation are briefly described. Its fast growth, resistance to drought and easy conservation are some of the factors that make cassava rank first among food plants. Sometimes the natives eat the fresh tubers after boiling, but the roots are mainly consumed in the form of gari (cassava flour) and tapioca. Export of cassava chips is one of the most important agricultural resources in Madagascar. *(Summary by T.M.)* D00 I02

0220-0856 LECOINTE, P. **La culture et la préparation du manioc en Amazonie.** *(Cultivation and preparation of cassava in the Amazon).* Revue de Botanique Appliquée et d'Agriculture Coloniale 2(11):334-337. 1922. Fr.

Cassava. Cultivation. Planting. Spacing. Cassava meal. Processed products. Food products. Uses. Cassava products. Beverages. Human nutrition. Cassava pastes. Brazil.

Remarks are made on the cultivation of cassava in the state of Amazonas (Brazil). A detailed description of the native method for extracting meal is given. Cassava meal is a raw material used in the preparation of various forms of foods (cassareep, cassave or the cassava bread, fuba) and some beverages (tarubá, arubé). Manicoba is cassava leaves prepared in the same way as spinach. Mujangue is a paste made of turtle eggs and cassava flour. *(Summary by J.L.S.)* D00 H01

0221-0062 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava program review conference.** Palmira, Colombia, 1972. 27p. Engl., Illus.

Cassava. Productivity. Plant breeding. Economics. Costs. Plant physiology. Cassava programs. Cultivation. Diseases and pathogens. Pests. Developmental research. Colombia.

The main objectives of the conference were to review the present status of cassava in the world and to promote international cooperation among institutions as well as among individuals. The following topics were fully discussed and considered to be of great interest for the development of cassava research activities: factors affecting productivity, cassava breeding, socioeconomical factors, cultural practices, entomology, production costs, by-products, mechanization, physiology, fertility, diseases and pathogens, and documentation. *(Summary by J.L.S.)* D00 102 E01.

0222-0133 CRUZ R., L. C. **Notas sôbre el cultivo de la yuca.** *(Cassava cultivation).* Revista Nacional de Agricultura (Colombia) 37(472):26-29. Span.

Cassava. Cultivation. Planting. Spacing. Harvesting. Economics. Costs. Production. Tubers. Composition. Colombia.

Information is given about appropriate soils for planting, land preparation, weed and pest control, harvesting, fertilizers and production costs. Samples of cassava tubers were chemically analyzed with the following results: starch ranged from 22.60 to 27.44%; moisture 62.69 to 65.50%; crude fiber 1.30 to 1.93%; fat 0.56 to 0.67%; reducing sugar 3.40 to 4.80% and ash 0.96 to 0.97%. *(Summary by A.N.)* D00.

0223-0828 CULTIVO E **industrialización de la yuca.** *(Cultivation and industrialization of cassava).* Revista del Instituto de Investigaciones Tecnológicas. Tecnología. (Colombia). no. 44:40-51. 1966. Span.

Cassava. Marketing. Industrialization. Economics. Animal nutrition. Prices. Processing. Cassava starch. Cassava flour. Concentrates. Bitter cassava. Starch content. Timing. Colombia.

A summary is presented of the paper "Technological and Economical Study of the Cultivation and Industrialization of Cassava in the Region of Acacías (Meta)." The original study was conducted by the Instituto de Investigaciones Tecnológicas. Figures on the production, prices and distribution of the crops are given; and the economic aspects of processing cassava starch and cassava flour are discussed. It also deals with the variation of the starch content in bitter cassava at the different ages of the plant, as well as with the economic possibilities of feeding and fattening chicks using bitter cassava flour. The results of a survey on marketing of cassava flour to be used in the preparation of concentrates for animals are presented as well. *(Summary by H.J.S.)* D00 102

0224-0404 SMITH, L.R. **Informe de los ensayos sobre la producción de yuca en El Cibao.** *(Report on cassava production trials at El Cibao).* Santiago de los Caballeros, República Dominicana, Instituto Superior de Agricultura, 1968. 14p. Span., Illus.

Cassava. Planting. Cuttings. Irrigation. Entomology. Harvesting. Cultivation. Cultivars. Productivity. Spacing. Nutritional requirements. Fertilizers. Pests. Diseases and pathogens. Cyanides. Timing. Mycoses. *Erinnyis ello. Carpolonchaea chalybea.* **Noxious animals. Injurious insects. Tuber productivity. Starch productivity. Dominican Republic.**

Results of experiments carried out in the Dominican Republic on local varieties of cassava (*Manihot utilissima* Pohl) and collections of material from Jamaica and the Virgin Islands are presented. Experiments included selection of varieties for adaptability to local climatic conditions and adaptability to irrigation in terms of edible root yields and commercially acceptable starch production, as well as experimentation on varied distances between plants, methods of planting and effect of fertilizer on root size and weight. *(Summary by P.A.C.)* D00

0225-0333 JENNINGS, D.L. **Cassava in Africa.** Field Crop Abstracts 23(3):271-275. 1970. Engl.

Cassava. *Manihot esculenta.* **Growth. History. Toxicity. Taxonomy. Cultivation. Productivity. Pests. Diseases and pathogens. Cassava mosaic virus. Cassava common mosaic virus. Viroses. Cultivars. Uses. HCN. Plant breeding. Genetics. Mycoses. Nutritional requirements. Fertilizers.** *Fomes lignosus. Phoeolus manihotis.* **Lasiodiplodia. Injurious insects. Noxious animals. Insect control. Pest control.** *Aonidomytilus allus.* **Hybrids. Crossbreeding. Africa.**

A summary is given of results of research carried out on cassava (*Manihot esculenta* Crantz) in Africa: its history and present status in Africa; nomenclature; growth cycle; yield and yield components; agronomy; diseases and pests (including nutritive value and toxic hazards); and future problems and possibilities of cassava cultivation. *(Summary by P.A.C.)* D00

0226-2661 LAGOS U., J. A. **Cultivo moderno de la yuca.** *(Modern cassava cultivation).* Agricultor Costarricense 10(11):255-257. 1952. Span.

Cassava. Cultivation. Costa Rica.

Short notes on modern cassava cultivation are presented. *(Summary by A. N.)* D00

0227-0983 RAO, N. S. **A short note on tapioca.** Mysore Agricultural Journal 27(3):70-73, 1951. Engl.

Cassava. Cultivation. Uses. Tuber productivity. Economics. Cassava starch. Tapiocas. Cassava flour. Costs. India.

Notes given concern cultivation, harvesting, yields and uses of cassava. A description is made of the prepartion of flour, soji, starch and sago. *(Summary by H.J.S.)* D00 J00

0228-2090 MARTIN, F. **Le manioc dans la France d'Outre-mer.** *(Cassava in French overseas territories).* Revue Internationale des Produits Coloniaux 26(256):45-47. (Cont.). 1951. Fr.

Cassava. History. Cultivation. Production. Indochina. Malagasy Republic.

Brief notes are presented about cassava in Indochina, Reunion and Madagascar. Data refer to historical aspects of introduction, production, cultivation and economic aspects. *(Summary by H.J.S.)* D00

0229-1771 MENDIOLA, N. B. **Cassava growing and cassava starch manufacture.** Philippine Agriculturist 20:447-476. 1931. Engl., 10 Refs., Illus.

Cassava. *Manihot esculenta.* **History. Plant geography. Sweet cassava. Bitter cassava. Cultivars. Composition. Productivity. HCN content. Timing. Cultivation. Harvesting. Cassava starch. Cassava products. Processing. Industrialization. Industrial machinery. Cottage machinery. Rasping. Costs. Economics. Production. Marketing. Prices. Consumption. Philippines.**

The chemical composition of varieties of cassava and of tapioca are given. The HCN content of cassava is discussed in relation to its use as food. The manufacture of starch is discussed. *(Summary by Chemical Abstracts)* D00 I02

0230-0109 MOLESTINA O., E. **La yuca.** *(Cassava)* . Revista del Consorcio de Centro Agrícolas (Ecuador). 16(87):5-8. 1957. Span.

Cassava. Cultivation. Cassava products. Cassava flour. Cassava starch. Processing. Casave. Cassava bread. Tapiocas. Cassareep. Washing. Peeling. Grinding. Temperature. Pressing. Drying. Silting. Screening. Industrial machinery. Ecuador.

Some information on cassava cultivation is given. The industrial processing of fresh cassava roots to obtain starch, flour and tapioca is described, including technical references to equipment used. The temperature considered as optimum during the drying process to obtain cassava starch, flour and tapioca was reported as 50-60°C. *(Summary by A.N.)* D00 I02

0231-3301 **LE MANIOC aux Indes Neerlandaises.** *(Cassava in the Dutch East Indies).* La Cochinchine Agricole 1930:252-261. 1930. Fr., Vietnamese.

Cassava. Cultivation. Processing. Tapiocas. Cassava flour. Processed products. Labour. Java.

Brief notes are given on cassava: cultivation, soil and climatic requirements, diseases and pests, yields, agricultural patterns, cassava food products and commerce in the Dutch East Indies. *(Summary by H.J.S.)* D00 I02

0232-2940 NOBRE, A. and MENEZES, D. M. DE. **Região de produção, cultura e industrialização da mandioca no estado do Espíritu Santo.** [*Cassava production, cultivation and industrialization in the state of Espirito Santo (Brazil).*] Rio de Janeiro: Centro de Tecnologia Agrícola e Alimentar. Boletim Técnico no. 9:27-37. 1973. Port., Sum. Port., Engl., 8 Refs.

Cassava. *Manihot esculenta.* **Processed products. Cassava meal. Cassava flour. Factories. Cassava starch. Prices. Marketing. Economics. Tapiocas. Tuber productivity. Productivity. Production. Cultivation. Climatic requirements. Soil requirements. Soil analysis. Cultivars. Composition. Protein content. HCN content. Industrialization. Brazil.**

Twelve counties in the state of Espirito Santo were selected as the most representative for their cassava production: Sao Mateus, Conceição da Barra, Guarapari, Pinheiros, Aracruz, Fancas, Mimoso do Sul, Colatina, Ecoporanga, Barra de Sao Francisco, Santa Leopoldina and Presidente Kennedy. Within the climatic conditions under which the cassava was grown, it was found that the best production average was obtained in the counties at altitudes of 4 to 10 m. Yearly rainfall in those counties was between 891 and 1,407 mm, and the average yearly temperature, 23.5 and 23.7°C. Forty-nine cassava flour mills were set up in 21 counties by 1972. The estimated number of "quitungos" (rudimentary cassava flour mills with a daily production of 50 to 150 kg|day) was 2,323. The average production of the 49 cassava flour mills was 2.23 tons| day, and may considered as quite significant. The best yield (4.25 and 4.07 tons|day) was obtained by the mills located at Conceição da Barra and Presidente Kennedy. There are two cassava centers of economic importance being developed: Conceição da Barra and Sao Mateus in the North and Presidente Kennedy and Mimoso do Sul in the South. *(Author's summary)* D00 I02 J00

0233-2146 FAUCHERE, A. **La culture du manioc a Madagascar.** *(Cassava cultivation in Madagascar).* Bulletin Economique de Madagascar nos. 1-2:208-214. 1924. Fr.

Cassava. Cultivation. Industrialization. Economics. Productivity. Soil fertility. Malagasy Republic.

Several aspects of cassava cultivation in Madagascar are discussed. Data concern local cultural practices, yields, harvesting and the feasibility of fertilization and manuring. *(Summary by H.J.S.)* D00 J00

0234-0276 MOSQUEDA V., R. **El cultivo de la yuca en la costa sur del Golfo de México.** *(Cultivation of cassava on the southern coast of the Gulf of Mexico).* Novedades Horticolas 11(1-4):9-12. 1966. Span.

Cassava. Land preparation. Planting. Harvesting. Cultivation. Climatic requirements. Soil fertility. Cultivars. Fertilizers. Pests. Diseases and pathogens. Mexico.

Recommendations are made for growing cassava (*Manihot esculenta* Crantz) on the southern coast of the Gulf of Mexico. Details include climate, soils, land preparation, varieties, planting time and methods, cultural practices, fertilization, pests, diseases and harvesting information. *(Summary by P.A.C.)* D00

0235-2110 CASSAVA CULTIVATION in **Papua.** Australian Sugar Journal 17:179. 1925. Engl.

Cassava. Cultivation. Spacing. Papua and New Guinea.

Brief notes are given on cassava cultivation in Papua. *(Summary by H.J.S.)* D00

0236-2243 CROP AND **pasture planting guide. III. Northern districts.** Queensland Agricultural Journal 95(12):818-821. 1969. Engl.

Cassava. Cereals. Root crops. Secondary crops. Vegetable crops. Cultivation. Planting. Australia.

Information in this paper is presented in tables, which deal with the main purpose for which the crop is grown, the months when it is convenient to sow and plant, planting distances, the quantity of seeds per acre, approximate period of growth, and some special remarks on agronomy and uses of the crops. Sixty-four crops are included, one of them being cassava. *(Summary by H.J.S.)* D00

0237-2213 COURS, G. **L'avenir des plantations de manioc.** *(The future of cassava plantations).* Marchés Coloniaux du Monde 10(440):1141-1142. 1954. Fr., Illus.

Cassava. Development. Cultivars. Resistance. Productivity. Malagasy Republic.

The general situation of cassava cultivation and research in Madagascar is briefly described. Emphasis is on the role played by the Alaotra Lake Station. It is believed that cassava has an excellent future in the country. *(Summary by H.J.S.)* D00

0238-2097 IYER, A. P. **The cultivation of tapioca in Travancore.** Mysore Economic Journal 11:510-512. 1916. Engl.

Cassava. Cultivation. Uses. India.

The state of Travancore is the biggest cassava producer in India. Brief notes are given on this crop concerning cultivation, areas under cultivation and uses. *(Summary by H.J.S.)* D00

0239-2106 LUC, M. **Le manioc à Madagascar.** *(Cassava in Madagascar).* Revue de Botanique Appliquée et de Agriculture Tropicale 5:915-920. 1925. Fr., 3 Refs.

Cassava. Cultivation. Climatic requirements. Trade. Legal aspects. Production. Tapiocas. Industrialization. Cassava starch. Malagasy Republic.

The cultivation of cassava in different regions in Madagascar is reviewed. The author has stressed the importance of appropriate industrialization of cassava. Exports of cassava in different forms were 55.5 tons in 1924, which was very significant since exports in 1923 were 29.5 tons. Some standards for the export of starch and tapioca are included. *(Summary by J.L.S.)* D00 J00

0240-2229 COLSON, L. and CHATEL, L. **Le manioc, culture et industrie a la Reunion.** *(Cassava, its cultivation and industry in Reunion).* Agriculture Pratique des Pays Chauds 5: 269-297. (Cont.). 1905. Fr., Illus.

Cassava. Cultivation. Productivity. Industrialization. Toxicity. Uses. Diseases and pathogens. Soil fertility. Climatic requirements. Pests. Cultivars. Reunion.

Notes are given on cassava cultivation and industry on Reunion Island. Information is also presented on toxicity, the history of cassava introduction at Reunion, varieties, soils and climate, uses and yields. *(Summary by H.J.S.)* D00 I02

0241-2105 ROLLOT, C. **Le manioc á Madagascar.** *(Cassava in Madagascar).* Revue Internationale de Botanique Appliquée et d'Agriculture Tropicale 6(55):52-159. (Concl.). 1926. Fr.

Cassava. Cultivation. Climatic requirements. Planting. Harvesting. Spacing. Malagasy Republic.

Climatic and edaphological aspects regarding cultivation of cassava are reviewed. Yields of 20 ton|ha are obtained in coastal areas, since soil and climate conditions are much better than in the center of the island where 10 ton|ha are scarcely obtained. Inland harvesting takes place 24-30 months after planting. Starch content is higher than in coastal areas. Planting and agricultural practices of natives are given. Trials are carried out by the Nanisana and Tuolojno experimental stations to obtain high-yielding varieties using propagation by seed. Recommendations for introduction of new local cultivation practices are given *(Summary by J.L.S.)* D00

0242-0474 SCHMIDT, N. C. AND PEREIRA, A. S. **Comportamento do cultivar "mantequeira", e de outros, de mandioca, em solos da série pinhao (terciario), no vale do Paraiba, Estado de São Paulo.** *(Behavior of the cassava cultivar Mantequeira and others in soils of the series "Pinhao" (tertiary) in the state of São Paulo).* Bragantia 27(22):249-256. 1968. Port., Sum. Engl., 7 Refs.

Cassava. Field experiments. *Manihot esculenta.* **Soil fertility. Cultivars. Selection. Pests. Resistance. Productivity. Cultivation. Diseases and pathogens. Bacterioses.** *Xanthomonas manihotis.* **Brazil.**

In competition trials of cassava cultivars *(Manihot esculenta,* Crantz) carried out in the Paraiba River Valley on a tertiary soil, the new cultivar Mantequeira selected by the Instituto Agronómico was superior to the others. This cultivar precociously produces initial shoots, is of high productivity, excellent root quality and type, facility in harvesting, straight stand which makes the cultural treatments easy, an apparent resistance to root rotting and bacteriosis caused by *Xanthomonas manihotis* (Arthaud-Berthet) Starr, rusticity and tolerance to droughts. It also was free of the common mosaic virus. *(Author's summary)* D00 E02

0243-1885 KUPPUSWAMI, B. S., NARASIMHAN, V. and NATARAJAN, R. **Problems and prospects of cassava in Tamil Nadul.** Salem, India, Tapioca Research Station, 1973. 5p. Engl., 18 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Cultivars. Productivity. Starch productivity. Selection. Industrialization. Development. India.

Tamil Nadu State is the second largest producer of cassava in India and is the biggest producer of cassava starch and sago in the entire country. More than 750 factories concentrated in the district depend on cassava for raw material. Popular cultivars of the species *Manihot esculenta* Crantz in the state and their performance are described. Problems facing cultivation and industry including low yield, susceptibility to mosaic disease, poor starch recovery and lack of proper cultivation practices are discussed. Future lines of work and prospects are outlined. *(Summary by D.H. and L.J.)* D00 D03

0244-0358 NORMANHA, E. S. and PEREIRA, A. S. **Aspectos agronómicos da cultura da mandioca,** *Manihot utilissima* **Pohl.** *(Agronomic aspects of cultivating cassava, Manihot utilissima Pohl.)* Bragantia 10(7):179-202. 1950. Port., Sum. Engl., 3 Refs.

Cassava. *Manihot esculenta.* **Pests. Diseases and pathogens. Nutritional requirements. Cultivation. Cuttings. Propagation materials. Productivity. Planting. Minerals. Absorption. Fertilizers. Timing. Spacing. Resistance. Cultivars. N. P. K.** *Xanthomonas manihotis.* **Bacterioses. Cassava common mosaic virus. Viroses. Brazil.**

The cassava plant *(Manihot utilissima* Pohl) is native to Brazil and was already used by the Indians as a main source of food before the arrival of the Europeans. Wild species of Manihot are found in several parts of Brazil and in other South American countries. Cassava is one of the chief sources of carbohydrates for a large part of the Brazilian population. It is also widely used to feed animals and is used as a raw material for the starch industry. In 1946 about 900,000 hectares of cassava were planted in Brazil. In the state of São Paulo, little attention had been given to the agricultural problems of the cassava crop prior to 1935. At that time an extensive series of field trials was started by the Instituto Agronómico, Campinas to obtain information on the various problems of this crop. Over 600 varieties were collected from several parts of Brazil to be used as basic material for selection or synthesis of high-yielding and disease-resistant types. Extensive field tests showed that the highest yielding and most resistant varieties were: Branca de Santa Catarina, Preta, Cafelha, Brava de Itu and Itu. They are more suitable for industrial purposes than the common variety know as Vassourinha. The variety Guaxupe was found to be the best for human consumption and as a forage. In experiments on planting methods, the use of cuttings 50 cm long, stuck in the soil in a vertical or slanting position, leaving about 35 cm above ground, gave better results than cuttings 15 cm long, placed in a horizontal position in furrows, as is usually done by the farmers. Fertilizer experiments showed that, phosphates generally gave the highest increase in yield. Nitrogen or potassium, either alone or together, had no effect on yield. When one or both of these were added to phosphates, the yields were better than with phosphates alone. The period from May to August is the regular cassava harvesting time in the state of São Paulo. Experimental plantings made during these months gave higher yields than those made in October, the usual time of planting. Furthermore, when planting was done soon after harvest, the losses of cuttings that occur after a long storage are avoided. In field tests, cuttings 20 to 25 cm long, planted in furrows, gave better stands and higher root production than shorter cuttings. Data from field trials indicated that a spacing ranging between 0.80 x 0.40 cm and 1.00 x 0.60, according to soil fertility, is more advantageous than the spacing of 1.20 x 0.60 cm as is usually adopted. Tests on depth of planting were made with 15 cm -long cuttings planted in fūrrows 5, 10 and 15 cm deep, and subsequently covered. The plants grown from cuttings planted 15 cm deep produced less and were more difficult to be dug out. Planting at 5 cm depth is also inadvisable because the plants may be easily uprooted by erosion or strong winds. Planting at 10 cm depth is to be recommended. Studies on cassava bacterial wilt, caused by *Xanthomonas manihoti* (Arthaud-Berthet)"Burk, revealed that several common varieties and clones derived from seedlings show more resistance than commonly cultivated types. Cuttings of the resistant types were released to the growers and are now being widely used. A virus disease of the witches'-broom type, present in some localities, caused severe losses in cassava plantings made with the variety Vassourinha. Tests carried out in infected areas showed that the variety Brava da Ponte is highly resistant to the disease, and the varieties Preta and Holandi do Itaguá show a fair degree of resistance. *(Author's summary)* D00 E00

0245-0146 MENDES, C. T. **Notas practicas sobre a cultura da mandioca.** *(Cassava cultivation).* Boletim Agricola (Serie 3) 1931:132-152. 1931. Port.

Cassava. Cultivation. Cultivars. Human nutrition. Animal nutrition. Timing. Land preparation. Soil fesrtility. Planting. Timing. Propagation materials. Cuttings. Spacing. Pruning. Harvesting. Brazil.

Recommendations on cassava cultivation including appropiate soil and its preparation, planting time, pruning, planting distance, selection of cuttings, cutting length and fresh root composition. Mandioca Palma, Mandioca Rosa and Vassaurinha are common names of local varieties used for human consumption. Vassaurinha grande, Grelo Roxo and Cubatao are varieties for animal feeds and industrial uses. In the state of São Paulo (Brazil), June, July and August are considered the best months for cassava harvesting. *(Summary by A.V.)* D00 H00

0246-3182 SILVESTRE, P. **Research on root crops.** *In* Conference on Agricultural Research Priorities for Economic Development in Africa, Abidjan, Ivory Coast, 1968. Contributed papers. Washington, National Academy of Sciences, 1968. v. 2, pp. 340-345. Engl., Sum. Engl., 13 Refs.

Cassava. Cultivation. Yams. Research. Togo. Malagasy Republic.

In Africa, tuber plants are essentially used for food. Only cassava has industrial outlets in the Malagasy Republic and Togo. Economically, the most important crops are cassava and yams. These species present very different problems for agricultural research. *(Author's summary)* D00.

0247-2281 HENRY, Y. and AMMANN, P. **Le manioc africain.** *(African cassava).* L'Agriculture Pratique des Pays Chauds 12(110):353-368. 1912. Fr., Illus.

Cassava. Cultivation. Cultivars. Human nutrition. Industrialization. Uses. Nigeria. Dahomey. Ghana.

Notes are presented on cassava cultivated in some countries of tropical Africa. Data given concern varieties, cultivation, nutritional and industrial uses. *(Summary by H.J.S.)* D00 H00 I02

0248-2407 KOCH, L. **Eenige geschiedkundige feiten met betrekking tot de cassave cultuur.** *(Some historical notes on cassava production).* De Indische Mercuur, Amsterdam; mei 2, 1934:263. Dutch.

Cassava. Cultivation. History. Uses. Production.

A brief history of cassava and its introduction in Indonesia is given. In 1934, cassava cultivation had increased to about 700,000 ha, yielding about 6 million tons. It has been used to supplement the rice diet in periods of rice shortage and for a wide range of industrial applications. *(Summary by A. van S.)* D00

0249-2411 BRAND, D. D. **Tapioca from a Brazilian root.** Agriculture in the Americas 3(5):93-96. 1943. Engl., 10 Refs., Illus.

Cassava. Cultivation. Uses. Plant geography. Processed products. Human nutrition. Climatic requirements. Brazil.

Cassava is briefly described. Data given deal with common names, uses, cultivation and countries where cassava is cultivated. *(Summary by H.J.S.)* D00

0250-2414 HANSON, A. P. **Notes on cassava.** Journal of the Jamaica Agricultural Society 43:602-603. 1939. Engl.

Cassava. Cultivation. Cuttings. Uses. Sweet cassava. Bitter cassava. Jamaica.

A brief description of cassava is presented. Data refer to cuttings, cultivation and uses. *(Summary by H.J.S.)* D00.

0251-2294 HEDIN, L. **La culture du manioc au Cameroun.** *(Cassava cultivation in Cameroon).* Revue de Botanique Appliquée et d'Agriculture Tropicale 9:311-314. 1929. Fr.

Cassava. Cultivation. Harvesting. Human nutrition. Food products. Processing. Foofoo. Gari. Cultivars. Uses. Cameroon.

Brief notes are given on cassava in Cameroon. Topics concern varieties, cultivation, harvesting, and preparation of local cassava food products; i.e., foo-foo, gari and ebobolo. *(Summary by H.J.S.)* D00 I02

0252-3658 WIJERATNE, W. B. **Cultivation, processing, and utilization of cassava in Sri Lanka.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.73-75. Engl., Sum. Engl., Fr.

Cassava. Cultivation. Cultivars. Economics. Prices. Cassava products. Productivity. Starch productivity. Timing. Uses. Cassava programs. Development. Sri Lanka.

Cassava has changed its status in Sri Lanka during the present decade, from a traditional minor crop to one of great economic significance, both as a human food and a base for agro-industry. New interest in the crop has resulted in expansion of cultivation to 24,777 ha in 1973. Processing cassava for human food is receiving considerable attention at the moment. Significance of cassava as a human food will be a temporary feature. Starch, chips and possibly pellet making will eventually form a stable cassava industry. *(Author's summary)* D00 J00 D03

0253-2300 HAUT DE SIGY, G. DE. **Etude agronomique de la cuvette d'Ankazomanga.** *(Agronomic study of D'Ankazomanga Basin).* Agronomie Tropicale 21(5):659-691. 1966. Fr., Sum. Fr., Engl., Span., Illus.

Cassava. Cultivation. Cultivars. Trade. Economics. Marketing. Developmental research. Malagasy Republic.

The total population of the Basin is estimated at 3,000 inhabitants. Attitudes towards the main agricultural problems-water, agricultural practices and animal husbandry-are discussed and evaluated. The main agricultural products are cassava, corn, cowpeas and sweet potatoes as food crops and groundnut and *Phaseolus aureus* as cash crops. Dried processed cassava is exported to cattle feed factories in France and Germany. There is strong competition for the peeled cassava from Angola. In this area there is mainly a subsistence economy, meaning there is a certain resignation and indifference towards economic mechanisms. Animal husbandry is traditionally placed almost complety outside the economic systems. *(Summary by H.J.S.)* D00 J00

0254-3653 COCK, J. H. **Agronomic potential for cassava production.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.21-26. Engl., Sum. Engl., Fr., 51 Refs.

Cassava. *Manihot esculenta.* **Production. Cultivation. Selection. Pests. Diseases and pathogens. Productivity. Developmental research. Research.**

Cassava has advantages over many other crops in that it tolerates very poor acid soils and still gives reasonable yields, is drought tolerant, and has no fixed harvest date, making farming systems more flexible. However, present cassava yields of about 10 metric tons| ha are far below the known potential of 50 tons| ha or more. The reasons for this are poor agronomic practices (especially weed control), use of varieties of low yield potential, and losses due to diseases and pests. Yields can be improved with little extra input by (1) using correct agronomic practices, such as optimum spacing adequate weed control and good-quality planting material; (2) using varieties of known high yield potential; and (3) planting disease-free cuttings and resistant varieties. The future yield potential of cassava was estimated to be close to 90 tons| ha per year under ideal conditions. *(Author's summary)* D00 J00

0255-2250 DUARTE, A.C. **Cultura da mandioca.** *(Cassava cultivation).* Rural 40(471):15. 1960. Port., Illus.

Cassava. Cultivation. Brazil.

Brief notes on cassava cultivation and production data are given. *(Summary by H.J.S.)* D00

0256-0711 CENTRO INTERNATIONAL DE AGRICULTURA TROPICAL. **Cassava production systems.** *In* _____. Annual report 1970. Cali, Colombia, 1971. pp. 19-22, 26. Engl., Illus.

Cassava. Development. Germplasm. Cultivation. Animal nutrition. Swine. Pests. Diseases and pathogens. Colombia.

CIAT's cassava program is directed toward an increase in the production and utilization of improved cassava in the lowland tropics. Activities include the development of higher yielding varieties, marketing, processing, storage and utilization systems, and international and regional testing programs. During 1970, work was conducted in the following areas: collection and evaluation studies, agricultural economics and swine feeding. *(Summary by H.J.S.)* D00.

0257-2061 SILVA, F. **A cultural da mandioca.** *(Cassava cultivation).* Gazeta do Agricultor 13(144):138-139. 1961. Port.

Cassava. Cultivation. Harvesting. Productivity.

A general description of cassava is presented. Data given deal with land preparation on both large- and small-scale plantations, harvesting, tuber conservation and yields. *(Summary by H.J.S.)* D00

0258-2160 BARRAU, J. **Le manioc.** *(Cassava).* *In*_____. L'Agriculture Vivriere Autochtone de la Nouvelle Caledonie. Noumea, Commission du Pacifique Sud, 1956. pp.91-93. Fr.

Cassava. History. Cultivation. Composition. Productivity. Australia.

Brief notes are given about cassava in New Caledonia. They concern historical aspects of cassava introduction to the island, varieties containing low amounts of HCN, areas under cultivation and uses of the crop. *(Summary by H.J.S.)* D00

0259-2055 FRITZ, J. and BOHL, P. **Le manioc á Madagascar.** *(Cassava in Madagascar).* Revue Internationale des Produits Tropicaux 40:51, 53. 1965. Fr.

Cassava. Cultivation. Harvesting. Fertilizers. Manures. Land preparation. Uses. Malagasy Republic.

A general description is given of cassava in Madagascar. Data deal with intercropping, land preparation, fertilizers and manures, varieties, planting, harvesting, yields and uses. Cassava is the second crop after rice (area cultivated) in Madagascar. *(Summary by H.J.S.)* D00

0260-2254 DUMAS. **L'agriculture dans la Vallée du Niger, le manioc.** *(Agriculture in the Niger Valley: Cassava).* Agriculture Pratique des Pays Chauds, 6:510-513. 1906. Fr.

Cassava. Cultivation. Composition. Uses. Productivity. Tuber productivity. Niger.

General remarks on cassava cultivation and utilization are given. A table on cassava root composition and data about tuber yields are also presented. *(Summary by H.J.S.)* D00

0261-0640 NUNES, W. DE O. **Resumo dos trabalhos do setor de fitotecnia do IPEACS.** *(Summary of work carried out by the plant production section of IPEACS.* *In* Reuniao da Comissao Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp. 51-54. Port.

Cassava. Field experiments. Cultivation. Fertilizers. N. P. K. Productivity. Spacing. Brazil.

Brief notes are given on cassava varieties, cultivation and harvesting, yields fertilization and manuring; plant spacing and density. *(Summary by H.J.S.)* D00

0262-2029 ARAQUE, R. **La yuca; su cultivo y sus usos.** *(Cassava; its cultivation and uses).* Venezuela. Ministerio de Agricultura y Cria. Serie de cultivos no. 2. 1961. 20p. Span., 5 Refs., Illus.

Cassava. History. Cultivars. Climatic requirements. Soil fertility. Cultivation. Diseases and pathogens. Pests. Economics. Industrialization. Nutritive value. Animal nutrition. Marketing. Feeds and feeding. Venezuela.

A short description is given of cassava dealing with origin, climatic requirements, varieties, cultivation techniques, pests and diseases, nutritional value of the roots and methods of processing in Venezuela. *(Summary by Tropical Abstracts)* D00 H00

0263-2060 MIRRADO, J. H. M. **Cultura da mandioca.** *(Cassava cultivation).* Gazeta do Agricultor 21(237):34-36. 1969. Port.

Cassava. Cultivation. Cuttings. Harvesting. Productivity. Uses. Cultivation systems. Propagation materials.

Data presented deal with uses, varieties, selection of cuttings, crop rotation, soil requirements, land preparation, fertilization, cultivation, harvesting and yields. *(Summary by H.J.S.)* D00

0264-3203 KENSINGER, K. M. **Manioc and the Cashinabua (Peru).** Bennington, Vermont, Bennington College, 1971. 16p. Engl., Illus.

Paper presented at: Symposium, "Manioc in Lowland South America," 1971.

Cassava. Human nutrition. Cultivation. Uses. Processing. Harvesting. Soil fertility. Ecology. Peru.

This paper describes the classification, production and usage of cassava by the Cashinahua, a group of Amerindians living along the Curanja and Alto Purus rivers in southeastern Peru. Information is presented from the point of view of an anthropologist. *(Summary by H.J.S.)* D00

0265-2064 BRAVO, A. F. **El cultivo de la mandioca.** *(Cassava cultivation).* Argentina. Ministerio de Agricultura y Ganadería. Publicación Miscelánea no. 330. 1950. 12p. Span., Illus.

Cassava. Cultivation. Uses. Starch productivity. Productivity. Food products. Factories. Industrial machinery. Cassava starch. Processing. Argentina.

This article presents a general overview of the various aspects of cassava cultivation in Argentina and includes the following topics: climate, varieties, soils, cultural practices and uses. Cassava is used for starch extraction. A detailed description is given of the processing machinery for starch extraction. *(Summary by J.L.S.)* D00 102

0266-2401 HASSANIA, Y. O. K. **Cassava growing in Zanzibar.** Poona Agricultural College Magazine 40(3):46-48. 1949. Engl.

Cassava. Cultivars. Cultivation. Uses. Zanzibar.

A brief description is given of cassava cultivation in Zanzibar. Data refer to land tenure of fields planted to cassava, its cultivation and uses. *(Summary by H.J.S.)* D00 102

0267-0760 GAIDE, M. **Au Tchad les transformations subies par l'agriculture traditionnelle sous l'influence de la culture cotonniere.** *(The transformation of traditional agriculture brought about in Chad by the introduction of cotton cultivation).* Agronomie Tropicale 11(6):707-731. (Concl.) 1956. Fr., Sum. Fr., Span., Engl., Illus.

Cassava. Cotton. Rice. Cultivation systems. Rotational crops. Africa.

In the whole southern part of Chad, the French introduced cotton cultivation to existing traditional agriculture. In the first section the following points are reviewed: rotation, clearing, fallowing, cultural methods: implements, food crops, animal breeding and human milieu. Modifications to customary practices are studied. Shorter fallowing periods, less time between rotations on exhausted soils, and decline of customary chief's authority are the most unfavorable conditions. In the second section, different solutions to various aspects of the problem of the evolution of native agriculture are studied. In an appendage, development and influence of two other crops also introduced in Chad—i.e., cassava and rice—are briefly examined. *(Author's summary)* D00 K01

0268-0370 GALANG, F. G. **Experiments on cassava at the Lamao Experiment Station, Lamao, Bataan.** Philippine Journal of Agriculture 2(2):179-188. 1931. Engl., Sum. Engl.

Cassava. Cultivars. Cuttings. Productivity. Composition. Cultivation. Climatic requirements. Planting. Propagation materials. Philippines.

After a 6-year cassava trial at the Lamao Experiment Station, the variety Unite ranked first in yield, both in tubers and starch. Red Manila was second and Mandioca Basiacao, third for planting cassava under soil and climatic conditions similar to those in Lamao. Either the base or the middle portion of the cassava stem should be used in planting, but preference should perhaps be given to the base cuttings. The planting of the whole stem is not to be recommended for obvious reasons. Cassava cuttings may be planted either in a slanting or erect position with practically equal results. *(Author's summary)* D00 D03

0269-0707 CHAN, S. K. **Notes on the growing of cassava at Serdang.** *In* Blencowe, E. K. and Blencowe, J. W. eds. Crop diversification in Malaysia. Kuala Lumpur, Malayasia, Incorporated Society of Planters, 1970. pp. 139-148. Engl., Sum. Engl., 5 Refs.

Cassava. Planting. Harvesting. Cultivars. Stems. Propagation. N. P. K. Productivity. Pruning, Timing. Tuber productivity. Cuttings. Propagation materials. Fertilizers. Malaysia.

The following aspects of cassava growing at Serdang are discussed: varieties, propagation, method of planting, manuring, stem density and time to harvest. Notes on the correlation of weight of roots with the top vegetative parts of the plant are also given. *(Author's summary)* D00

0270-0385 MOLINYAWE, C. D. **Cassava: a guide to its culture.** University of the Philippines, College of Agriculture. Farm Crops Division. Farm Bulletin no. 24. 1968. 13p. Engl.

Cassava. Propagation. Harvesting. Processing. Storage. Production Costs. Planting. ***Manihot esculenta.*** **Soil fertility. Climatic requirements. Nutritional requirements. Fertilizers. Economics. Spacing. Cultivation Philippines.**

This agricultural bulletin, prepared for Philippine farmers, presents a brief general background on cassava (*Manihot utilissima* Pohl), a botanical description of the plant, a discussion of poisonous and nonpoisonous varieties and indicates the most suitable varieties; soil and climate; propagation methods; land preparation and planting methods; weeding and cultivation practices; fertilization; important pests and diseases; best harvesting, storing and processing methods; and production costs. *(Summary by P. A. C.)* D00

0271-0709 STEHLE, H. **La culture du manioc a la Martinique et ses possibilités industrielles.** *(Cultivation of cassava in Martinique and its industrial possibilities).* Bulletin Agricole de la Martinique 9:229-245. 1940. Fr., 3 Refs.

Cassava. Cultivation. Soil fertility. Green manures. Manures. Productivity. Production. Costs. Prices. Cassava flour. Processed products. Uses. Bakery products. Composition. Industrialization. Processing. Martinique.

The object of this paper is to study the status of cassava and to review its cultivation on the island, including edaphological aspects, planting, cultural practices, harvesting, yield and production costs. Results obtained from agricultural and industrial experiments serve to establish the approximate costs for the marketing and the industrialization of cassava flour for use in the bakery industry. *(Summary by J.L.S.)* D00 I02.

0272-0552 RIOS R., M., PATERNINA H., O. and ESTRADA R., N. **Informe sobre las investigaciones de yuca,** ***Manihot esculenta*** **Crantz, en Colombia.** *(Report on cassava, Manihot esculenta Crantz, research in Colombia).* Bogotá, Instituto Colombiano Agropecuario, Programa de Tuberosas, 1970. 10p. Span.

Cassava. *Manihot esculenta*. Fied experiments. Cassava programs. Composition. Cultivation. Poultry. Productivity. Animal nutrition. Swine. Diseases and pathogens. Pests. Colombia.

A description is given of the status of cassava projects headed by Colombian Government Agencies. Results are presented of projects carried out by ICA, Palmira on yields and chemical analyses of tubers, cultural practices, utilization for animal nutrition, weeding and disease and pest control. Average yields are 7 tons| ha| yr, but some varieties yielded 30 ton| ha in 10 months in commercial plots and the variety CMC91, Llanera, yielded 60 tons|ha in 10 months in experimental plots. Future research projects are listed. *(Summary by H.J.S.)* D00 E00

0273-0171 CALI. UNIVERSIDAD DEL VALLE. CENTRO DE FORMACION PROFESIONAL E INVESTIGACION AGRICOLA. **Posibilidades económicas de la yuca seca para la alimentación en el Valle del Cauca.** *(Economic possibilities of dried cassava as a feed in the Cauca Valley). Cali, Colombia, 1964. 12p. Span.*

Cassava. Feeds and feeding. Swine. Production. Costs. Economics. Cultivars. Animal nutrition. Cultivation. Productivity. Colombia.

This article presents some general economic aspects of the cultivation of cassava (*Manihot esculenta* Crantz) in the Cauca Valley (Colombia) and the possibility of using cassava as a swine feed. Appendices include observations of several varieties of cassava; production costs per ton of corn; production costs for dried cassava; and a budget of production costs per hectare for cassava in the Cauca Valley in 1963. *(Summary by P.A.C.)* D00 J00

0274-0701 LULOFS, R. B. **A study of method and costs for commercial planting of tapioca in Kedah.** *In* Blencowe, E. K. and Blencowe, J. W., eds. Crop diversification in Malaysia. Kuala Lumpur, Malaysia, Incorporated Society of Planters, 1970. pp. 149-166. Engl., Sum. Engl., 10 Refs.

Cassava. Land preparation. Planting. Harvesting. Costs. Soil fertility. N. P. K. Climatic requirements. Fertilizers. Soil requirements. Productivity. Production. Weeding. Pests. Pest control. Diseases and pathogens. Mycoses. *Fomes lignosus*. Noxious animals. Mechanization.

Cassava is most profitable if grown within easy reach of a processing factory. It grows best on well-drained, fertile sandy loam soil; sloping land should be avoided. Varieties should be chosen whose starch content exceeds 30%. Planting material may be purchased ($5-15| acre) and will store, if necessary, for several weeks. Planting on the flat is satisfactory, but ridging may give a more even stand, easier harvesting, and possible assistance in erosion control. Generous fertilizer applications, especially of potash, are required. Maturity of the tubers may be assessed visually, and sale agreements made with local mill owners on that basis. Stems are cut at 1 1|2-2 ft above the ground, leaving a "handle" to assist the harvester when he pulls out the tubers. Harvesting must start immediately after cutback. The crop needs careful supervision, is fairly labor-intensive and calls for substantial outlay for fertilizer and maintenance. However, estate costings suggest that a crop of 12-15 tons| acre can readily be obtained and should give profits of $100-160| acre. *(Author's summary)* D00 J00

0275-2444 REGNAUDIN, A. **Le manioc: culture, industrie.** *(Cassava: cultivation, industry).* Paris, Société d'Editions Geographiques, Maritimes et Coloniales, 1932. 102p. Fr., Illus.

Cassava. Cultivation. Industrialization. Factories. Processing. Washing. Rasping. Peeling. Grinding. Silting. Steeping. Screening. Drying. Glucose industry. Industrial machinery. Cassava flour. Cassava starch. Tapiocas. Dextrins. Glucose. Soluble carbohydrates. Composition. Production. Analysis. Food products. Confectioneries.

The following aspects are discussed: deficits of starchy materials in France and its colonies in 1931, cassava growing, cassava starch factories in the colonies, tapioca manufacturing, dried cassava-starch factories, dextrin manufacturing, cassava glucoses, vegetal and animal charcoal, laboratory confectionery trials, conclusions. *(Summary by H.J.S.)* D00 102

0276-1601 TAN, K. H. and BERTRAND, A. R. **Cultivation and fertilization of cassava.** *In* Hendershott, C. H. *et al.* A literature review and research recommendations on cassava. Athens,Ga., University of Georgia, 1972. pp.37-72. Engl., 95 Refs.

Cassava. *Manihot esculenta.* **Cultivation. Climatic requirements. Soil requirements. Soil impoverishment. Water requirements (plant). Cuttings. Propagation materials. Land preparation. Planting. Harvesting. Storage. Fertilizers. Productivity. Nutritional requirements. Manures. Green manures. Crotalaria. Diseases and pathogens. Pests. Costs. Production. Soil fertility.**

The cultivation of cassava has always been limited to the tropics, but recent information indicates that cassava can adapt itself to a subtropical or warm temperature climate. The climatic types where cassava is grown are discussed. Soils and soil characteristics considered as potentially important to cassava are reported. Cultural practices, harvesting, fertilization, diseases and pests and production are also discussed. *(Summary by J.L.S.)* D00

0277-3317 AMON, B. O. E. **The response by crops in a rotation to nitrogen, phosphorus and potassium in the savannah zone of western Nigeria.** Publ. Comm. Techn. Cooper Africa 98:339-348. 1967. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Yams. Maize. Fertilizers. Savanna. N. P. K. Soil requirements. Cultivation. Rotational crops. Productivity. Nigeria.

The paper describes the responses obtained to major fertilizers by the stable food crops maize, yams and cassava in the savanna zone of western Nigeria. The crops are grown in rotation; the combined results for yams cover a 3-year period while those for maize and cassava covered a 4-year period. The soils of the sites of the experiments are sandy to a depth of at least 20 in and may contain quartz gravel and ironstone concretions over mottled clay subsoil overlying weathered rock material. The experimental results show that high yield increases were obtained with application of fertilizers and the quantities needed for best yields on the savanna soils are given. *(Author's summary)* D00 K01

0278-0147 MOLINARY-SALES, E. **La yuca** (*Manihot manihot* **(L) Cockerell).** *(Cassava, Manihot manihot (L) Cockerell).* Revista de Agricultura de Puerto Rico 51(2):50-54. 1964. Span.

Cassava. *Manihot esculenta.* **Toxicity. Harvesting. Cultivars. Cultivation. Fertilizers. Diseases and pathogens. Pests. Puerto Rico.**

General background information is given on cassava (*Manihot manihot* (L) Cockerell). Results of experiments with cassava carried out at the Agricultural Experiment Station of the University of Puerto Rico are presented. Data include best varieties, fertilization, general considerations on crop management in the field (seed, planting, cultivation, fertilization, pest and diseases), harvesting, and potential industrial uses. *(Summary by P.A.C.)* D00.

0279-3389 **NOTICE SUR la culture du manioc dans la circonscription des Bakougnis.** *(Notes on cassava cultivation at the Bakougnis district).* Bulletin Economique de l'Afrique Ecuatoriale Francaise 5(13):3-5. 1929. Fr., Illus.

Cassava. Cultivation. Harvesting. Tubers. Productivity. Processing. Congo.

Cassava is a staple foodstuff in the Middle Congo. Methods of cultivation are described. Harvesting follows 2 patterns: (1) All the tubers of a plant are harvested at once. This process continues for about 1 year until the harvest is complete. After harvest the land lays fallow for 2 years. (2) Only the thickest tubers of a plant are harvested; thus the harvest period of one plant is about 3 years. Tubers yields average about 15 ton| ha. The preparation of "chicobangue" and cassava meal are described: *(Summary by H.J.S.)* D00

0280-0744 NORMANHA, E. S. **Yuca; observaciones y recomendaciones sobre su cultivo en Nicaragua.** *(Cassava; observations and recommendations for its cultivation in Nicaragaua).* Managua, Banco Central de Nicaragua, 1971. 29p. Span., Illus.

Cassava. Mycoses. Bacterioses. Entomology. Injurious insects. *Silba pendula.* **Bemisia. Development. Pests. Diseases and pathogens. Disease control.** *Cercospora henningsii. Cercospora caribaea. Xanthomonas manihotis.* **Noxious animals. Insect control. Pest control. Insecticides. Soil fertility. Fertilizers. Cultivation. Planting. Harvesting. Timing. Cuttings. Propagation. Nicaragua.**

An agronomic evaluation of cassava in Nicaragua is given. Fungal diseases (**Cercospora** spp.), and bacterioses *(Xanthomonas manihotis)* are briefly discussed; control measures are given as well. The main pests are a *Colepterous cerambycidae* of the genus **Lagoecheirus** spp., the bud maggot *(Silba pendula),* Acares, and whiteflies (**Aleyrodidae** belonging to the species *Bemisia tabaci,* capable of transmitting virus diseases). Recommendations are given for the production of chips (dried cassava) to export to European countries or to be utilized domestically in human and animal nutrition. Prospects for industrial units are included. *(Summary by J.L.S.)* D00.

0281-0382 KOSHY, T. K. **The tapioca plant and methods for evolving improved strains for cultivation.** Proceedings of the Indian Academy of Sciences (Section B) 26(2):32-59. 1947. Engl., Sum. Engl., Illus., 8 Refs.

Cassava. Plant breeding. Planting. Harvesting. Cultivars. Ceara rubber. *Manihot esculenta.* **Hybridizing. Backcrossing. Plant anatomy. Flowers. Stems. Tubers. Leaves. Petioles. Identification. Cultivation. Seed. Plant development. Hybrids. Composition. Genetics. Spacing. Fertilizers, India.**

By the application of genetical methods , a good number of new strains of cassava and cassava x ceara hybrids have been produced in a search for high-yielding strains. The selected strains will soon be made available to the ryot for cultivation. Experiments are also being undertaken to ascertain the best mode of planting seed canes, optimun spacing for planting, number of plants per pit, effective manures, and the best period for harvesting. All these experiments are conducted on the basis of a statistical design furnished by the Department of Statistics at the University. The applications of genetical methods for evolving better strains of cassava are presented as the first paper from the Tapioca Research Farm in order to stimulate further work on this important crop plant in order to improve its cultivation in Travacore. *(Author's summary)* D00 G01

0282-0777 ARAQUE, R. **Cultive la yuca valioso alimento de los trópicos.** *(Cultivate cassava, a vabluable foodstuff for the tropics).* La Hacienda 60(10):56,58-59. 1965. Span., Illus.

Cassava. Cultivation. Diseases and pathogens. Harvesting. Analysis. Toxicity. Pests.

A brief description is made of cassava including origin, botany, soil preparation and planting, fertilization, important diseases and pests, harvesting, chemical composition and toxicity. *(Summary by H.J.S.)* D00

0283-0779 FRITZ, A. **Sur deux produits agricoles du nord-ouest de Madagascar.** *(Concerning two crops of northwestern Madagascar).* Agronomic Coloniale 17:9-19. 1928. Fr.

Cassava. Cultivation. Uses. Cultivars. Planting. Spacing. Harvesting. Malagasy Republic.

Brief notes are presented on cassava. Data given refer to climatic and edaphic requirements, cultivation, cultural practices, harvesting, industrialization, and diseases and pests. *(Summary by H.J.S.)* D00

0284-0795 COLOM, J. L. **La yuca; su cultivo y aprovechamiento.** *(Cassava: its cultivation and use).* Revista de Agricultura (Costa Rica) 19:245-269. 1947. Span.

Cassava. Cultivation. Harvesting. History. Uses. Composition. Processing. Cassareep. Gaplek. Dried tubers. Cassava pastes. Cassava products. Wastes. Marketing. Economics. Trade. Costa Rica.

Notes are presented on cassava concerning its common names, history, botanical description, tuber and flour composition, cultivation, manuring, harvesting, diseases and pests, uses, international trade, and importance in the U.S.A. and Latin America. *(Summary by H.J.S.)* D00 102

0285-0819 **EL CULTIVO de la yuca.** *(Cassava cultivation).* Boletin de Información (Colombia) 3:14-16. 1958. Span.

Cassava. Cultivation. Colombia.

Brief notes about cassava cultivation are given. *(Summary by H.J.S.)* D00.

0286-0852 **LE MANIOC.** *(Cassava).* Recherche Agronomique de Madagascar no. 1:49-52. 1952. Fr., Illus.

Cassava. Identification. Plant anatomy. Fertilizers. Ecology. Productivity. Cultivars. Soil fertility. Cultivation. Climatic requirements. Development. Nutritional requirements. Malagasy Republic.

The paper is divided into three parts: Part 1 deals with the characteristics of 15 varieties. Cassava clones have little plasticity; every clone fits to a certain type of environment (soil and climate). Part 2 is a key to identify those 15 varieties. Part 3 concerns field trials on fertilizing two types of lateritic soils cultivated with cassava. *(Summary by H.J.S.)* 00.

0287-0657 CHACON, S.O. **Resúmenes de trabajos con yuca realizados en Jusepin.** *(Abstracts of cassava studies at Jusepin).* Tropical Root and Tuber Crops Newsletter no. 4:19-23. 1971. Span., 1 Ref.

Cassava. Productivity. Tuber productivity. HCN content. Leaves. Clones. Field experiments. Soil fertility. Climatic requirements. Composition. Identification. Venezuela.

Results are given of several studies dealing with tuber yields of some cassava varieties, HCN content in the leaves, and observations on some vegetative characteristics for the identification and description of cassava clones. Data are also given on the soil and climatic conditions at Jusepin. *(Summary by H.J.S.)* D00 D03

0288-0661 FRANKE, G. **Maniok,** *Manihot esculenta* **Crantz.** *(Cassava, Manihot esculenta Crantz). In* Nutzpflanzen der Tropen und Subtropen. Leipzig, S. Hirzel Verlag, 1967. v.1, pp.266-267. Germ., 20 Refs., Illus.

Cassava. HCN. Identification. Fertilizers. K. Productivity. *Manihot esculenta.* **Plant anatomy. Cultivars. Soil fertility. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus.** *Fomes lignosus.* **Mycoses.**

The genus center, which probably originated in the amazon area of Brazil, has now spread all over the tropics. **Manihot** has about 150 species. A botanical description is given. Due to vegetative reproduction, generative reproduction was lost in several varieties. The cyanide levels of 49 varieties varied from 30-370 mg HCN| kg of root, while the low cyanide roots contain the cyanide in the 2 outer tissue layers. Cassava is adapted to warm, humid climates although it is drought resistant. Soil requirements as well as cultural methods and fertilization are discussed. Potassium fertilization increased yield and reduced cyanide levels (same as drought). The attack of root by **Fomes** and virus diseases are mentioned. Harvesting and uses are discussed. *(Summary by A. van S.)* D00

0289-0575 DELGADO, R. E. **El cultivo de la yuca en el Perú.** *(Cassava cultivation in Peru).* Lima, Perú, Instituto Interamericano de Ciencias Agrícolas, 1970. 16p. Span., 4 Refs.

Cassava. Cultivation. Germplasm. Manihot. Cuttings. Spacing. Composition. Starch content. Protein content. Water content. Peru.

A description is given of the present status of cultivated areas, industrialization, **Manihot** species and cultivars, cultivation, germplasm banks and diseases and pests in Peru. Data are given of investigations carried out by 3 research agencies in Peru. Research described deals with starch, protein and moisture content of cassava tubers, size of cuttings and density of planting. *(Summary by H.J.S.L.)* D00 C03

0290-0339 MOLEGODE, W. **Cassava or manioc in Ceylon and its cultivation.** Tropical Agriculturist 63:41-45. 1924. Engl.

Cassava. Cultivation. *Manihot esculenta.* **Spacing. Harvesting. Starch content. Composition. Productivity. Cassava flour. Uses. Processing. Toxicity. Nutritive value. Sri Lanka.**

This article reviews the history of cassava (*Manihot utilissima* Pohl) in Ceylon. It includes a description of varieties, local cultivation conditions and practices, harvesting and yields, uses of cassava, its food value, local methods of preparing cassava flour, starch manufacture, and characteristics of and antidotes for cassava poisoning. *(Summary by P.A.C.)* D00 I02.

0291-0307 ESTRADA R., N. **Cultivo de la yuca.** *(Cassava cultivation).* Bogotá, Instituto Colombiano Agropecuario, Programa de Papa y Yuca, n.d. 7p. Span.

Cassava. Production. Taxonomy. Roots. Planting. Harvesting. Uses. Climatic requirements. Soil fertility. Seed. Propagation materials. Spacing. Cultivation. Fertilizers. Pests. Diseases and pathogens. Cultivation systems. Cultivars. Productivity. Composition. Colombia.

This article presents a general overview of the cultivation of cassava *(Manihot utilissima)* and includes the following topics: common names, production, classification, root forms, climate, soils, seed planting systems, fertilization, insect control, pruning, diseases, harvesting, rotation, best Colombian varieties, uses, yields, improvement and chemical composition. *(Summary by P.A.C.)* D00

0292-0452 POLANCO, I. DE and LANDAU, C. E. **Ensayos experimentales en el cultivo de la yuca.** *(Experimental trials in the cultivation of cassava).* Panamá, Minesterio de Agricultura y Ganadería, 1967. 13p. Span.

Cassava. Research. Production. Productivity. Cultivation. Harvesting. Planting. Timing. Tuber productivity. Cultivars. Field experiments. Panama.

An evaluation was made of 2 collections of Panamanian cassava in terms of time to harvest, yields and cooking qualities. The first collection consisted of 21 varieties from the province of Chiriqui and the second of 23 varieties from several regions of the country. Cuttings of 0.25-0.30 cm from the first collection were planted at a distance of 1.5 m between plants and 1.8 m between rows. 12-24-12 fertilizer was applied 6 weeks after planting. During the dry season, the plants were attacked by red spider and **Lonchaea** sp. larvae; symptoms of Cercospora were also present. Yields in pounds of roots per plant are presented for harvest at 10, 12, 13, 17 and 21 for the 21 varieties, as well as a comparison of number and pounds of roots per plant for all varieties at 7 and 12 months. The 12 best-yielding varieties from this Chiriqui collection were then included in the second collection for further testing. In this second group, plantings were made, one variety per row, at a distance of 2 m between plants and between rows. 12-24-12 fertilizer was applied at 6 weeks, at a rate of 600 lb|ha. The plants were harvested at 8 and 12 months, and the number and weight of roots per plant are presented. In general, yields from the harvests at 12 months were greater than those at 8 months. *(Summary by P.A.C.)* D00.

0293-0308 ESTRADA R., N. and VARON, L. A. **El cultivo de la yuca.** *(Cassava cultivation).* Bogotá, Instituto Colombiano Agropecuario, nd. 5p. Span.

Cassava. Harvesting. Cultivation. Climatic requirements. Soil fertility. Cultivars. Seed. Propagation materials. Spacing. Nutritional requirements. Pests. Fertilizers. Diseases and pathogens. Cultivation systems. Uses. Colombia.

This article presents a general summary of the best climate and soil conditions for growing cassava, the best varieties, best seeding times, best seeds and systems of planting, recommended fertilization, possibilities for analysis, pest control, diseases, harvesting, rotation and uses for cassava in Colombia. *(Summary by P.A.C.)*
D00

0294-0838 PEREZ, O. **Anotaciones sobre el cultivo de la yuca.** *(Notes on cassava cultivation).* Medellin, Instituto Colombiano Agropecuario. 1972. 7p. Span.

Cassava. Cultivation. Land preparation. Planting. Spacing. Pests. Injurious insects. Noxious animals. *Erinnyis ello. Carpolonchaea chalybea.* **Galls. Insect control. Pest control. Insecticides. Bacterioses. Pseudomonas. Mycoses. Phoma. Rosellinia.** *Cercospora henningsii. Cercospora caribaea.* **Oidium. Disease control. Colombia.**

Tubers, fresh vegetables and cereals exhibit great variations in their humidity content due to growth, storage and climatic factors. These variations affect the relative energy value. A method to calculate the nutritive value (calories) of foodstuffs containing variable amounts of moisture is described. *(Summary by H.J.S.)*
D00 F00 E01.

0295-0309 ESTRADA, R. N. **Informe para la agenda de la discussión sobre la investigación en yuca,** *Manihot esculenta. (Report on the agenda for discussion of cassa, Manihot esculenta, research).* Bogotá, Colombia, Instituto Colombiano Agropecuario, Programa de Tuberosas, 1969. 12p. Span.

Cassava. *Manihot esculenta.* **Research. Cultivation. Mechanization. Starch productivity. Pests. Colombia.**

The author presents various aspects of research work on cassava carried out at the Instituto Colombiano Agropecuario, ICA: germplasm collections, breeding, diseases and pests, weed control, cultural practices, mechanization, storage, quality, technology (industrial utilization), animal feeding, principal work locations, personnel from ICA working in the cassava program, cooperation with institutions from other countries, and coordination between ICA and CIAT, Centro Internacional de Agricultura Tropical. *(Summary by P.A.C.)* D00

0296-0608 DULONG, R. **Le manioc á Madagascar.** *(Cassava in Madagascar).* Agronomie Tropicale 26(8):791-829. 1971. Fr., Sum. Fr., Engl., Span., 41 Refs., Illus.

Cassava. Composition. Starch content. HCN content. Nutritive value. Pests. Cultivation. Planting. Harvesting. Fertilizers. N. P. K. Mechanization. Costs. Diseases and pathogens. Viroses. Mycoses. Bacterioses. Disease control. Noxious animals. Injurious insects. Nematodes. Entomology. Selection. Hybridizing. Genetics. Plant breeding. Cultivars. Productivity. Malagasy Republic.

The following general background data are given on cassava: the HCN content of roots; the variations of this content according to varieties; plant development and cultivation conditions; starch content; food value; and its use for animal feeds. The second chapter concerns cultivation in Madagascar. A cost study of cassava growing is given, which indicated that a complete mechanization of production is profitable only under very favorable conditions. Problems relative to plant health include pest and virus diseases, especially mosaic; physiological diseases such as heart necrosis; pests and weeds. The last chapter is dedicated to the study of varietal improvement. The general objectives of genetic plant improvement and the particular objectives for 4 main ecological zones in Madagascar are given. Currently used breeding methods are described, especially those introducing sexual reproduction and hybridization. Hybridization can be artificial (emasculation, pollination, bagging) or natural (pollination by insects and wind) with the plants to be hybridized being emasculated, or male sterile parents are used (53 male sterile clones exist in the IRAT cassava collections in Madagascar). Because of the high heterozygosity of cassava clones, the probability of obtaining promising clones by hybridization among them is poor and requires a great number of hybrid seeds, thus the last hybridization method is the most profitable. An improved efficiency of the methods of genetic cassava improvement would require a better knowledge of the genetic determinism of the useful characters. The selection of the best clones in the different ecological conditions of Madagascar through multilocal experiments is described. Although cassava is not the most important food crop in Madagascar, a great deal of knowledge has already been obtained on varietal improvement; therefore research work, especially as regards the development of new varieties, should be more specifically oriented towards growing conditions and present market demand (animals feedstuffs) rather than towards increasing yields. *(Author's summary)* D00 G01.

0297-0642 WHITTY, E. B. **Report of 1970 sweet cassava variety trial at Ebini.** Gainesville, University of Florida, Cooperative Extension Service, 1971. 3p. Engl.

Cassava. Spacing. Land preparation. Sweet cassava. Cultivars. Fertilizers. Plant anatomy. Cultivation. Savannas. Guyana.

Results of these preliminary cassava trials indicate that aceptable yields can be produced on the intermediate savanas of Guyana. Over 5 tons/acre were obtained from 2 varieties. Optimum spacing and fertilization along with improved cultural practices should result in even greater yields. Harvesting trials are imperative; it was intended that the cassava would be harvested about 10 months after planting. This would be and ideal situation for animal feeding because the cassava could be planted in April or May at the start of the long rainy season and be harvested from February to April, the time that feed is in short supply in Guyana. If maturing characteristics of cassava varieties do not allow this schedule, then other planting schemes will be necessary. *(Author's summary)* D00

0298-0454 VIRIECO, S. D. **Comparación de variedades de yuca originarias del Municipio de Malambó en los suelos arenosos de "Loma Grande".** *(Comparison of cassava varieties from Malambó on sandy soils at Loma Grande).* Barranquilla, Cooperativa Agrícola del Atlántico, 1961. 19p. Span.

Cassava. Productivity. Field experiments. Timing. Cultivation. Harvesting. Planting. Soil fertility. Cultivars. Plant anatomy. ***Manihot esculenta.*** **Colombia.**

Trials were carried out on the Caribbean Coast of Colombia with 8 local varieties of sweet cassava (*Manihot palmata* Muel.) to evaluate their yielding capacity, maturing time and starch content. Plantings were made with a distance of 1m between plants and between rows. After harvest (at 17 mo), 2 of the varieties were eliminated from the evaluation, one for susceptibility to rot and one for low yield. Morphological, biological and physiological characteristics are presented for each of the remaining 6 varieties: Monter, Solita, Pie Paloma, Blanca Mona, Monposina and Cartagena. From the harvest, cuttings were planted on a commercial farm; from this planting, only one variety survived the first year. Observations of this plant at the end of the first and second years are presented. *(Summary by P.A.C.)* D00 B00.

0299-2452 KERVEGANT, D. **Le manioc et son utilization à la Martinique.** *(Cassava and its uses in Martinique).* Bulletin Agricole de la Martinique 7(2):60-73. 1938. Fr.

Cassava. Cultivation. Production. Bakery products. Economics. Trade. Marketing. Industrialization. West Indies.

A description is given of cassava cultivation and its uses in Martinique. Data refer to production, commercial possibilities, bread making and the socioeconomic advantages of cassava cultivation. *(Summary by H.J.S.)* D00 J00

0300-2417 TOURNEUR, M. **La culture du manioc.** *(Cassava cultivation).* *In* Congres du Manioc et des Plantes Féculentes Tropicales, Marseille, 1949. pp. 58-62. Fr.

Cassava. Climatic requirements. Soil requirements. Soil fertility. Planting. Harvesting. Cultivation. Cassava mosaic virus. Viroses. Diseases and pathogens. Pests. Malagasy Republic.

A description is given of cassava cultivation in Madagascar. Data refer to climatic and edaphic requirements, cultivation, harvesting, diseases and pests. *(Summary by H.J.S.)* D00

0301-2406 **NOTE SUR le manioc en Indochine.** *(Notes on cassava in Indochina).* *In* Congres du Manioc et des Plantes Féculentes Tropicales, Marseille, 1949. Compte-rendu. Marseille, Institut Colonial, 1949. pp. 134-136. Fr.

Cassava. Cultivation. Productivity. Trade. Economics. Tapioca. Indochina.

Brief notes are given on varieties of cassava cultivated, area and production, yields, commerce and legal aspects. Four tables of statistical data are presented dealing with exports and imports of cassava and tapioca from 1938-48. *(Summary by H.J.S.)* D00 J00

0302-2405 STOVALL, R. P. **Dominican yuca plays a dual role.** Agriculture in the Americas 7(12):153-155. 1947. Engl., Illus.

Cassava. Development. Cultivars. Productivity. Uses. Cultivation. Dominican Republic.

A general description is given of the present status of cassava cultivation, its uses and industrialization in the Dominican Republic. *(Summary by H.J.S.)* D00

0303-2207 CHEVALIER, A. **Possibilité de développer la culture du manioc au Sénégal.** *(The possibility of expanding cassava cultivation in Senegal).* Revue de Botanique Appliquée et d'Agriculture Tropicale 10:676-678. 1930. Fr.

Cassava. Cultivation. Development. Productivity. Senegal.

Cultural practices of cassava cultivation in Senegal, as well as climate and soil requirements of the crop, are briefly described. General comments are made on labor input, yields, potential markets and other economic aspects. The author feels that cassava could be an important crop in Senegal. *(Summary by H.J.S.)* D00

0304-0218 CRAWFORD, J., comp. **Cassava report on growing cassava in St. Elizabeth.** Jamaica, Kaiser Bauxite, 1961. 23p. Engl., Illus.

Cassava. Cultivation. Cultivars. Selection. Planting. Rooting. Developmental stages. Cuttings. Propagation materials. Fertilizers. Starch content. Productivity.

Experiments with cassava growing in Jamaica are reported for 1958-59. Aspects dealt with include methods of cultivation, characteristics of varieties, yields and starch contents. *(Summary by Tropical Abstracts)* D00

0305-2092 RAO, H. A. G. **Cultivation of cassava and preparation of its products.** Mysore Agricultural Journal 27:57-69. 1951. Engl., 5 Refs., Illus.

Cassava. Cultivation. Cassava products. Cassava starch. Cassava flour. Human nutrition. Tapiocas. Processing. Gaplek. India.

This paper is intended to serve as a guide for the cultivation of cassava in the State of Mysore (India). Recommendations are made on cultivation systems such as planting material, cutting positions, spacing, cultural practice, manuring and harvesting. Remarks are given on the uses of cassava and the manufacture of the following products: gaplek, starch, sago, soji, flour and tapioca. *(Summary by J.L.S.)* D00 102.

0306-0198 MARWAHA, P. S., MAINI, O. S. and PAREEK, L. P. **Tapioca; a boon to Keralites.** Agriculture and Agro-Industries Journal 5(3):16-19. 1972. Engl.

Cassava. Cultivation. Identification. Fertilizers. Productivity. Stems. Petioles. Cultivars. Plant anatomy. Uses. India.

This is a general overview of the cultivation and uses of cassava in the state of Kerala (India). Average yield is 15 ton|acre. Morphological characteristics are given of the following improved varieties: H 96|44, H 105|44, H 7|49, H 9|49, H 12|49, H 10|50, H 20|50, H 21|50, M 4 and M 5. *(Summary by J.L.S.)* D00 B00

0307-2080 SILVA, J. R. DA. **Mandioca, plantio e cultivo.** *(Cassava, cultivation and planting).* Chacaras e Quintais 113(5):474. 1966. Port.

Cassava. Cultivation. Brazil.

An answer is given to a question on cassava cultivation and industrialization. Brief notes are given on cultivation methods and on type of machinery to be used. *(Summary by H.J.S.)* D00

0308-2118 GULLIVER, T. A. **Cassava.** Queensland Agricultural Journal 23:414-415. 1925. Engl.

Cassava. Cultivation. Productivity. Sweet cassava. Bitter cassava. Uses. Australia.

The possibility of growing cassava in North Queensland for producing power alcohol has been stated. Brief notes on cassava cultivation and yields are presented. *(Summary by H.J.S.)* D00.

0309-0093 KAISER BAUXITE COMPANY. **Report on cassava cultivation.** Kingston, 1961. 24p. Engl., Illus.

Cassava. Cultivation. Cultivars. Land preparation. Planting. Propagation materials. Cuttings. Productivity. Composition. Starch content. Water content. Timing. Harvesting. Production. Costs. Economics. Jamaica.

Experiments with cassava growing in Jamaica are reported for 1958-59. Aspects dealt with include methods of cultivation, characteristics of varieties, yields and starch content. *(Summary by Tropical Abstracts).* D00.

0310-0443 RODRIGUEZ, N. F., SANCHEZ DE B. C. A. and TARABANOFF, J. **Algunos factores que influyen en el comportamiento del cultivo de mandioca en la Provincia de Misiones.** *(Influence of cultural factors on cassava yields in the province of Misiones).* Revista de Investigaciones Agropecuarias 3(11):167-208. 1966. Span., Sum. Span., Engl., 61 Refs.

Cassava. Harvesting. Planting. Tuber productivity. Starch productivity. Leaves. Productivity. Cultivars. Spacing. Cultivation. Stems. Field experiments. Argentina.

A randomized block experiment with a split-split-split plot design was carried out in the province of Misiones from 1955-58 to test the influence of several cultural factors on cassava yields. Six planting periods, 2 varieties, 4 planting densities and 3 harvesting periods were taken into consideration. The experiment was conducted on level, well-drained terraces. Results were submitted to an analysis of variance. (1) As regards root production, Pombo was the best variety when planted early (Aug.-Sept.); Azul was better for the late crop (Oct.-Nov.). Optimum planting density was 1.00 x 0.50m. Best harvesting times were May and June, respectively. (2) For stalks and leaves, Azul planted early at 1.00 x 0.50m or 1.00 x 0.75m gave the best results. The most suitable harvest time was April. (3) For total production, the best planting time was Aug. and Sept. Azul was the best variety. Best planting density was 1.00 x 0.50m, and best harvest time was April or the first half of May. *(Summary by T.M.)* D00 D03

0311-0618 AFONJA, B. **Analysis of a uniformity trial on cassava.** Experimental Agriculture 4(2):135-141. 1968. Engl., Sum. Engl., 7 Refs.

Cassava. Field experiments. Cultivation.

The analysis of a uniformity trial on cassava is briefly discussed, mentioning possible effects of plant losses on the methods of analysis. Two methods of calculating comparable variances (on a per plant and per unit area basis) gave very high values for the index of heterogeneity, with a mean of 0.94. When the ratio of overall cost per plot to cost per unit area lies between one and two, an optimum plot size of between 16 and 32 plants is obtained. Comparable plot sizes would range from 192-385 ft² giving a coefficient of variation of less than 20. *(Author's summary)* D00

0312-2269 GOHIER, M. **La culture du manioc a Madagascar.** *(Cassava cultivation in Madagascar).* Tananarive, Madagascar, Lavigne, 1917. pp.17-29. Fr.

Cassava. Cultivation. Climatic requirements. Land preparation. Planting. Spacing. Nutritional requirements. Fertilizers. Soil impoverishment. Soil fertility. Rotational crops. Cultivation systems. Harvesting. Productivity. Production. Costs. Malagasy Republic.

Brief notes are given on climatic and edaphic requirements of cassava, its cultivation, harvesting, yields, diseases and pests, costs of cultivation and commerce. Final conclusions stress economic aspects. *(Summary by H.J.S.)* D00

0313-2448 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Manioc.** *(Cassava). In* ________. Compte rendu analytique des travaux realisés en 1965-1966. Paris, 1966. v.3. pp.71-133. Fr.

Cassava. Clones. Identification. Roots. Stems. Leaves. Plant height. Plant anatomy. Plant development. Cultivars. Resistance. Tuber productivity. Starch productivity. Productivity. Harvesting. Timing. Cultivation. Propagation. Planting. Cuttings. Propagation materials. Herbicides. Fertilizers. N. P. K. Insecticides. *Carpolonchaea chalybea.* **Injurious insects. Noxious animals. Pest control.**

Detailed descriptions are given of research carried out at IRAT, Guadalupe (Antilles). Research dealt with identification and separation of clones, testing of yields, propagation, fertilization, starch yields, herbicides and disease and pest control. *(Summary by H.J.S.)* D00

0314-1886 HASSAIN, Z. **The cultivation and importance of cassava (*Manihot esculenta* Crantz) in the tropics.** Gottingen, Germany, University of Gottingen, 1973. 13p. Engl. 34 Refs.

Paper present at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Cultivation. Rainfall data. Climatic requirements. Tuber development. Planting. Cuttings. Propagation materials. Spacing. Nutritional requirements. Fertilizers. N. P. K. Potash. Plant physiology. Manures. Ammonium sulphate. Potassium chloride. Productivity. Soil fertility. Cassava products. Uses. Food energy. Protein content. Composition.

Cassava has been grown successfully on soils of poor status in Africa or on soils where no other crop can be grown. Too high fertility may result in higher vegetative growth and may also affect carbohydrate quality. In this paper the economic cultivation and importance of cassava, especially in Africa today, are extensively reviewed. *(Summary by D. H. and L. J.)* D00.

0315-3485 **CLONES DE manioc préconisés à Madagascar.** ***(Cassava clones recommended in Madagascar).*** Cahiers d'Agriculture Pratique des Pays Chauds 21(4):167-171. 1966. Fr.

Cassava. Clones. Cultivars. Uses. Cultivation. Starch productivity. Selection. Industrialization. Human nutrition. Productivity. Malagasy Republic.

Cassava clones recommended for both direct consumption and starch manufacturing in regions of Madagascar are given, together with an outline of cultural practices. *(Summary by Tropical Abstracts)* D00.

0316-0620 MONTALDO, A. **Fases de desarrollo de la yuca,** *Manihot esculenta. (Developmental stages of cassava, Manihot esculenta).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1972. 11p. Span., Sum. Span.

Cassava. Cultivars. Harvesting. Dry matter. Composition. Field experiments. Research. Productivity. Roots. Tubers. Plant anatomy. Leaf area. ***Manihot esculenta.*** **Venezuela.**

A study of the developmental stages of cassava (*Manihot esculenta* Crantz) was carried out in Venezuela to determine the optimum period for harvesting as regards starch content and production of dry matter per hectare. Six varieties were studied in Lara and 4 in Carabobo. Successive, monthly harvesting was done 10 months after planting. Detailed results for both areas are given in tables. *(Summary by T.M.)* D00

0317-3321 **MANDIOCA. INFORMAÇOES importantes.** *(Cassdva. Important information).* São Paulo, Brasil. Secretaría de Agricultura. Instrucoes Prácticas no. 128. 1973. 18p. Port., Illus.

Cassava. Cultivation. Cuttings. Land preparation. Injurious insects. Fertilizers. Insect control. ***Erinnyis ello.*** **Pest control. Planting. Cultivars. Noxious animals. Entomology. Brazil.**

This a pamphlet addressed to farmers. Information deals with soil preparation, fertilization, characteristics of some varieties, selection of cuttings, planting season, cultural practices, and the control of 3 cassava pests: the hornworm, the stemborer and the shoot fly. *(Summary by H.J.S.)* D00

0318-3304 **LE MANIOC; sa culture, son utilisation.** *(Cassava: its cultivation and uses).* Revue Agricole (Guadeloupe) 1931:12-16. 1931. Fr.

Cassava. Cultivation. Fertilizers. Harvesting. Uses.

Brief notes are given on cassava concerning plant morphology, cultivation, fertilization and manuring, harvesting and uses. *(Summary by H.J.S.)* D00

0319-3368 PAPADAKIS, J. **Other summer crops; cassava.** *In* ________. Agricultural potentialities of world climates. Buenos Aires, 1970. pp.15-16. Engl.

Cassava. Climatic requirements. Soil fertility. Cultivation.

Cassava **(Manihot).** The growing period of **Manihot** is often longer than 1 year; that is why the bulk of the crop is grown in tropical climates, extending little beyond their limits. Warm long nights favor leaf-shoot growth at expense of root growth; that is why yields are usually low, but this difficulty can be now overcome by growth retardants. The great advantage of cassava is that it grows in soils of very low fertility; it defends itself well against weeds, and planting costs very little. That is why in the tropics it is planted at the end of the cropping cycle when the field is to be abandoned to adventitious vegetation, in order to recuperate its "potential" fertility. The crop is harvested **if and when** food is needed; by shading the soil, it controls grasses, favors woody plants and that results in higher yields when the field is again put in cultivation. Cassava is also extensively grown in areas where population density is high, and continuous cropping prevails, and in regions with poor soils (Papadakis, 1966). *(Full text)* D00

0320-3473 MARINET, J. **La culture du manioc.** *(Cassava cultivation).* Revue Agricole de la Nouvelle Calédonie no. 11:8-11. 1960. Fr.

Cassava. Cultivation. Planting. Spacing. Fertilizers. Harvesting. Productivity. Starch productivity. Cultivars. Tuber productivity.

Some aspects of cassava cultivation in New Caledonia, where it is mainly used for human consumption and starch extraction, are dealt with. Five of the most promising varieties from Madagascar (H 32, H 35, H 40, H 45 and H 51) were introduced. Recommendations of fertilizers and cultural practices are also included. Average yield is 30 tons fresh roots|ha. *(Summary by J.L.S.)* D00.

0321-0576 ESTRADA, R. N. **Observaciones sobre algunos cultivos de yuca en Sevilla y Aracataca, Departamento del Magdalena, Colombia.** *(Observations on cassava cultivation in Sevilla and Aracataca, Departamento del Magdalena, Colombia).* Bogotá, Instituto Colombiano Agropecuario, Programa de Tuberosas, 1969. 7p. Span.

Cassava. Cultivation. Cassava programs. Development. Colombia.

A description is given of the present status of some cassava commercial plots in the Departamento del Magdalena. The plots were not duly tended, thus yields were much lower than expected. *(Summary by H.J.S.)* D00.

0322-3377 NORMANHA, E. S. **Culturas subsidiarias na fazenda de cafe. II. A mandioca.** *(Subsidiary crops a coffee farm II. Cassava).* Boletim da Superintendencia dos Servicos do Cafe (Brazil) 21:189-199. 1946. Port.

Cassava. History. Cultivation. Soil requirements. Climatic requirements. Pests. Cuttings. Spacing. Diseases and pathogens. Inter-cropping. Propagation materials. Pruning. Harvesting. Brazil.

This paper is addressed to farmers. Information deals with historical aspects of cassava cultivation in Brazil, climatic and edaphic requirements, land preparation, varieties, selection of cuttings and their preparation, planting season, manuring, spacing, planting, cultural practices, pruning, diseases and pests, production, storage of cuttings and intercropping. *(Summary by H.J.S.)* D00.

0323-3369 MARTIN, F. **Le manioc.** *(Cassava). In* ________. Cultures industrielles tropicales dans les territoires français du Pacifique Austral, Nouvelle Caledonie, Tahiti, Nouvelles Hébrides. Paris, Vitiano, 1949. pp.25-33. (Document R.E.P.A. no. 7). Fr.

Cassava. Cultivation. Climatic requirements. Harvesting. Uses.

The following aspects of cassava are discussed briefly: stems, cuttings, roots, chemical composition of the tubers, cultivation, climatic requirements, harvesting and uses. The author encourages increased cassava cultivation in New Caledonia. It could replace yams and taro, which are eaten by the natives, and become an important source for animal feed. *(Summary by H.J.S.)* D00

0324-1884 GURNAH, A. A. **The effects of plant population and fertilizers on the yield and components of yield of cassava in the forest zone of Ghana.** Kenya, University of Nairobi, 1973. 9p. Engl., 17 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria. 1973.

Cassava. ***Manihot esculenta.*** **Yams. Cocoyams. Tuber productivity. Sweet-potatoes. Potatoes. Cultivation. Fertilizers. Productivity. Spacing. N. P. K. Planting. Timing. Field experiments. Research. Ghana.**

In 2 experiments using the cultivar Ankra in the forest zone of Ghana in 1970-71, plant populations ranging from 9,259 to 74,074 plants| ha were tested in combination with 3 levels of compound fertilizers. The best yield of tubers| ha was obtained at a density of 18,519 plants| ha (90 x 60 cm). Yield dropped when the density was higher or lower. Yield| plant, average number of tubers| plant, average tuber weight, weight of tops and average number of stems| plant all decreased with an increase in plant population. Increasing compound fertilizers up to 70 kg| ha each of N, P_2O_5 and K_2O had no effects on yield and its components. The weight of tops increased with increased fertilizer levels. There were no interactions between density and fertilizers. *(Summary by D.H. and L.J.)* D00.

0325-2128 BIRKINSHAW, F. **A brief summary of tapioca cultivation on what is now a valuable rubber estate in province Wellesley.** Malayan Agricultural Journal 14(11):361-364. 1926. Engl., Sum. Engl.

Cassava. Cultivation. Productivity. Malaya.

In Malaya it is generally thought that the cultivation of cassava exhausts the soil. A study was made on a private farm where cassava had been intercropped with rubber for many years. Cultivation met ds consisted of thorough tillage (weeds and grass were plowed under) between harvesting and planting and a continuous system of manuring (using potassium nitrate, ammonium sulfate and bone meal) generally after the 4th successive crop. It was concluded that there were no detrimental effects when cassava was intercropped with rubber. *(Summary by T.M.)* D00.

0326-2063 ALBERTO, J. **A mandioca, sua origen, descrição, e cultura.** *(Cassava, its origin, description and cultivation).* Gazeta Agrícola de Angola 1(8):295-300, 307. 1957. Port.

Also available in English, translated by Tropical Products Institute.

Cassava. Soil fertility. Cultivation. Fertilizers. Tuber productivity. Productivity. Cultivation systems. Angola.

A general overview is presented of the various aspects of cassava cultivation in the Portuguese Congo. Topics include growing cycle, soils, defense against erosion, crop rotation, planting periods, land preparation, fertilization, planting systems and intercropping. The best yields up to now are between 15 and 20 tons| ha of fresh roots at 24-30 months after planting. *(Summary by J.L.S.)* D00.

0327-3486 SCAIFE, A. **Cassava cultivation in western Tanzania.** Ukiriguru, Tanzania. Western Research Center. Progress Report no. 3. 1966. 2p. Engl.

Cassava. Cultivation. Planting. Cultivars. Selection. Manihot. Harvesting. Fertilizers. Productivity. Cultivation systems. Rotational crops. Tanzania.

Results of fertilizer trials and trials to determine best planting time and to select high-yielding varieties in western Tanzania are reported. N, P, K, lime and farmyard manure did not increase yields significantly, and the author advises against their use. It was found that if the crop is harvested at 18-24 months, the varieties recommended as a result of these trials could be expected to yield at least 6 tons of fresh roots| acre. A further trial in which cassava was left in the ground for up to 3 years and allowed to get weedy proved to have a beneficial effect on a cotton crop planted subsequently, even without the application of fertilizers to either crop. *(Summary by L.Y.Y.)* D00 K01.

0328-3426 EKANDEM, M. J. **Cassava in Nigeria. II: Northern Nigeria.** Nigeria. Federal Department of Agricultural Research. Memorandum no. 87. 1965. 26p. Engl., 6 Refs.

Cassava. Cultivars. Cultivation systems. Diseases and pathogens. Pests. Bemisia. Aleyrodidae. Entomology. Injurious insects. Gari. Food products. Productivity. Cassava mosaic virus. Vectors. Nigeria.

Despite the varying climatic conditions and soil types, cassava is now found in all provinces of northern Nigeria and accounts for 4% of the crops planted. This introduction, which is slow in developing due to the traditional preference for cereals in the north, requires adoption of a cassava package of practices, including processing techniques for gari. Information is given on total acreage planted to cassava for each province in northern Nigeria in 1957-58. Also discussed are the origin of varieties, names of local varieties, methods of cropping, pests and diseases, yields, future prospects, and an appendix for each province with soil type, method and time of planting, diseases and pests, high-yielding varieties, early maturing varieties, varieties prepared like yam, principal food products and their transportation. *(Summary by G.K.)* D00

0329-0233 MEJIA F., R. **El cultivo de la yuca, y su explotación industrial. III. Cuidados del cultivo, fertilización del suelo, enfermedades fungosas, y su tratamiento, plagas y su represión, cosecha.** *(The cultivation of cassava and its industrial uses. III. Cultural practices, soil fertilization, fungus diseases and their treatment, pests and their control, and harvesting).* Agricultura Tropical (Colombia) 1(3):13-21. 1946. Span.

Cassava. Cultivation. Fertilizers. Diseases and pathogens. Pests. Mycoses. *Uromyces manihotis. Gloesporium manihotis. Erinnyis ello.* **Biological control.** *Lagochirus obsoletus. Tetranychus telarius.* **Rosellinia.** *Carpolonchaea chalybea.* **Galls. Injurious insects. Injurious mites. Entomology. Pest control. Disease control. Colombia.**

Recommended cultural practices for cassava *(Manihot esculenta)* are as follows: the first weeding and hilling should be carried out when the plant reaches about 10 cm in height. A second weeding should be done 3-4 mo latter; however, if the crop becomes infected sooner, the second weeding should be done immediately. Once the crop approaches maturity, it should not be weeded; this only increases water absorption in the roots, reduces evaporation, decreases starch content and flour quality, and increases the HCN content of the roots. Pruning tends to decrease root starch content and lower flour quality. Nitrogen, phosphoric acid and potash can be broadcast, using chemical fertilizers in a 4-8-12 formula, at 15-20 tons| ha, or they can be buried in the ground or at the bottom of furrows and well mixed with the ground, 7-13 days before beginning to plant. Cassava should be rotated with maize and legumes; in some countries it is also rotated with sugar cane. Seven fungus diseases of cassava are rust, leaf spot *(Cercospora henningsii),* leaf spot or **Helminthosporiosis,** "fumagina," leaf wilt (Anthracnosis), root and stem rot and rotting of stored cassava. Descriptions of insects which attack cassava and symptoms of their presence of the plant include the following: *Lonchaea chalybea, Cecidomyia cecropia, Erinnyis ello, Lagocheirus obsoletus, Lepidosaphes alba,* the leaf borer, leaf-cutting ants (genus **Atta**) *Cryptocephalus commutatus* and *Tetranychus binaculatus.* When unprocessed cassava is to be used for human food, it should be harvested a little before maturity; but when it is to be used for starch or flour, it must be completely mature. It is difficult to determine the exact harvesting time, as this varies considerably according to variety and other local factors. Harvesting methods according to soil conditions are given. Yields vary considerably but average about 20,000 kg| ha in Medellin (Colombia). *(Summary by P.A.C.)* D00 F01 E01

0330-0715 PICKLES, A. **Cassava in the Amazon Valley.** Proceedings of the Agricultural Society of Trinidad and Tobago 42:141-149. 1942. Engl.

Cassava. Cultivation. Uses. Processed products. Human nutrition. Farinha. HCN. Detoxification. Beverages. Cooking. Tapiocas. Cassava products. Toxicity. Brazil.

Most cassava grown in Amazonas is of the bitter type. Certain cassava varieties are early maturing and are planted on lands subject to seasonal inundation. On lands above the flood level of the river, planting usually commences at the beginning of the rainy season, but may take place at any time except at the height of the dry season if continuous cropping is desired. In such situations the crop takes from 15-20 months to mature. The preparation of cassava products has two main purposes to eliminate the toxic ingredient and to obtain a product that can be stored for a long period without deterioration. HCN, which develops in harvested tubers can be driven out either by thorough heating or by fermentation. Most of the cassava produced in the Amazon Basin is used in the preparation of a coarse meal ("farinha") and many other products, including cassava bread, tapioca, starch, condiments and beverages, the preparation of which is described. *(Summary by J.L.S.)* D00 H04

0331-3413 HARPER, R. S. **Cassava growing in Thailand.** World Crops 25(2):94-97. 1973. Engl., Sum. Engl., Fr., Span., 11 Refs., Illus.

Cassava. Cultivation. Planting. Fallowing. Fertilizers. *Manihot esculenta.* **Diseases and pathogens. Pests. Cultivation systems. Cassava flour. Soil fertility. Climatic requirements. Weeding. Harvesting. Tubers. Thailand.**

Cassava *(Manihot utilissima)* is grown chiefly in eastern Thailand, where the crop is well suited to the warm, humid climate and the light sandy soil. Planting is done by hand either in flat or in ridged land, with repeated cultivations on the same land for a number of years without rotation or a fallow period. Fertilizers are not generally applied. There are few serious pests and diseases affecting the crop. Weed control is a major problem and is traditionally done by hand although herbicides are suitable. Harvesting is a hand operation; the roots are processed into products such as cassava flour or pellets, the bulk of which are exported. *(Author's summary)* D00

0332-0217 MARASSI, A. **La manioca in Costa d'Avorio e la sua importanza negli ordinamenti produttivi del paese.** *(Cassava in the Ivory Coast and its importance for the production sector of the country).* Rivista di Agricoltura Subtropicale e Tropicale 62(7-9):201-227. 1968. Ital., 17 Refs., Illus.

Cassava. Cultivation. Cultivars. Production. Savannas. Composition. Food energy. Human nutrition. Cassava products. Nutritive value. Uses. Productivity. Soil fertility. Processed products. Ivory Coast.

An outline of food and industrial agriculture in the Ivory Coast is followed by a discription of the production, marketing, local foods prepared from cassava in the different ecological zones and of the research conducted on this crop. Cassava might become much more important and could support a food industry, both for local consumption and export; however, this would require a more rational cropping of better varieties in the best growing regions, with the full support of research, which so far has been limited and fragmented. Nevertheless, technological research on the use of cassava flour is being conducted. *(Summary by Tropical Abstracts)* D00 H01

0333-0532 ELSKENS, O. **La culture du manioc dans la region de Yangambi, district de Stanleyville.** *(Cassava cultivation in the Yangambi region, Stanleyville district).* Bulletin Agricole du Congo Belge 4(4):765-771. 1913. Fr., Illus.

Cassava. Cultivation. Productivity. Agricultural equipment. Cultivars. Spacing. Sweet cassava. Bitter cassava. Stems. Tubers. Flowers. Fruits. Plant anatomy. Identification. Planting. Congo.

Cassava is the principal crop in the Yangambi region. Three varieties are planted: 2 sweet, Akuru and Apeli; and one bitter, Limela or Libeta. The principal characteristics of these varieties are given. Cassava is planted in almost any soil. Planting is done all year round, but a preference is shown for the dry season (Dec-March). Yields depend on planting distances and number of cuttings used per hole. The average yields is about 28-33 ton| ha. Indigenous methods of cultivation, as well as drawings of some tools used, are given. *(Summary by J.L.S.)* D00

0334-3495 MOLINYAWE, C. D. **Some pointers on growing cassava.** Agriculture at Los Baños 3(4):16-18. 1964. Engl.

Cassava. Cultivars. Cultivation. Planting. Spacing. Fertilizers. Philippines.

Cassava is grown for its tubers, which serve as a staple food in many areas. The tubers may be used as livestock feed, sources of starch, alcohol and many other products. Some useful recommendations are given for growing cassava in the Philippines. The best varieties are Java Brown, Aipin Mangi, Aipin Manteiga, Vassourinha, Mandioca Tapicuro, Hawaiian Red, Balinhoy, Gariasa and White Anabu. A leaf spot disease has been observed in cassava but may be controled, using resistant varieties such as Vasourinha and Bogor 397. *(Summary by J.L.S.)* D00

0335-0319 MIER, J. M. **El cultivo de la yuca.** *(The cultivation of cassava).* Mimeo. 30p. Span., 9 Refs.

Cassava. History. Taxonomy. Land preparation. Fertilizers. Planting. Harvesting. Uses. Production. Costs. Entomology. Climatic requirements. Soil fertility. Seed. Manures. Cultivation. Productivity. Composition. Cultivars. Pests. Diseases and pathogens. Injurious insects. Noxious animals. Economics. Colombia.

A general summary is made of cassava (*Manihot esculenta* Crantz) cultivation in Colombia. Data include the history, nomenclature, botany, climates and soils in which it is cultivated, land preparation, fertilizers, seed selection, planting, cultural practices, yields, harvesting, chemical composition, uses, cost and return of production, varieties, pests, diseases and economic importance. *(Summary by P.A.C.)* D00

0336-2127 **THE CULTURE and industry of manioc.** Pan American Union Bulletin 48(2):152-157. 1919. Engl.

Cassava. Cultivation. Industrialization. Consumption. History.

General notes are given on the basic requisites needed to assure the development of cassava industrialization on an ever-increasing scale. The origin of the word manioc (cassava) is given ("mani," bread and "og," a virgin), as well as historical aspects of its cultivation by Amerindians and its introduction into Africa. *(Summary by H.J.S.)* D00

0337-3451 ORTIZ, M. A. **Cultivo de la yuca.** *(Cassava cultivation).* Tierra 27(9):651-653, 686. 1972. Span.

Cassava. Cultivation. Cassava products. Uses. Mexico.

Brief remarks are given on the origin of cassava, climate and soil requirements, propagation, planting, cultural practices, fertilizers, harvesting, yields and products made from cassava. *(Summary by J. L.S.)* D00

0338-3205 RIOS, F. **La yuca o mandioca.** *(Cassava).* Surco 71(1):9. 1966. Span., Illus.

Cassava. Cultivation. Productivity. Cultivars. Mexico.

Brief notes are presented on cassava cultivation in the state of Chiapas (Mexico). A proper preparation of the soil and a careful selection of the cuttings produced 36 tons|ha, 9 months after planting. *(Summary by H.J.S.)* D00

0339-0713 VERTEUIL, J. DE. **Cassava experiments.** Bulletin of the Department of Agriculture, Trinidad and Tobago 16(1):18-21. 1917. Engl.

Cassava. Cultivation. Cuttings. Spacing. Inter-cropping. Cultivation systems. Planting. Cultivars. Selection. Adaptation. Propagation materials. Trinidad and Tobago.

Brief notes are given on selecting the best local varieties, planting distances, parts of stalks used for planting, planting methods and suitability of intercropping. *(Summary by H.J.S.)* D00 K01

0340-4341 UPHOF, J. C. T. **El cultivo de la yuca en Java.** *(Cassava growing in Java).*• Hacienda (USA) 39:266. 1944. Span.

Cassava. Cultivation. Cassava starch. Uses. Java.

The following aspects of cassava growing in Java are described: appropriate soils, moisture required, systems of propagation, planting, cultural practices, rotation with other crops, and time to harvest. *(Summary by L.C. Trans. by T.M.)* D00

0341-3324 CASTRO, C. **Cultivo de la yuca.** *(Cassava cultivation).* Colombia. Ministerio de Agricultura. Boletín de Información no. 105:1-15. Span.

Cassava. Climatic requirements. Soil requirements. Cultivars. Cuttings. Spacing. Planting. Weeding. ***Erinnyis ello.*** **Insect control. Insecticides. Galls. Harvesting. Timing. Productivity. Colombia.**

Brief notes are given on cassava cultivation, climatic and edaphic requirements, varieties, diseases and pests, yields and industrial uses. Most data given refer to Colombia. *(Summary by H.J.S.)* D00

0342-3228 ESTRADA R., N. and VARON, L. A. **El cultivo de la yuca.** *(The growing of cassava).* Boletín Agrícola (Colombia) no. 582:11365-11367. 1969. Span.

Cassava. Climatic requirements. Harvesting. Soil requirements. Cultivars. Timing. Cuttings. Planting. Spacing. Weeding. Fertilizers. Insect control. Uses. Colombia.

The following aspects of cassava cultivation are described: origin, appropriate growing climates, planting, insect and disease control, and varieties grown in Colombia, as well as cultural practices, production systems and the different uses of cassava. *(Summary by L.C. Trans. by T.M.)* D00

0343-4994 SCHMIDT, C. B. **Laboura caiçara.** *(Native methods for growing and processing cassava on the Brazilian coast).* Brazil. Ministerio da Agricultura, Servicio de Información Agrícola. Documentario da Vida Rural no. 14. 1958. 78p. Port., Sum. Engl., 55 Refs., Illus.

Cassava. History. Plant geography. Cultivation. Harvesting. Cottage machinery. Processing. Cassava flour. Pressing. Rasping. Drying. Brazil.

A general historical background is given on cassava. Native ("Caiçara") methods for growing and processing cassava in Ubatuba (on the northern coast of the state of São Paulo, Brazil) are studied in detail. Cassava is grown for local consumption only and processed in 4 small flour mills. The work is done by the whole family. Social aspects of this home industry are discussed. *(Summary by T.M.)* D00 102

0344-3225 MARCUS, A. **Maniok,** ***Manihot utilissima*** **Pohl.** *(Cassava, Manihot utilissima Pohl).* Tropenpflanzer 38:144-157. 1935. Germ., 12 Refs.

Cassava. HCN. Cuttings. Beans. Maize. Cultivation. Injurious insects. Processing. Economics. Inter-cropping. Cultivation systems. Diseases and pathogens. Pests. Noxious animals. Propagation materials. Propagation. Cassava starch. Trade. Marketing. ***Manihot esculenta.***

A study is made of *Manihot utilissima,* native to Brazil. A literature review is made as regards floral biology, roots and HCN levels in different root sections. The use of long stakes, planted 5-8 cm deep and tied to sticks for support, permits harvesting 4 mo earlier, with the same yield. Cassava can be intercropped with beans, maize and tobacco; or it can be planted between various palm and rubber trees. Fertilizer requirements are reviewed. Diseases mentioned are *Fomes lignosus, Bacillus manihot* and cassava mosaic. Pests include grasshoppers *(Valanga nigricornis),* crickets *(Brachytrypes portentosus)* and a caterpillar *(Tiracola plagiata).* The **Tetranychus** mites are also a problem. Root composition, root products, starch extraction and preparation are dealt with. Some export data are also given. *(Summary by A. van S.)* D00

0345-2437 SILVESTRE, P. and DELCASSO, G. **Le manioc dans la région maritime du Togo, expérimentations effectuées par l'IRAT.** *(Cassava in the coastal region of Togo. Research conducted by IRAT). In* Séminaire sur les Plantes à Racines et à Tubercules. Ibadan, 1971. Paris, IRAT, 1971. 20p. Fr., Sum. Fr., Illus.

Cassava. Production. Soil requirements. Climatic requirements. Cultivars. Fertilizers. Inter-cropping. Maize. Rotational crops. Consumption. Cassava programs. Starch productivity. Tuber productivity. Togo.

Since 1966, an intensified program on the productivity of cassava and maize has been undertaken in Togo. Emphasis is made on the better utilization and expansion of starch factories. Varietal trials and cultural technique experiments have been carried out by IRAT. Fertilization experiments were conducted on the poorest soils. Maize-cassava associations were studied on the basis of a faster crop rotation on the same field. Research on planting and harvesting data with an optimal production should determine the conditions under which the qualitative (starch content) and quantitative (rôot yield) improvement of the product can be obtained. *(Author's summary)* D00 K01

0346-0032 INSTITUTO COLOMBIANO AGROPECUARIO, MANIZALES. **Programa de tuberosas: trabajo en yuca; informe a la XIV Reunión del Programa a realizar en Santa Marta del 22 al 26 de Julio de 1970.***(Tuber program: work in cassava; report to the XIV Meeting of the Program to take place in Santa Marta from July 22-26. 1970).* Manizáles, Colombia, 1970.

Cassava. Cultivars. Weeds. Pests. Pest control. Herbicides. Productivity. Starch productivity. Tuber productivity. Bacterioses. Diseases and pathogens. Colombia.

The results are given of 4 studies on cassava (*Manihot esculenta* Crantz) in Caldas (Colombia): (1) Varietal Adaptation presents data on root, dry matter and starch yields of 20 varieties studied; (2) Weed Control evaluates the selectivity of 5 products in terms of germination and plant toxicity; (3) Cassava Bacterial Rot describes symptoms observed and reactions to the bacterium *Aeorobacter cloacae;* and (4) Planting Distances for Cassava. *(Summary by P.A.C.)* D00.

0347-3457 STEHLE, H. **La culture du manioc et ses possibilités industrielles aux Antilles Françaises.** *(Cassava cultivation and possibilities for industrialization in the French Antilles).* Riz et Rizculture 5(4):188-192. 1959. Fr., Sum. Fr., Engl., Span., Illus.

Cassava. Breads. Planting. Productivity. Fertilizers. Starch productivity. Cultivation. Bakery products. Soil fertility. Industrialization. Organoleptic examination.

About 1,200 ha in Guadeloupe are planted to cassava, mainly in small plots. The most suitable soils are sandyclay, deep, humic soils. Various indigenous species *(Paspalum plicatulum, Euphorbia prostata* and principally *Croton hirtus)* indicate the best soils for cassava growing. The fields are generally ridged with 1.50m between rows and 0.70m between plants. Applications of fertilizers and organic matter make it possible to replant immediately after the first harvest, obtaining a 10% increase in yields. Sweet cassava yields 30 tons|ha in Martinique and could yield 40-50 with manuring and rational crop rotation. With traditional methods, 1 kg starch is obtained from 5 kg of roots. The use of cassava in animal feeds should be increased. Its use in bread-making has also been studied. The proportion of cassava can be as much as 30% (60% wheat flour, 10% leaven), and bread and taste qualities are still excellent, provided the flour is from winter wheat. With spring wheat, the proportion of cassava can hardly be higher than 4-5%. *(Author's summary)* D00 H00

0348-4811 AW-YONG, K. K. and MOOI, S. W. **Cultivation and production of tapioca in Perak.** Kuala Lumpur, Jataban Pertanian, Kementerian Pertanian dan Perikanan, 1973. 47p. Engl., Sum. Engl., Illus.

Cassava. History. Soil requirements. Land preparation. Climatic requirements. Planting. Spacing. Manures. Weeding. Harvesting. Shifting cultivation. Factories. Washing. Pulping. Screening. Silting. Steeping. Grinding. Cassava flour. Tapioca pearls. Tapioca flakes. Cassava chips. Distribution. Production. Costs. Income. Prices. Waste utilization. Marketing. Productivity. Cottage machinery. Industrial machinery. Rotational crops. Malaysia.

Cassava production and processing is a major industry ($25 million in 1966) in the west Malaysian state of Perak. The industry has helped increase state export earnings from about $2.6 to $5.4 million from 1955-65. Of the 49 cassava factories in the state, 20 produce flour and 29 produce chips. Some 35,000 acres were planted in 1966 although about 72% of that area was illegal (on state-owned lands or lands reserved for other purposes). This in-depth study explores all aspects of cassava production and processing. Land tenure problems of production, yields from various types of land, costs and returns of all stages of production and marketing and processing of the crop are analyzed. The study concludes that important problem areas are the proper planning for crop production and marketing (both locally and for export) and a better land utilization plan devoted to cassava production so that the industry can be stabilized or expanded. *(Summary by C.B.)* D00 102 J00

0349-4846 ALBUQUERQUE, M. DE. **Notas sobre mandioca.** *(Notes on cassava).* Boletim Técnico do Instituto Agronómico do Norte no. 41. 1961. 92p. Port., Sum. Engl., Port., Fr., 6 Refs., Illus.

Cassava. Composition. Cassava products. Cassava flour. Bacterioses. *Xanthomonas manihotis.* **Injurious mites. Resistance. Cuttings. Timing. Fertilizers. Spacing. Planting. Pollination. Cultivars. Alcohol.** *Manihot glaziovii.* **Productivity. Farinha. Processing. Cultivars. Sweet cassava. Bitter cassava. Selection. Resistance. Uses. Brazil.**

Recommendations are presented on farming problems regarding the cultivation of **Manihot** on periodically flooded land and on high, dryer lands, planting methods, the seasonal and biological cycle of the plant, types of cuttings to be used, etc. Observations are made on the adaptability of the varieties in accordance with the types of culture in view. The role of cassava cultivation in the history of the Amazonia is taken into account, and regional food products made from cassava are described. *(Author's summary)* D00.

See also 0009 0013 0091 0910 0930 0951 1006 1018 1116 1429 1518 1556 1733 1819 1844 1895 1914 D00

0350-0395 KROCHMAL, A. and SAMUELS, G. **Deficiency symptoms in nutrient pot experiments with cassava.** Ceiba 14:1-9. 1968. Engl., Sum. Engl., Span., 11 Refs.; Illus.

Cassava. Deficiencies. Magnesium. Analysis. Mineral deficiencies. N. P. K. Ca. SA. Minerals. Chlorosis. Iron. Manganese. Boron. *Manihot esculenta.* **Stems. Petioles. Leaves. Plant development. Plant height**

Cassava (*Manihot utilissima* Pohl) was grown in a sand culture using nutrient solutions to develop deficiencies of nitrogen, potassium, magnesium, calcium, sulfur, iron, manganese and boron. The results were as follows: (1) Both height and weight of plant were severely reduced when N was omitted from the nutrient solution. (2) Plant analyses for the complete treatment revealed that the leaf was highest in N; the stem was highest in P and K; the petiole was highest in Ca and Mg. (3) The leaf did not appear to be sensitive enough for detection of mineral deficiencies. The petiole showed lowest values for N, Ca and Mg; the stem was lowest for P and K. (4) Visual deficiency symptoms of lighter green color and poor growth were obtained for N deficiencies. Potassium deficiency was characterized first by a bronzing or purpling of the leaf followed by a marginal chlorosis. No visual symptoms were obtained for P deficiency. (5) Deficiency symptoms are also described for calcium, magnesium, sulfur, iron, manganese and boron. *(Author's summary)* D01 C01

0351-2312 NIJHOLT, J.A. **Opname van voedingsstoffen uit den boden bij cassave.** *(Absorption of nutrients from the soil by a cassava crop).* Buitenzorg. algemeen Proefstation voor den Landbouw. Mededeelingen no. 15. 1935. 25p. Dutch, Sum. Engl., 13 Refs., Illus.

Cassava. Absorption. Minerals. Nutritional requirements. Soil impoverishment. Soil fertility. Fertilizers. Manures. Green manures. Spacing. Cultivation. Timing. Crotalaria. Harvesting. N. P. K. Java.

In the "Moeara" Experimental Garden belonging to the General Agricultural Experiment Station at Buitenzorg (Java), some field experiments were run in order to investigate at which stage manuring and harvesting of cassava crop would give the best results, which will be published later. Simultaneously, a number of plants were analyzed in order to gain an insight into the absorption of the principal nutrients during growth. Ten replications each of 2 varieties (Mangi and Sao Pedro Preto) were planted at 90 x 94 cm in a young, reddish brown andesitic tuff lateritic soil, containing 0.059% P_2O_5, 0.027% K_2O, 0.065% MgO and 0.15% CaO, soluble in strong hydrochloric acid, and with a pH of 5.2 (suspension of the soil in water). Shortly before planting, the field received a dressing of 265 quintals|ha of the green manure *Crotalaria anagyroides.* During the first 5 months, a monthly sample was taken for chemical analysis from a part of the field outside the plots themselves. At the age of 6 months, 24 plants from every plot were harvested and weighed, and 1 or 2 of these were analyzed. This procedure was repeated at 2-month intervals. Plant growth was very regular, and maximum yield had no been reached when the experiment was stopped. Chemical analyses showed that young cassava roots are higher in protein than older ones and that the dry matter content (and therefore also the starch content) may increase even after the tenth month, contrary to what is sometimes supposed. The analysis was confined to the principal nutrients. The amounts of K_2O and P_2O_5 proved to be very high in comparison to other plants. The absorption of nutrients during growth was fairly regular and took place without interruption, except in the case of N. Irregular curves must, in the writer's opinion, be attributed to the loss of N in abscissed leaves. The amount of absorbed nutrients in proportion to their maximum absorption is given. It is evident that at an early stage of growth, the absorption of nutrients took place somewhat more rapidly than the formation of dry matter. *(Summary by T.M.)* D01 D02

0352-0441 DE GEUS, J. G. **Root crops; cassava.** *In* ———— Fertilizer guide for tropical and subtropical farming. Zurich, Centre d'Etude de l'Azote, 1967. pp. 181-185. Engl.

Cassava. N. P. K. Ca. Plant assimilation. Absorption. Nutritional requirements. Fertilizers. Minerals. Cyanides. Starch productivity. Tuber productivity. Productivity.

Once established, cassava resists drought and has a remarkable capacity to extract nutrients. It removes 60:50:258 from soil in Kerala and in Madagascar 85:62:280. In high N plots, it produces many tubers: in K-only plots, tubers were big. K is important for starch laydown. Increasing N decreases starch:protein ratio. value cost ratio of 45 kg N, 45 kg P_2 O_5 is 22%. Split applications are best. Optimal NPK ratio is 1:1:2. *(Summary by J.H.C.)* D01 D03

0353-2416 DOOP, J. E. A. DEN. **Groene bemesting, kunstmest en andere factoren in sisal- en cassave-productie. V.** *(Green manure fertilizers and other factors in sisal and cassava production. V).* Bergculture 11(9):264-287. 1937. Dutch., Illus.

Cassava. Soil fertility. Nutritional requirements. Cultivation. Minerals. N. P. K. Fertilizers. Manures. Green manures.

For the exhausted soils of this cassava district, the following recommendations were made: N fertilization had no effect; it may even be detrimental when it interferes with the uptake of soil P. Potassium needs to be applied although higher K levels increase the P requirement. Drought, as well as applications of organic manure, reduces the availability of K. *(Summary by A. van S.)* D01

0354-3818 SERGIPE. SUPERINTENDENCIA DA AGRICULTURA E PRODUÇÃO. **Competição de cultivares de mandioca** *Manihot esculenta* **Crantz no Estado de Sergipe.** *(Competition of cassava, Manihot esculenta, cultivars in the State of Sergipe).* Aracaju, Brazil, 1974. 23p. Port., Sum. Port., Engl., 3 Refs., Illus.

Cassava. *Manihot esculenta.* **Cultivars. Nutritional requirements. Fertilizers. N. P. K. Experiment design. Field experiments. Cultivation. Productivity. Starch productivity. Tuber productivity. Statistical analysis. Brazil.**

In order to find the best cassava (*Manihot esculenta* Crantz) cultivars for root and starch production, three yield trials were conducted in 1971-73 in the counties of Lagarto, Nossa Senhora das Dores and Estancia. It was concluded that (1) the best cultivar for root production in the three counties was Aipim Bravo, followed by Salangor Preta, Barrinha and Maria Preta for Lagarto county; Salangorzinha, Mamao and Cigana Preta for N.S. das Dores county; Mamao, Pretinha, Itapicuru da barra and Salangorzinha for Estancia county. (2) Maximum starch production was obtained with Maria Preta, Cigana Preta and Sutinga in Lagarto county; Milagrosa, Itapicuru da Serra, Cigana Preta, Sutinga, Salangorzinha and Salangor Preta in N.S. das Dores county; and Salangorzinha, Catarina Seca, Cigana Preta, Milagrosa, Salangor Preta and Itapicuru da Barra in Estancia county. *(Author's summary)* D01 D03

0355-2656 MANDAL, R. C. and MOHAN KIMAR, C. R. **A note on response to tapioca to variable tillage.** Indian Journal of Agronomy 18(1):97-99. 1973. Engl.

Cassava. Cultivation. Economics. Mechanization. Productivity. Agricultural equipment. Tuber productivity. Manures. Land preparations. Dung. Nutritional requirements. Fertilizers. N. P. K. India.

An experiment was carried out to compare the effect of tractor plowing and spade digging, hilling the standing crop at monthly intervals. A uniform basal dressing of 12 tons of farmyard manure and 100 kg each of N, P and K.| ha were applied at planting time. No significant effect on tuber yield was obtained with either one and two tractor plowings or one or two diggings. An increase of 8.8 and 9.7 tons| ha over the control was obtained by carrying out 2 or 3 hillings, respectively. Economically, it is better to have 2 hillings during the first and second month after planting. *(Summary by J.L.S.)* D01 D03

0356-0340 CIFERRI, R. **Le malattie della manioca (*Manihot esculenta* Crantz) in San Domingo. I. Notizie sull'ambiente in cui si effettuarono gli studi.** *(A disease of cassava Manihot esculenta Crantz in Santo Domingo. I. Report on the environment where the studies were carried out).* Bolletino della Stazione di Patologia Vegetale di Roma 13(2):227-239. 1933. Ital., Sum. Ital., Engl.

Cassava. Climatic requirements. Soil fertility. Cultivars. *Manihot esculenta*. Sweet cassava. Bitter cassava. Dominican Republic.

A few data are given on the climatic, meteoric, edaphic and topographic conditions of cassava cultivation on an industrial scale in Santo Domingo. From an agricultural standpoint, cassava plants are classified into 3 variety groups: Negrona, Agriadulce and Andujita. Each variety is designated by a "formula," summarizing the most outstanding distinctive characteristics. *(Author's summary)* D01

0357-0336 LAMBOURNE, J. **Experiments on the economic maintenance of soil fertility under continuous cropping with tapioca.** Malayan Agricultural Journal 25(4):134-145. 1937. Engl., Sum. Engl., 3 Refs.

Cassava. Crotalaria. Cultivation. Nutritional requirements. fertilizers. Economics. Manures. Green manures. N. P. K. Soil fertility. Soil requirements. Productivity. Rotational crops. Cultivation systems. Malaysia.

A crop rotation experiment with cassava is described, and progress since initiation in May, 1933 is given. The experiment has not been operated long enough to obtain definite results. Indications are that soil fertility has been maintained; however, the resulting crops have not been profitable under the conditons at the Central Experiment Station at Serdang. A possible crop rotation similar to that described may be profitable if carried out in conjunction with pig rearing. *(Author's summary)* D01 K01

0358-1587 OFORI, C. S. **Decline in fertility status of a tropical forest ochrosol under continuous cropping.** Experimental Agriculture 9(1):15-22. 1973. Engl., Sum. Engl., 8 Refs.

Cassava. Soil impoverishment. Soil fertility. Fertilizers. Productivity. Maize. Groundnut. Soil requirement. N. P. K. Soil analysis. Nutritional requirements. Ghana.

Studies on the fertility status of a tropical forest ochrosol under continuous cropping for 19 years showed that the crop yield was maintained at a fairly high level by the application of mineral fertilizer. The mean cassava yield had not declined as a result of continuous cropping with moderate fertilizer applications. Significant increases in yield found were with P for 2 of the 3 years and with K for the whole cropping period. Cassava did not respond significantly to liming. Soil analysis showed that small, but frequent applications of $(NH_4)_2SO_4$ significantly lowered the soil pH with a significant reduction in the divalent ions Ca and Mg. The annual application of 5 tons of dried grass mulch significantly increased the organic matter content, as well as K and Mg contents of the soil. *(Summary by Chemical Abstracts)* D01 D03

0359-1924 GODFREY-SAM-AGGREY, S. **Effects of different fertilizers on root yield, rooting density and top root weight ratio of cassava in two cropping systems in Sierra Leone.** Njala, University of Sierra Leone, 1973. 10p. Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta*. Field experiments. Research. Tuber productivity. Fertilizers. Ammonium sulphate. Potash. Ca. Magnesium. Timing. Production. Costs. Economics. Productivity. Absorption. Nutritional requirements. Rooting. Cuttings. Spacing. Propagation materials. Sierra Leone.

Effects of various fertilizers on root yield, rooting density and top root weight ratio from 2 differently aged cassava cuttings in 2 different cropping systems on the upland soils of Sierra Leone were studied. In addition to the type of cropping system which dictates nutrient responses, the type or age of planting setts affect responses to different nutrients even in the same cropping system, as measured by root yields and top root weight ratio. Considerations of economic returns and time of harvest should influence the choice of fertilizers and type of planting sett. *(Summary by D.H. and L.J.)* D01 D03

0360-2220 DOMMERGUES, Y. **Influence de differents types de fumure sur l'activite bacteriologique du sol.** *(Influence of the different types of manures on the bacteriological activity of soils.)* Memoires de l' Institut Scientifique de Madagascar (Serie D) 5:337-351. 1953. Fr., Sum. Fr., 4 Refs., Illus.

Cassava. Soil fertility. Soil requirements. Fertilizers. Manures. N. Cultivation. Malagasy Republic.

The reaction of soils treated with different fertilizers and manures in cassava plots was studied in Madagascar. Data obtained led to an understanding of the succesion of biological phenomena taking place after fertilizing and manuring. The importance of bacteriological techniques is stressed. *(Summary by H.J.S.)* D01

0361-2178 BONNEFOY, J. V. **Compte-rendu d'un essai de culture du manioc en terre enrichie par fumure.** *(Report of a cassava cultivation trial in manured soils).* Bulletin Economique de Madagascar no. 81:55-57. 1933. Fr.

Cassava. Fertilizers. Cultivation. Productivity. Tubers productivity. Timing. Soil requirements. Climatic requirements. Malagasy Republic.

The soil and climate conditions of the Nanisana, Madagascar area are described. Thirty tons| ha of cassava were harvested after 21 months. *(Summary by H.J.S.)* D01 D03

0362-0465 JACOB, A. and UEXKULL, H. VON. **Fertilización de los cultivos tropicales y subtropicales; yuca o mandioca.** *(Fertilization of tropical and subtropical crops; cassava or mandioca). In* ————Fertilización. 3 ed. Hannover, Kali und salz. 1966. pp.153-159. Span., 14 Refs.

Cassava. Nutritional requirements. Fertilizers. N. P. K. Magnesium. Starch productivity. Productivity.

Cassava grows best in soils that are deep and light, with plenty of humus. It has a high nutrient requirement, extracting 124 kg| ha of N; 104 kg| ha P_2O_5; 584 kg| ha K_2O:217 kg| ha CaO and 71 kg| ha of MgO. Cassava produces 6 times as much as wheat. When K is low, starch content is low and HCN is high. There are strong NPK interactions in the usual direction. In general fertilizers are beneficial, especially K. *(Summary by J.H.C.)* D01 D03

0363-1915 FORNO, D. A., ASHER, C. J. and EDWARDS, D. G. **Physiological studies on the mineral nutrition of cassava (*M. esculenta* Crantz).** St. Lucia, Australia, University of Queensland, 1973. 6p., Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* Nutritional requirements. Stems. Shoots. Leaves. Plant reproduction. Plant development. N. Ca. Mineral deficiencies. Roots. pH. Nitrate. Minerals. Fertilizers. Soil fertility. Cultivars. Plant physiology. Australia. Puerto Rico.

The nutritional physiology of 11 cassava strains from a wide range of environmental conditions in northern Australia and Puerto Rico was studied in a series of greenhouse experiments. Substantial differences were found among strains in their response to nitrate and ammonium nitrogen and in their abilities to absorb N at low substrate nitrogen concentrations. An unusual boron requirement by cassava is examined in two strains. Also experiments on the effects of pH and calcium supply on the growth of cassava are described. Prospects for exploiting nutritional differences among strains in breeding programs are discussed. *(Summary by D.H. and L.J.)* D01 C01

0364-2163 BERSON, P. **Manioc hauts plateaux.** *(Cassava in high plateaus). In*_____. Rendements en Culture Paysannale sur les Plateaux Malgaches. Tananarive, Institut Recherches Agronomiques de Madagascar, 1969. p. 24. Fr.

Cassava. Cultivation. Fertilizers. Malagasy Republic.

Brief notes on cassava fertilization are given. Figures on success and failure of cuttings planted during the winter are also given. *(Summary by H.J.S.)* D01

0365-2168 BLIN, H. **La fumure du manioc.** *(Fertilization of cassava).* Bulletin Economique de Madagascar no. 3:419-421. 1905. Fr.

Also in Agriculture Pratique des Pays Chauds 5:426-430. 1905.

Cassava. N. K. Productivity. Fertilizers. Soil requirements. Starch productivity. Cultivation. Tuber productivity. Malagasy Republic.

After the application of K to the soil, the starch content of tubers increases and the nitrogenous materials responsible for bitterness in cassava decrease. A table is given of yields gathered from a cassava fertilization trial using 4 kinds of K on soils which were siliceus-clayish. Yields varied from 6.6 to 10.0 tons| ha. *(Summary by H.J.S.)* D01 D03

0366-3195 WEISS, B. E. **Adaptation of manioc to moist soils.** Tropical and Tuber Crops Newsletter no. 6:35-36. 1973. Engl., 2 Refs.

Cassava. Productivity. Ecology. Soil fertility. Climatic requirements. Cultivation. Rainfall data. Nicaragua.

The Miskito Coast in Nicaragua is one of the wettest areas in Central America, with an annual rainfall of 3,400-4,500 mm and a 7-month rainy season. Soils are poorly drained and the nutrient content is also poor. Nevertheless, cassava yields 9,500 lb| ha, which exceeds those reported for "suitable" soils in the Maya region (5,720 lb| ha). Therefore, it is necessary to reexamine the agronomic requirements of cassava and other tuber crops. *(Summary by H.J.S.)* D01

0367-2415 DOOP, J. E. A. DEN. **Groene bemesting, kunstmest and andere factoren in sisal- en cassave-productie. VI.** *(Green manure fertilizers and other factors in sisal and cassava production. VI.).* Bergcultures 11(36):1290-1305. 1937. Dutch., Illus.

Cassava. Fertilizers. Water requirements (plant). Manures. N. P. K. Plant physiology.

The application of organic manure and potassium resulted in higher yields; however, a K dosage response was present. The application of both K and organic manure resulted in P fixation. Potassium alone gave better yields than organic manure alone. Soil moisture influences the availability of K. The physical influence of organic manure, water relationships and K availability are also discussed. *(Summary by A. van S.)* D01

0368-0364 NORMANHA, E. S. **Adubação da mandioca no Estado de São Paulo. I. Efeito da adubação mineral.** *(Cassava fertilization in the state of São Paulo. I. Effect of mineral fertilization).* Bragantia 11(7-9):181-194. 1951. Port., Sum. Port., Engl., 3 Refs.

Cassava. Nutritional requirements. N. P. K. Minerals. Calcium superphosphate. Plant development. Fertilizers. Ammonium sulfate. Bone meal. Potassium chloride. Brazil.

Results are presented of 14 cassava (*Manihot utilissima* Pohl) fertilizer experiments conducted in 4 regions of the state of São Paulo, varying in soil types. Ammonium sulfate, superphosphate of lime, bone meal and potassium chloride were applied separately or mixed at the rate of 80 kg N, 120 kg phosphoric acid and 60 kg of potassium oxide per hectare. The fertilizers were applied in advance of planting at a 10-cm depth in the planting furrows. The results were as follows: (a) Ammonium sulfate caused rather poor sprouting of the cuttings; (b) the influence of N, P, K fertilizers (separately or mixed) varied according to soil type: in rather poor soil (glacial and terra roxa cansada), P fertilizers increased root production; in better salmourao soil, N fertilizer alone or mixed with P gave good results; in other regions either no beneficial effects of fertilizer application were noticed, or a slight effect of N or N + K was recorded. Due to high prices of fertilizers and to the relatively low value of cassava roots, the beneficial effects obtained in some of the regions were not usually considered to be of economic interest to the farmer. *(Author's summary)* D01

0369-2985 CONCEICAO, A.J. DA., SAMPAIO, C.V. and MENDES, M.A. **Competição de variedades de aipi e mandioca para forragem.** *(Competition between sweet and bitter cassava cultivars used as forage).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):129-142. 1973. Port., Sum. Port., Engl., 8 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Sweet cassava. Bitter cassava. Foliage. Tubers. Productivity. Composition. Water content. HCN content. Protein content. Amino acids. Forage. Animal nutrition. Field experiments. Soil analysis. Brazil.**

Results of competition experiments of six wild and improved cassava varieties (Maragogipe, Grande, Casca roxa, Cavalo, Bravo and Sutinga) were carried out in 1969-72 at the school of Agronomy at the Universidade Federal da Bahia (Cruz das Almas) in colonial latosol tertiary sediment of Barreiras series in flat lands ("tabuleiro") with a humid tropical climate, rainfall of 1,196 mm and an annual average temperature of 24.4°C. The experiment showed a high statistical significance to the improved cassava variety "Maragogipe" for branch production. The wild variety Bravo was the best for root production. *(Author's summary)* D01 H03

0370-0741 MALAVOLTA, E. *et al.* **Studies on the mineral nutrition of cassava (*Manihot utilissima* Pohl).** Plant Physiology 30(1):81-82. 1955. Engl., Sum. Engl., 5 Refs.

Cassava. ***Manihot esculenta.*** **Nutritional requirements. Fertilizers. Tubers. N. P. K. Composition. Dry matter. Starch content. Ash content. Protein content. Productivity. Minerals.**

This paper relates the results of a sand culture experiment designed to study the physiological basis for the nutrition of cassava (*Manihot utilissima* Pohl). Chemical analyses of the roots were run to determine the effects of the mineral nutrients N, P, and K on the composition of the roots. The following conclusions were drawn: (1) Under the experimental conditions, P and N proved to be the most important nutrients for cassava. Where P was omitted from the fertilizers, the poorest yields were obtained; and the reduction in starch content paralleled the fall in root weight. Treatment $N_1 P_1 K_1$ produced 32% starch wheareas $N_1 P_1 K_1$ gave 25%. (2) Where K was omitted from the nutrients, the weight of shoots increased while that of roots dropped. This result can be explained on the basis of the well-known K requirement for the translocation of carbohydrates. (3) By raising the N level, the weights of shoots and roots increased. However, the starch content of the roots fell from 32 to 24%; and the increase in root yield did not compensate for such a drop. On the other hand, there was a corresponding increase of about 50% in the protein content where the plants were given the higher doses of N. (4) Under Brazilian conditions, it appears that field responses of cassava to P fertilization are not wholly due not to low soil P but also to the unusually high P requirement of cassava. *(Author's summary)* D01

0371-0700 NORMANHA, E. S., PEREIRA, A. S. and FREIRE, E. S. **Modo e época de aplicação de adubos minerais em cultura de mandioca.** *(Experiments on methods of applying fertilizers to cassava).* Bragantia 27(12):143-154. 1968. Port., Sum. Port., Engl., 4 Refs.

Cassava. Fertilizers. Field experiments. Research. N. P. K. ***Manihot esculenta.*** **Timing. Cultivation. Brazil.**

In 4 preliminary experiments comparing methods of applying mineral (N P K) fertilizers to cassava

(*Manihot esculenta* Crantz), the best results were obtained by the lateral application of the 3 nutrients at planting time, or by applying P K at planting and N as a top dressing later on. *(Author's summary)* D01

0372-2175 BONNEFOY, J. V. **Calcul des éléments fertilisants enlevés au sol par une récolte de manioc.** *(Calculation of the fertilizer elements taken from the soil by a cassava harvest).* Bulletin Economique de Madagascar no.83:75-77. 1933. Fr.

Cassava. Fertilizers. N.P.K. Ca. Leaves. Tubers. Stems. Nutritional requirements. Magnesium. Minerals. Absorption. Analysis. Soil impoverishment. Soil fertility. Malagasy Republic.

Data are given about Ca, K, H_2PO_4, Mg and N, removed from the soil by cassava tubers, leaves and stems. Discussions are presented about mineral content of the soil and fertilizers applied. *(Summary by H.J.S.)* D01

0373-2461 TAKYI, S. K. **Effects of postassium, lime and spacing on yields of cassava (*Manihot esculenta* Crantz).** Ghana Journal of Agriculture Science 5(1):39-42. 1972. Engl., Sum. Engl., Fr., 5 Refs.

Cassava. *Manihot esculenta.* Nutritional requirements. Fertilizers. K. Ca. Soil analysis. Spacing. Productivity. Tuber productivity. Cultivation systems. Fallowing. Ghana.

On an undisturbed (unplowed) silt loam, forest-savanna ochrosol at Adidwan, cropped intermittently for several years by local farmers without fertilizers, K and lime had little effect on cassava yields, but N (60 lb N| acre) and P (45 lb P_2O_5| acre) used as a basal dressing increased yields by 46.7%. Mean response to K (0, 75, 150, 225 lb k_2O| acre) was 1.4%, and mean response to lime (0, 350, 700 lb| acre) was negative (-3.0%). On a plowed (disturbed) soil at Kwadaso, a sandy loam forest ochrosol cropped almost continuously for over 15 years, mean response to K (0, 80, 160 lb K_2O| acre) was negative (-2.7%) while response to lime (0, 350 lb| acre) was low (3.1%). Closer spacings (3 ft x 2 ft and 3 ft x 3 ft) of stem cuttings gave significant increases in yield over wider spacings (3 ft x 4 ft) but there were few large-size tubers with closer spacing. *(Author's summary)* D01 D03

0374-3387 **TAPIOCA.** Malaya. Federated Malay States. General Series no. 16:16-18. 1933. Engl., Illus.

Cassava. Maize. Soil impoverishment. Cultivars. Soil fertility. Cultivation systems. Rotational crops. Malaysia.

Materials and methods followed in 3 cassava experiments are given. One experiment was to ascertain what fertility loss would result from continuous cropping and what was necessary to maintain the land in a fertile condition. The second was to obtain further information on the comparative yields of different varieties and to maintain stocks for planting materials. The third was growing cassava in rotation with the short duration crops, maize and *Crotalaria anagyroides. (Summary by H.J.S.)* D01 K01

0375-1540 CONCEICAO, A. J. DA., TAVARES, F. D. and GUIMARAES, C. D. **Calagem em solos para mandioca.** *(Fertilizer application for cassava).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):53-60. 1973. Port., Sum. Port., Engl., 13 Refs., Illus.

Cassava. *Manihot esculenta.* Fertilizers. Soil requirements. Soil Analysis. pH. Cultivation. Nutritional requirements. Rainfall data. Temperature. Brazil.

Effects of several lime levels were tested on soil-planted cassava (*Manihot esculenta* Crantz). In this study, 5 levels of dolomitic lime stone were applied in Colonia latosoil at the Escola de Agronomia da Universidade Federal da Bahia in Cruz das Almas from 1969-72. The levels varied from zero to 2,000 kg| ha; no significant difference was observed among the treatments. *(Author's summary)* D01

0376-0747 INSTITUTO COLOMBIANO AGROPECUARIO. **Respuesta de la yuca a la fertilización en parcelas demostrativas.** *(Cassava response to fertilization in trial plots).* Tibaitatá, Colombia, Centro Nacional de Investigaciones Agropecuarias, 1971. 22p. Span., Sum. Span., 14 Refs.

Cassava. Fertilizers. N. P. K. Minerals. Economics. Colombia.

Twenty-three fertilizer trials were carried out in certain areas of Colombia in order to evaluate the response of cassava to N, P, K. This response was compared to the results obtained from a soil analysis of organic matter, P and K. In accordance with the results obtained and because of the instability of cassava prices, it was not possible to arrive at reliable conclusions on the optimum economic level of fertilizer applications. Further studies should be conducted with the purpose of orienting the farmer toward a better use of fertilizers. Until more information is gathered from other areas in Colombia, the only reasonable guide in making recommendations on the use of fertilizers in cassava growing should be ICA's tentative research work, which is based on the analysis of soils. *(Author's summary)* D01

0377-1539 CARMO, G. F. DO. **Balanço hídrico do município de Cruz das Almas para a cultura da mandioca (*Manihot esculenta* Crantz).** *(Hydric balance in Cruz das Almas, Brazil).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):61-77. 1973. Port., Sum. Port., Engl., 23 Refs., Illus.

Cassava. *Manihot esculenta.* Soil analysis. Soil requirements. Soil water. Climatic requirements. Rainfall data. Water requirements (plant). Brazil

This study deals with the climatic factors that limit the development and adaptation of cassava crops in Cruz das Almas County, state of Bahia (Brazil). The climatic factors, are related to the normal thermic and hydric conditions of the zone. Special attention was given to the relationship among rainfall, evaporation and soil water storage. Here, the soil water retention capacity was considered at a level of 125 mm. According to the edaphic and climatic conditions there are 4 distinct periods during the year: a dry period; a period of brief soil water replacement; a period of surplus water; and another when water is utilized by the plants. *(Author's summary)* D01.

0378-2206 CHADHA, T. R. **Fertilizer experiments on tapioca in the Kerala State.** Journal of the Indian Society of Soil Science 6(1):53-63. 1958. Engl., Sum. Engl., 4 Refs.

Cassava. Fertilizers. Economics. Growth. N. P. K. Field experiments. Climatic requirements. Productivity. Cultivation. Rainfall data. India.

Detailed experiments to study the effects of NPK manuring of cassava were carried out in cultivators' fields at three places in Kerala State during 1956-57. Crop observations showed that the plants in the plots receiving fertilizers had better growth and tuber development than those in the control plots. The mean response from individual experiments due to doses of nitrogen varied from 20 to 54% for 40 lb N|acre and from 23 to 79% for 80 lb N|acre. The mean response due to doses of phosphoric acid varied from 4 to 12% for 40 lb P_2O_5|acre and from 3 to 25% for 80 lb P_2O_5|acre. Similarly, the mean response due to doses of potash varied from 19 to 43% for 80 lb K_2O|acre and from 23 to 75% for 160 lb K_2O|acre. There was a highly significant interaction between doses of nitrogen and potash. The productivity due to one of these nutrients was highly limited by the amount of the other with which it was combined. Analysis of the combined data showed a significant main effect due to application of phosphoric acid but not a statistical interaction with N or K. The data indicated that greatest yields can be obtained from use of N and K_2O in a 1:1.75 ratio. The data did not indicate a marked difference in the predicted economic optimum yields by a change of event 30% in the price of the produce and fertilizers. This is due to the fact that profits due to application of fertilizers were very high as compared to the cost of fertilizers. *(Author's summary)* D01

0379-0322 MONTALDO, A. and GARCIA B., J. **Exigencias hídricas de la yuca, *Manihot esculenta.*** *(Water requirements of cassava, Manihot esculenta).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1970. 19p. Span., 9 Refs.

Cassava. *Manihot esculenta*. Water requirements (plant). Cultivation. Field experiments. Research. Cultivars. Starch content. Composition. Climatic requirements. Soil requirements. Productivity. Venezuela.

A progress report of the results obtained on the water requirements of cassava (*Manihot esculenta* Crantz) is presented; intervarietal differences are also studied. Eight varieties were analyzed in Maracay, Venezuela during 6 planting seasons (12 and 18 months each) for the years 1962-1968. An exhaustive analysis of the water balance in the soils was made using the most modern methods of calculation. *(Author's summary)* D01

0380-0430 LORIA, M., W. **Adaptación de las variedades de yuca de la colección de la Estación Experimental Agrícola "Fabio Baudrit M." en la zona de Atenas.** *(Adaptation of cassava varieties at the Estación Experimental Agrícola "Fabio Baudrit M." in the area of Atenas).* Alajuela, Costa Rica. Estación Experimental "Fabio Baudrit M." Boletín Técnico 1(1):1-10. 1968. Span.

Cassava. Productivity. Research. Field experiments. Cultivars. Soil fertility. Rainfall data. Costa Rica.

Three field trials were conducted in 1959-1961 and 1962 to test the tuber production of 55 cassava varieties. One variety yielded 37.4 ton| ha| yr. Data are given on monthly rainfall and on physicochemical analyses of soils. *(Summary by H.J.S.)* D01

0381-0767 GRANER, E. A. **Contribuição para o estudo da adubação da mandioca.** *(Contribution to fertilizer studies in cassava).* Revista de Agricultura (Brazil) 33(4):205-212. 1958. Port., Sum. Port., Engl., 7 Refs.

Cassava. Fertilizers. Manures. Dung. N. P. K. Nutritional requirements. Minerals. Brazil.

This paper deals with application of organic and mineral fertilizers in cassava plants. The results obtained did not show statistical differences among treatments with fertilizers and treatments without fertilizers used for comparisons. *(Author's summary)* D01

0382-0796 ANGLADETTE, A. **Le problème des engrais en Indochine.** *(The problem of fertilizing in Indochina).* Agronomie Tropicale 2(9-10):490-530. 1947. Fr.

Cassava. Cereals. N. P. K. Minerals. Prices. Soil fertility. Nutritional requeriments. Development. Economics. Fertilizers. Indochina.

It is possible to increase the yields of Indochinese crops by using mineral fertilizers which could with a few exceptions, be produced in the country. The higher limits of fertilizer prices are established.Most data refer to crops other than cassava. *(Summary by H.J.S.)* D01

0383-3370 SHENG, C. Y. **Crop response to potash in Taiwan.** Soils and Fertilizers in Taiwan 1963:35-50. 1963. Engl., 51 Refs.

Cassava. Starch crops. Cereals. Soil fertility. Climatic requirements. Potash. Productivity. Cultivation. Fertilizers. Taiwan.

Response of crops to added K is discussed. The influence of soil conditions is clearly demonstrated by the wide range of K recommendations, which extend from 0 to 300 kg| ha of K_2O for sugar cane and from 0 to 800 kg| ha for pineapple. Under favorable climatic conditions, crop development is good; and in general, the effects of fertilizers are more significant. Effects of K are influenced by N and P and by method of application. The response of crops to added K was studied for rice, sugar cane, sweet potatoes, wheat, jute, cotton, pineapple, bananas, soybeans (and other legume crops), corn, *Citrus* spp., tobacco and cassava. The following data are given for cassava: in a 1938-39 experiment, the cassava increment was 63 kg for the K_2O rate of 37,5 kg| ha, under the application of 7,500 kg| ha of compost and N and P_2O_5, both at 75 kg| ha. In 1962-63, and NPK experiment resulted in an increase of 12,99 kg of roots or 1.77 kg of starch at 90 kg| ha of

K O; between 90 kg| ha of K_2O, this increase rose to 33,58 kg of roots or 9,96 kg of starch. *(Summary by H.J.S.)* D01

0384-0812 DIAS, C. A. DE C. **Mandioca també́n se aduba.** *(Cassava should also be fertilized);* Revista Fir 8(9):14-16. 1966. Port., 2 Refs.

Cassava. N. P. K. Leaves. Tubers. Nutritional requeriments. Mineral deficiencies. Fertilizers. Composition. Stems. Brazil.

This article is a summary of the author's original paper, "Cultura da Mandioca" (Cassava cultivation). Data deal with extraction of minerals from the soil by cassava (it apparently exhausts the soil); mineral deficiencies (N, P, K) of soils and the way these deficiencies influence the plant; general pattern of manuring and fertilization; types of manures and fertilizers to be used; recommendations on manuring and fertilization; and suggestions for liming. Two tables are given, one dealing with chemical composition of leaves, branches and roots, the other with yields gathered after fertilization. *(Summary by H.J.S.)* D01

0385-0804 STEPHENS, D. **Fertilizer trials on peasant farms in Ghana.** Emphire Journal of Experimental Agriculture 28(109):1-15. 1960. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Savannas. Groundnut. Rice. Field experiments. Productivity. Millets. Soil fertility. Fertilizers. Yams. N. P. K. Ghana.

Following experiments with fertilizers on agricultural stations, nearly 1,200 small trials have been carried out on peasant food farms to confirm the major nutrient deficiencies of the different areas and determine the economic uses of fertilizers under present conditions in Ghana. The results of these trials are described, and fertilizer recommendations are made for the chief food crops in different areas. *(Author's summary)* D01

0386-0459 GARCIA B., J. and MONTALDO, A. **Exigencias hídricas de la yuca o mandioca,** *Manihot esculenta. (Water requirements of cassava, Manihot esculenta).* Agronomía Tropical (Venezuela) 21(1):25-31. 1971. Span., Sum. Span., Engl., 9 Refs., Illus.

Cassava. Nutritional requirements. Climatic requirements. Water requirements (plant). Soil fertility. Cultivation. Timing. Cultivars. Field experiments. Productivity. *Manihot esculenta.* **Venezuela.**

The preliminary results obtained in relation to the water requirements are presented for cassava *(Manihot esculenta)* intervarietal differences are noted. Six plantings of 8 varieties were analyzed for periods of 12 and 18 months from 1962-68 in Maracay, Venezuela. The water balance in the soil is exhaustively analyzed. *(Author's summary)* D01.

0387-0464 JACOBY, T. **Nutrición y abono de tubérculos tropicales. Yuca.** *Manihot utilissima* **Pohl.** *(Fertilization and nutrition of tropical tubers. Cassava, Manihot utilissima Pohl).* Boletin Verde no. 19:9-16. 1965. Span., Illus.

Cassava. Propagation. *Manihot esculenta.* **Nutritional requirements. Fertilizers. N. P. K. Plant assimilation. Absorption. Minerals. Climatic requirements. Plant physiology. Productivity. Tuber productivity. Field experiments. Brazil. Costa Rica. Nigeria. India. Vietnam. Malagasy Republic.**

A general review is presented of the origin and propagation, economic importance and ecological requirements of cassava, *Manihot utilissima* Pohl. Because of its well-developed root system, cassava extracts large amounts of soil nutrients, especially those located deep in the soil, which are unavailable to most crops. A cassava nutrient absorption table, by plant age (in months) is presented. The average nutrient extraction for a 60,000 kg| ha yield is as follows: N= 124 kg| ha; P_2O_5 = 104 kg| ha; K_2O = 584 kg| ha; CaO = 217 kg| ha; and MgO = 71 kg| ha. Cassava response to fertilizer varies with soil and climatic conditions, as well as varieties used. Results are given on an experiment to measure fertilizer response of 8 varieties. Also presented are results of fertilizer trials and recommendations for several cassava-producing countries, including Brazil, Costa Rica, Nigeria, Madagascar, India, Vietnam and the Fiji Islands. *(Summary by P. A. C.)* D01.

0388-2443 PREVOT, P. and OLLAGNIER, M. **La fumure potassique dans les régions tropicales et subtropicales.** *(Potassium fertilization in tropical and subtropical regions). In* Potassium Symposium, Berne, 1958. pp.277-318. Fr., Sum. Span., Germ., Engl., Fr., 78 Refs., Illus.

Cassava. Soil fertility. Fertilizers. P. Nutritional requirements. Productivity.

The quantities of nutrient elements removed from the land by various tropical and subtropical crops are given. The K| N quotient, which eliminates differences arising from the great variations of yield among the plants considered, allows the crops to be classified into three groups: (1) those in which K predominates (cassava, bananas, oil palms, pineapple, coconut, sugar cane); (2) intermediate crops (dates, tobacco, sisal, soybeans, cacao, coffee); and (3) crops in which N predominates (maize, rice, tea, rubber, cotton, groundnut). The authors review some results (which have appeared since 1953) relating to K manuring. The table presented contains 57 data summaries on 14 tropical crops. Few investigations have provided limiting K values indicative of the threshold of deficiency. "Critical levels" for K, as determined by foliar diagnosis, are quoted for cassava (1.2%) and other crops. The authors feel that the basis of the employment of foliar diagnosis, is the concept of "critical levels", together with the study of the reciprocal relationships between the various elements. The N-P relationship is given for various crops; and the balances among the elements N, P, K, Ca and Mg are represented by pentagonal diagrams. In conclusion, the author's opinion is that foliar diagnosis provides a method of interpretation whereby general conclusions can be made rapidly from the results collected at a research station, as exemplified by the development of the work in Senegal on the inorganic manuring of the groundnut. The authors believe that soil analysis combined with foliar diagnosis will prove a most fruitful line of action in the study of fertility. Specialists in the application of these two branches of science to tropical and subtropical regions should come together for discussion and map out a unified program. *(Author's summary)* D01 C03

0389-0460 KROCHMAL, A. and SAMUELS, G. **The influence of NPK levels on the growth and tuber development of cassava in tanks.** Ceiba 16(2):35-43. 1970. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Plant height. N. P. K. Productivity. Tuber development. Fertilizers. Nutritional requirements. Developmental stages. Growth. *Manihot esculenta.*

Cassava (*Manihot utilissima* Pohl) grown in nutrient solution tanks with various combinations of NPK indicated the following: (1) Only high P increased plant height. (2) Production of tops (g| plant) was favored by high N levels but lowered with high K levels. (3) No tubers were formed with N and low PK levels. High N levels reduced tuber growth per pot by 41%. The major effect on tuber yields was due to higher P levels that raised production 93%. High K levels did not favor tuber production. (4) Greatest tuber production was associated with a 1:1 top-to-tuber ratio and a high P level. *(Author's summary)* D01 C01.

0390-0143 HONGSAPAN, S. **Does planting of cassava really impoverish the soil?** Kasikorn 35(5):403-407. 1962. Thai., Sum. Engl.

Cassava. Nutritional requirements. Fertilizers. N. P. K. Minerals. Tuber productivity. Absorption. Soil impoverishment. Soil Fertility. Analysis.

Yields of cassava roots were reduced from 4,200-6,000 kg to 2,000-3,000 kg| rai (approx. 1|6 ha) in the province of Cholburi (Thailand). Fertilizer experiments carried out for 4 years indicated that the best increase in yields could be obtained by applying 65-100 kg of 8-8-4 fertilizer per rai. An analysis of cassava roots showed that 6,000 kg of roots removed 6 kg N, 4 kg 1,205and 19 kg K2) from the soil. The removal of K from the soil is always excessive and might be a major cause of soil depletion. The amount of soil removed during each torrential rainfall was enormous and might be another factor contributing to the rapid decline of soil fertility. A comparison of the amounts of N, P and K removed for each ton of corn, sugar cane, bananas and cabbage showed that cassava was not the most soil-depleting crop as is generally believed. For growing cassava in sandy soils, it is suggested that measures be taken to prevent soil erosion and that organic manures be applied as much as is economically feasible. *(Author's summary)* D01.

0391-0323 CHAN, S. K. **Tapioca varietal investigations at Federal Experiment Station, Serdan 1966-67.** Malaysia. Ministry of Agriculture and Cooperatives. Information paper no. 24. 1967. 15p. Engl., Sum. Engl., Illus.

Cassava. Cultivars. Selection. Productivity. Tubers. Growth. Timing. Starch productivity. Photoperiod. Climatic requirements. Composition. Starch content. Fibre content. Plant development. Tuber development. Malaysia.

Results of trials carried out at Serdang and elsewhere from 1948-54 showed that Medan Kekabu, Tiga Bulan, Berat and an unnamed variety (32) were more adaptable for root production. It was found that a growing period of 12 or 14 mo gave higher yields than 10 mo. Recently, more varieties are being screened; their root development at different growing stages is being studied simultaneously. During the period 1966-67, 3 trials over a one-crop period were completed. The more adaptable varieties for root production were Green Twig, Black Twig, Jurai, Ubi Puteh, Kekabu, Medan, Ubi Ladang, Berat and one unnamed variety. The 4 top-yielding varieties were Green Twig, Black Twig, Jurai and Ubi Puteh; they are recommended for starch production but not for human consumption. The most popular eating variety is Kekabu (or Medan). Kekabu and Medan are probably the same variety; other varieties in the following pairs are also probably the same: Ubi Puteh and Tiga Bulan, Berat and Betawi, Ubi Ladang and Batang Puteh. There was no difference in root yield between the 2 growing period (12 and 14 months). The apparent response of Green Twig and Black Twig to the higher level of NPK was insignificant. The different growing periods at which the higher varieties appeared to give maximum root yield within the period under observation were 9 - 9 1|2 months for Kebabu (Medan), Berat (Betawi), 10 - 10 1|2 months for Green Twig and Black Twig, and 12 months for Jurai, Ubi Ladang (Batang, Puteh), and Ubi Puteh (Tiga Bulan) and one unnamed variety. An examination of starch| fiber in the roots at different growing periods showed that there was a fluctuation, apparently influenced by the marked variation in the amount of sunshine. It may be concluded that in order to obtain maximum yield of roots with high starch content there should be no marked fluctuation in sunshine, particularly from the time when storage roots begin to form to the time when they reach maximum yield. *(Author's summary)* D01 D03 C03

0392-0472 NORMANHA, E. S. and FREIRE, E. S. **Consequencias da aplicação de adubos em contato com ramas de mandioca.** *(Effect of fertilizer application in contact with cassava cuttings).* Bragantia 18:1-4. 1959. Port., Sum. Engl., 3 Refs.

Cassava. Ammonium sulphate. Potassium chloride. Field experiments. Fertilizers. Sodium nitrate. Minerals. Nutritional requeriments. Germination. Planting. Cuttings. Developmental stages. ***Manihot esculenta.*** **Brazil.**

The author's report the results obtained in a small experiment with cassava (*Manihot utilissima* Pohl), in which Chilean nitrate, ammonium sulfate, and potassium chloride were applied, in the planting furrows just before the cuttings were placed in them. All fertilizer treatments delayed the emergence of the sprouts considerably. They all had a slightly detrimental effect on the stand. In case of an unusually high dose of potassium chloride, the reduction in stand was great. It is pointed out that the first type of injury might be frequently overlooked by experimenters because of the difficulty in inspecting the trials during the emergence period. *(Author's summary)* D01.

0393-0453 KUMAR, B. M., MANDAL, R. C. and MAGOON, M. L. **Influence of potash on cassava.** Indian Journal of Agronomy 16(1):82-84. 1971. Engl., Sum. Engl., 6 Refs.

Cassava. Potash. Nutritional requirements. Fertilizers. Tuber productivity. Productivity. Absorption. Starch productivity.

Tuber yields of cassava increased progressively with the application of potash up to 100 kg|ha, beyond which they decreased; the optimum level was found to be 103 kg|ha. As regards the optimum time of potash application for maximum root yield and starch content, ½ dose as basal + ½ dose applied one month after planting was found beneficial as compared to other split applications studied. The maximum starch content (33.5%) was obtained at the same split application. The uptake of potash by plant parts (i.e., tuber, leaf and stem portions) also increased with the increase in potash application. *(Author's summary)* D01 D03.

0394-3314 ESSAIS DE **fumure du manioc.** *(Fertilizer trials for cassava).* Recherche Agronomique de Madagascar. Compte Rendu no. 2:85-88. 1953. Fr., 3 Refs.

Cassava. Fertilizers. Soil fertility. Cultivation. K.

Trials with green manure, chemical and mixed fertilizers were carried out to study their effect on cassava. Three soil types were used: young alluvial, old (yellow) lateritic soils and red lateritic soils. The maintenance of good soil structure and the applications of chemical fertilizers are recommended. Potassium deficiency occurs first. *(Summary by Tropical Abstracts. Transl. by A. van S.)* D01

0395-0220 SILVA, J. R. DA. **Mandioca e calcáreo.** *(Cassava and lime).* Revista Fir 10(4):17-18. 1967. Port.

Cassava. Minerals. Fertilizers. Field experiments. Productivity. Brazil.

The results are given of fertilization trials with lime in acid soils. The purpose of this study was to determine quantity and time of application. Yields significantly increase when lime is used. Dolomitic should be applied before the first plowing. The results of 3 trials are given as tables. *(Summary by J.L.S.)* D01

0396-2657 MUTHUKRISHNAN, C. R., THAMBURAJ, S. and SHANMUGAM, A. **Tapioca needs less water and care.** Farm and Factory 7(9):29-30. 1973. Engl.

Cassava. Irrigation. Costs. Economics. Productivity.

Experiments were carried out at Tamil Nadu Agricultural University to assess the profitability of raising cassava as a rainfed irrigated crop. Irrigating cassava once in 8 days led to an additional profit of Rs.2769|ha over the rainfed crop followed by treatments involving 4- and 12-day intervals, resulting in additional profits of 2525 and 2193 respectively. Cassava lends itself as a rainfed crop with a net return of Rs. 2290|ha. *(Summary by J.L.S.)* D01

0397-0438 SILVA, J. R. DA and FREIRE, E. S. **Influencia da aplicação de adubos minerais nos sulcos de plantio, sobre los "stands" de culturas de mandioca.** *(Effects of aplying some fertilizers in furrows on cassava stands).* Bragantia 27(6):291-300. 1968. Port., Sum. Port., Engl., 5 Refs.

Cassava. Nutritonal requirements. Calcium superphosphate. Minerals. N. P. K. Ammonium sulphate. Potassium chloride. Fertilizers. Brazil.

The effects of lime and some fertilizers on stands of cassava were studied in the state of São Paulo. Three factorial experiments showed that lime broadcast and ammonium sulfate used as a top dressing did not influence the stands, whereas ordinary superphosphate as well as potassium chloride, applied in the furrows at planting time, significantly decreased them. In 3 other experiments in randomized blocks, the application of ordinary superphosphate plus potassium chloride in the planting furrows, with ammonium sulphate as a top dressing, also reduced the stands, but these reductions were significant only in 2 cases. *(Author's summary)* D01

0398- 2084 VELLY, J. **Contribution à la determination de la fumure d'entretien; les exportations en elements mineraux de principales cultures.** *(Contributions to the determination of soil maintenance fertilization; the extractions of mineral elements by main crops).* Bulletin de Madagascar 19(282):872-890. 1969. Fr.

Cassava. Minerals. Potatoes. Sweet-potatoes. Groundnut. Rice. Soil requirements. Fertilizers. Soil fertility. Cultivation. Nutritional requirements. Productivity. Absorption. Malagasy Republic.

A schedule was developed to determine mineral extraction by plants to serve as a basis for the determination of minimum soil fertilizer requirements. Data are given for about 25 crops. In a yield of 40 ton| ha, cassava roots extracted 73 kg N, 34 kg P_2O_5, 87 kg K_2O, 20 kg CaO and 72 kg MgO. *(Summary by H.J.S.)* D01

0399-3489 WAFFELAERT, T. **Essai d'estimation de la valeur agricole de familles do sols au Congo.** *(Attempt to estimate the agricultural value of soil families in the Congo).* Annales de Gembloux 69(3):688-699. 1963. Fr., 2 Refs.

Cassava. Soil fertility. Soil requirements. Savannas. Productivity. Millets. Rotational crops. Cultivation systems. Analysis. Spacing. Zaire.

Based on a soil map of the Aru territory in the Congo (Leopoldville), a sampling method was developed to estimate the agricultural value of these soils. The crops involved were finger millet and cassava. The author concludes that this material is a valuable means by which basic statistical information may be obtained, allowing sound agricultural development planning. *(Summary by Tropical Abstracts)* D01 K01.

0400-0439 SILVA, J. R. DA. and FREIRE, E. S. **Efeito de doses crescentes de nitrogenio, fósforo e potássio sobre la produção de mandioca em solos baixa e alta fertilidade.** *(Responses of cassava to increasing doses of nitrogen, phosphorus and potassium).* Bragantia 27(29):357-364. 1968. Port., Sum. Port., Engl., 5 Refs.

Cassava. N. P. K. Research. Fertilizers. Tuber productivity. Nutritional requirements. ***Manihot esculenta.*** **Field experiments. Soil analysis. Productivity. Foliage. Prunning. Brazil.**

Three experiments were conducted in the state of São Paulo to study the responses of cassava (*Manihot esculenta* Crantz) to N.P.K. Effects of N and P were small in all the experiments, whereas K increased the root yields significantly in 2 of them, located on poor, sandy soils. *(Author's summary)* D01

0401-0440 ALBUQUERQUE, M. DE. **Estudo de fertilidade con mandioca em latosolo amarelo esgotado da Zona do Estuario Amazonico.** *(Fertility studies with cassava on exhausted yellow latosol in the Amazonian Estuary Zone).* Brasil. Instituto de Pesquisas e Experimentação Agropecuarias do Norte. Boletim Informativo no. 134. 1968. 5p. Port.

Cassava. N. P. K. Nutritional requirements. Minerals. Soil fertility. Fertilizers. Dung. Manures. Productivity. Brazil.

Experiments were carried out over 3 years using N, P, K, calcium and cattle manure, N as ammonium sulfate (300 kg| ha), superphosphate (500 kg| ha) and potassium chloride (300 kg| ha). Maximum yields of about 30 tons| ha were obtained, using farmyard manure or full NPK levels. *(Summary by J.H.C.)* D01

0402-0623 ALMEIDA, F. C. G. DE. **Pesquisas em mandioca.** *(Cassava research). In* Reuniao da Comissao Nacional da Mandioça, 5, Sete Lagoas, Minas Gerais,, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp. 33-40. Port.

Cassava. Clones. Fertilizers. Potassium chloride. Ammonium sulphate. Cuttings. Spacing. Field experiments. Research. Cultivation. Nutritional requirements.

A work program was arranged to obtain the best clones, producing roots with a high protein content, and with resistance to drought, diseases and pests. Three experiments were carried out with 10 cassava varieties. In the first, the yields of 9 varieties were compared with the variety that was known for its high yield in the Ceará region. Only one variety showed a significant difference from the control plant. Another experiment was developed to determine the competence of spacing versus fertilizing. No significant differences were recorded. A third experiment was carried out to determine cassava response to the application of 3 fertilizers (ammonium sulfate, superphosphate, potassium chloride). Only the nitrogenous compound was statistically significant. *(Summary by H.J.S.)* D01.

0403-2085 VIJAYAN, M. R. and AIYER, R. S. **Effect of nitrogen and phosphorus on the yield and quality of cassava.** Agricultural Research Journal of Kerala 7(2):84-90. 1969. Engl., Sum. Engl., 6 Refs.

Cassava. Fertilizers. Productivity. Minerals. Nutritional requirements. Cultivation. HCN content. Leaves. Dry matter. Starch content. Composition. P. N. Cultivars. Roots. India.

Response of two varieties of cassava (M 4 and H 105) to graded doses of N (0,75 and 150 kg N|ha) and P (0,75 and 100kg P_2O_5 | ha) as regards root yield and quality, was determined in a field experiment. Application of N (as ammonium sulfate) and P_2O_5 (as superphoshate) at 150 and 100 kg| ha gave the highest yields (28.6 and 30.9 metric tons of roots and 26.7 and 37.7 metric tons of shoots| ha for M 4 and H 105, respectively). Doses of 75 kg of N and 50 kg of P_2O_5| ha ranked second in yield. An increase of N from 0 to 75 kg| ha increased the number of tubers, but further increases in N decreased this number. The variety H 105 was significantly superior to M 4, both in yield and in number of tubers produced. The former produced more leaves and grew to a greater height than the latter. Nitrogen and P_2O_5 at 150 kg| ha gave the highest percentage of dry matter content in the tubers; an increase in the nutrients individually did not affect percentages significantly. None of the nutrient treatments had a significant effect on the percentage of edible portion of the tubers. Starch content of the tubers increased with an increase of N up to 75 kg| ha but decreased with further increases of N. A combination of N and P_2O_5 at 150 and 100 kg| ha, respectively, gave the maximum starch content. Crude protein content increased with an increase in N and was highest when N and P_2O_5 were combined at 150 and 100 kg| ha. HCN content increased with increases in N and decreased (or there was no effect) with P_2O_5. A balanced application of N and P_2O_5 at ratio of 3:2 was indicated as the most advantageous for cassava *(Author's summary)* D01 D03

0404-0705 KANAPATHY, K. and KEAT, G. A. **Growing maize, sorghum and tapioca on peat soil.** *In* Blencowe, E. K. and J. W., eds. Crop diversification in Malaysia. Kuala Lumpur, Malaysia, Incorporated Society of Planters, 1970. pp.25-35. Engl., Sum. Engl., 6 Refs.

Cassava. Maize. Sorghums. Productivity. Soil fertility. Fertilizers. Cultivation. Nutritional requirements. N. P. K.

Tests have shown that the addition of copper is very important on West Malaysian peat soils. Potash, nitrogen, boron, phophorus and lime are also required. Experiments have shown that with the addition of suitable fertilizers, cassava can be planted continuously on peat; yields are high in comparison to those on other soils. The fertilizer requirement for annual crops such as cassava and maize require substantially more fertilizer than tree crops; production costs can probably be reduced by suitable rotation and integration with livestock. *(Author's summary)* D01

0405-0863 CHEW, W. Y. **Varieties and NPK fertilizers for tapioca** ***(Manihot utilissima*** **Pohl) on peat.** Malaysian Agricultural Journal 47(4):483-491. 1970. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. Fertilizers. Plant height. Tubers. Nutritional requirements. Cultivars. Field experiments. N. P. K. Productivity. Plant development. Tuber productivity. Malaysia.

One cassava variety trial and one NPK fertilizer trial on peat during the period 1967-1969 are described. The

6 highest yielding varieties were Black Twig, Medan Kekabu, Green Twig, Jurai and Betawi, giving 10-14 tons|acre of fresh tubers. N, P and K each resulted in yield increases. A strong linear response of 23%|60 lb|acre was obtained for N. P gave a quadratic yield response of 5%|25 lb of P_2O_5. K resulted in a similarly small linear response of 8%|50 lb of K_2O|acre. P and K interacted with N, enhancing the response to it. The best NPK fertilizer mixture for cassava on peat was 180 lb N, 50-60 lb P_2O_5 and 110-120 lb K_2O per acre. *(Author's summary)* D01 D03.

0406-2455 MALAVOLTA, E. *et al.* **Adubação da mandioca,** ***Manihot utilissima*** **Pohl. I. Ensaio em areia lavada.** *(Fertilization of cassava, Manihot utilissima Pohl. I. An experiment in washed sand).* Anais da Escola Superior de Agricultura "Luiz de Queiroz" 10:217-222. 1953. Port., Sum. Engl., 5 Refs.

Cassava. Plant physiology. Productivity. Tubers. Fertilizers. Soil fertility. Starch productivity. N. P. K. Brazil.

Preliminary results are given of a sand culture experiment carried out to obtain physiological bases for studying the fertilization of cassava in the state of São Paulo. The possible influence of mineral nutrients on starch quantity and quality was studied. The variety Branca de Sta. Catarina was grown under 7 different N.P.K. treatments. It was found that P and N must be applied simultaneously because a deficiency of N limits yields in spite of the response to P. The favorable results obtained were not only due to the applications of P but also to the good physiological response of the plants. *(Author's summary)* D01 C00.

04C 3896 CHEW, W. Y. **Yields of some varieties of tapioca (*Manihot utilissima* Pohl) grown on Malaysian peat as affected by different planting methods, plant densities, fertilizers and growth periods.** Malaysian Agricultural Journal 49(3):393-402. 1974. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Cultivars. Fertilizers. Planting. Spacing. Growth. Tuber productivity. N. P. K. Plant height. Stems. Nutritional requirements. Field experiments. Harvesting. Malaysia.

Several experiments to determine the best variety, planting method, N and K fertilizers, plant density and length of growing period for maximizing the yields of cassava grown on West Malaysian peat soil are described. Of the varieties tested, Medan, Black Twig, Green Twig and Kekabu gave significantly higher yields than the others with yields of 15.59, 14.32, 14.01 and 14.07 tons|acre, respectively. Responses to N and K fertilizers were obtained only during the first season, with yield increases of 1.78 and 1.15 tons|acre of fresh roots per additional 120 lbs of nutrient above the 120 lbs|acre level of both N and K_2O respectively. Flat planting did not result in higher yields of fresh tubers per plant than slant planting but tended to give lower incidence of lodging. The greatest proportion of plants (variety Jurai) in the population were of the 2- or 3-stem type; these gave higher mean yields per plant than plants with 1 or 4 stems. The varieties Black Twig, Jurai, Medan, Puteh and Melaka did not show any yield difference when planted at distances varying from 3ft x 2ft to 3ft x 6ft. Only the 3 varieties Jurai, Medan and Pulut responded significantly to a longer growing period. Medan and Jurai produced maximum yields when harvested 14 months after planting whereas Pulut gave the best yields when harvested 12-16 months after planting. *(Author's summary)* D01 D03.

0408-0756 ACOSTA J., R. and PEREZ G., J. **Abonamiento en yuca.** *(Fertilization of cassava).* Suelo Tico 7(31):300-308. 1954. Span., Sum. Span., 4 Refs., Illus

Cassava. ***Manihot esculenta.*** **Fertilizers. N. P. K. Planting. Spacing. Productivity. Production. Costs. Field experiments. Costa Rica.**

A trial was conducted on a private farm in La Alajuela (Brazil) to evaluate the profitability of NPK applications and different planting densities. A 33 factorial experiment was conducted with NPK and 3 replications and randomized blocks including 3 planting densities and 12 replications. Results of the effect of fertilizers on cassava production per "manzana" (8,000 m²), the 3 different planting densities and their relationship to costs and net profit are shown in tables. The following conclusions were drawn: (1) NPK increased cassava yields per manzana; (2) application of 75 lb of N increased yields, but higher quantities reduced them; (3) P application is unnecessary as it only gives good results in the presence of N and the increase in yields is equal to that obtained with 75 lb N; (4) a 5% increase was obtained by reducing the distance between stakes from 80 to 40 cm. *(Summary by S.S. de S.)* D01

0409-5209 FOX, R.H., TALLEYRAND, H. and SCOTT, T.W. **Effect of nitrogen fertilization on yields and nitrogen content of cassava, Llanera cultivar.** Journal of Agriculture of University of Puerto Rico 59(2):115-124. 1975. Engl., Sum. Engl., Span., 7 Refs.

Cassava. Cultivars. N. Growth. Tuber productivity. Fertilizers. Analysis. Stems. Leaves. Tubers. Protein content. Puerto Rico.

Experiments were conducted on 2 Ultisols in Puerto Rico to determine the fertilizer N requirements of a high-yielding, high root protein variety of cassava (*Manihot esculenta* Crantz cv. Llanera) from Colombia. This variety appeared to be day-length sensitive; top growth ceased from mid-November to mid-February when days were shorter than 11 1|2 hours. At Corozal (Humatas clay)), crop was grown from mid-March to mid-December, and top growth responded strongly and root growth moderately to applied N. High N rates produced low root|top ratios (.67-.87); but in view of the experience at the Cidra site, it was assumed that root|top ratios would have increased to higher levels had the crop continued to grow. Apparent recovery of fertilizer N was high (68-69%) for the 10 and 80 kg|ha rates. At Cidra (Torres clay), where the crop grew from mid-June until the following May and was dormant for the 3 winter months, there was no response to N, the top yields were lower, but root|top ratios were higher (average, 1.37). The lack of response to N was due to the high N-supplying power of this soil. Maximum root yields were 23 metric tons|ha at Corozal and 33 metric tons|ha at Cidra. Plants in the highest yielding treatments contained 125-175 kg|ha N. Assuming all N was protein N, unpeeled root protein contents averaged 3.4% and peeled, 2.3% on a dry weight basis and were increased only slightly by higher N rates. The N content of the 4th and 5th fully expanded leaves 4-5 months after planting was well correlated with final root yield at Corozal ($R^2 = .99$ for 0-160 kg|ha N rates). It appears that a minimum of 5% N in these leaves 2 1|2 months after planting is necessary for maximum yields. *(Author's suumary)* D01

0410-0524 SAMUELS, G. **The influence of fertilizer leaves and sources on cassava production on a Lares clay in Puerto Rico.** *In* Annual Meeting C.F.C.S., 7th, Martinique, Guadeloupe, 1969. Proceedings. 1970. pp.33-36. Engl., Sum. Engl., Fr.

Cassava. Ca. K. Nutritional requirements. Fertilizers. Soil fertility. Magnesium. Research. Field experiments. Puerto Rico.

Cassava *(Manihot esculenta)* was grown on an acid Lares clay soil in the mountainous area of north central Puerto Rico using various levels and sources of fertilizers. The results were as follows: (1) There was no significant response to N at rates of 100 and 200 lbs|acre nor to sources of N such as ammonium sulfate, urea and calcium ammonium nitrate. (2) There was no response to triple superphosphate (45% P_2O_5), but a significant response was obtained from diammonium phosphate (21-53-0) at the rate of 100 lbs|acre. (3) There was a significant response to the use of 100 lbs of K_2O|acre. (4) There was a significant response to the use of 1 ton of calcium carbonate|acre. (5) Calcium metasilicate, garbage compost and potassium-magnesium sulfate all failed to increase yields. (6) An application of all or one half of the N at time of planting was better than applying all the N 2-3 months after planting. *(Author's summary)* D01

0411-0637 SAINT AMAND, R. D. DE and FRITZ, J. **Les sols cultivés en manioc dans la région de Moramanga.** *(Cassava-cultivated soils in the Moramanga region).* Riz et Riziculture. 5:49-53. 1959. Fr., Sum. Fr., Engl., Span., Illus.

Cassava. Nutritional requirements. Fertilizers. Soil analysis. Soil fertility. Malagasy Republic.

The region of Moramanga is located in the Mangoro basin at an altitude of roughly 900 m in eastern Madagascar. This is one of the regions where cassava is grown on an industrial scale. A description is given of 6 typical soil profiles formed by old lacustrine alluvial deposits. Results of physicochemical analyses of soil samples from various horizons are given in a table. On the whole, particle size of these soils is optimal; Ca, Mg and K content of exchangeable ions is low; the same applies to P_2O_5. The total exchange capacity is satisfactory. The pH is acid; the organic matter content is generally satisfactory in the upper horizon (owing to cultivation methods: fertilizing with stable manure or green manure); however, humification percentage is rather low. Further fertilizing experiments are being conducted. *(Author's summary)* D01

0412-3487 **CULTIVATION OF tapioca.** n.p., Chemara Research SDN. BHD. KGSB Techinique, 1968. 6p. Engl.

Cassava. Climatic requirements. Soil requirements. Land preparation. Planting. Timing. Spacing. Harvesting. Fertilizers. N. P. K. Ca. Magnesium.

Practical recommendations are given for the growing of cassava *(Manihot utilissima)* in Malaya. Climatic and soil requirements, land preparation, choice of the planting material, planting time and methods, manuring, pest and disease control, and harvesting are discussed. *(Summary by Tropical Abstracts)* D01 D02

0413-1654 GUILLEN, R. D. **Zonas ecológicamente aptas para el cultivo de la yuca en Venezuela.** *(Zones ecologically suitable for growing cassava in Venezuela).* Seminario Nacional sobre Yuca, Tacarigua, Venezuela, 1973. Revista de la Facultad de Agronomía de la Universidad Central de Venezuela Alcance no. 22:41-44. 1973. Span., 4 Refs.

Cassava. Soil requirements. Soil analysis. Rainfall data. Venezuela.

Growing cassava requires special ecological conditions and soil characteristics for good root development. The best areas for this crop are described: the eastern part of Venezuela, the Plains of San Carlos, south of the Lake of Maracaibo and south of the Orinoco River. A part of the Valley of Aroa is also described as being potentially exploitable for this purpose. *(Summary by L.C. Trans. by T.M.)* D01

0414-3253 MANDAL, R. C., SINGH, K. D. and MAGOON, M. L. **Relative efficacy of different sources, levels and split application of nitrogen in tapioca.** Indian Journal of Agronomy 16(4):449-452. 1971. Engl., Sum. Engl., 4 Refs.

Cassava. Fertilizers. N. Ca. Productivity.

Yields of cassava are very low in India. Since different sources of nitrogenous fertilizers differ in their basic characteristics and as the amount of N has a direct effect on tuber yield, experiments were conducted using a high-yielding hybrid to test its response to form, optimum level and time of application of these fertilizers. The trials were conducted over a 4-year period on an acid laterite soil in factorial randomized block designs. Calcium ammonium nitrate was found to be the best source of N, followed by ammonium phosphate and urea. Applications of N at 100 kg/ha (half as basal + half after 2 mo) gave the best response among 7 treatments. The carbohydrate content of the tubers also increased with the application of calcium ammonium nitrate and a split application of N at 100 kg/ha (half as basal + half after 2 mo). *(Summary by T.M.)* D01.

0415-3807 SETZER, J. **A produção de alcool de cana e mandioca do ponto de vista pedológico.** *(Production of alcohol from sugar cane and cassava from a pedalogical standpoint).* Engenharia 4(39):97-102. 1945. Port., 9 Refs.

Cassava. Soil analysis. Soil requirements. Rainfall data. Soil fertility. Brazil.

This paper classifies São Paulo soils suitable for the growing of sugar cane and cassava, according to their main geological, physical and chemical characteristics. There are fewer soil requirements for cassava than for sugar cane: deep soil with good drainage and a moderate clay content. Cassava also resists severer climatic conditions. The use of cassava as a raw material in the manufacture of alcohol is highly advantageous because it can be grown on São Paulo's poorest soils (20% of them), which would otherwise be totally unusable. *(Summary by S.S. de S.)* D01

0416-3170 **MANIOC. ESSAIS culturaux |Madagascar|.** *(Cassava. Cultural trials |Madagascar|).* Bulletin Trimestriel du Centre Technique d'Agriculture Tropicale (Nogent| M.) no. 1:35-41. 1956. Fr .

Cassava. Cultivars. Field experiments. Fertilizers. N. P. K. Tuber productivity. Planting. Growth. Stems. Analysis. Cuttings. Malagasy Republic.

Two cultural trials carried out at the Agronomy Station of Lake Alaotra are presented. The first experiment studied the influence of the position in which the cutting was planted on survival, growth and yields at Ambohidray (a region of Moramanga). The position of the cuttings did not affect yields. The second experiment included a series of fertilization trials at Moravitsika N, P, K and Ca in 9 different combinations were studied. K fertilizers improved the response of NPK, increased plant density and root yields. There was a correlation between phelloderm P content and root yields. *(Summary by S.S. de S.)* D01 D03

0417-2345 TARDIEU, M. and FAUCHE, J. **Contribution á l'étude des techniques culturales chez le manioc.** *(Contribution to the study of cassava cultivation).* Agronomie Tropicale 16(4):375-386. 1961. Fr., Sum. Fr., Engl., Span., 1 Ref., Illus.

Cassava. Cultivation. Fertilizers. Soil fertility. Cuttings. N. P. K.

Cultivation of cassava is mostly primitive in the northern part of West Africa. Since cassava is relatively easy to grow and gives high yields, farmers prefer to plant it rather than fruits or vegetables that take more time and money. However, agricultural techniques need to be updated. It would be interesting to incorporate cassava into a crop rotation system. This would involve more complex problems such as the order in which the crops should be cultivated, fertilizing techniques, and maintenance and improvement of soil fertility. *(Summary by T.M.)* D01

0418-1961 LOPEZ Z., M. **Estudio comparativo de 6 variedades de yuca.** *(Comparative study of six varieties of cassava).* *In* Santa Clara, Cuba. Universidad Central de las Villas, Centro de Investigaciones Agropecuarias. Memoria Anual. 1966. pp.156-158. Span.

Cassava. Cultivars. Productivity. Fertilizers. Insect control. *Carpolonchaea chalybea.* **Rainfall data. Field experiments. Cuba.**

A study was done to select high-yielding cassava varieties that are resistant to moisture in the soil and that germinate well. Twenty-four varieties were tested, evaluated and selected over a 2-year period. The 6 best varieties were then retested a third time to determine the best one. The experiment was a 6 x 6 Latin square design with an area of 50 m^2 per lot. Two applications of fertilizer were made (10-10-10 and 8-9-12, respectively) at planting and 2 months later. A statistical analysis showed the variety Señorita produced significantly better than the others, besides being resistant to soil moisture and germinating well. *(Summary by L.C. Trans. by T.M.)* D01 F01

0419-2049 IRVING, H. **Fertiliser studies in eastern Nigeria, 1947-51.** Enugu, Nigeria, The Government Printer, 1956? 34p. (Technical Bulletin no. 1). Engl., 5 Refs., Illus.

Cassava. Fertilizers. N. Potash. Ammonium sulphate. Soil fertility. P. K. Inter-cropping. Yams. Maize. Nigeria.

Fertilizer studies on different field crops (principally yams) were conducted on 3 different soil groups (Benin, Ogoja and Calabar) in eastern Nigeria. In general, the soils are light in texture, have a moderate to strong acid reaction, the percentage of base saturation is low, and they respond to applications of lime. When cassava was intercropped with yams, the residual effect of ammonium sulfate, as well as potassium chloride, increased yields. *(Summary by T.M.)* D01 K01

0420-4842 LIM, C. K., CHIN, Y. K. and BOLLE-JONES, E. W. **Crop indicators of nutrient status of peat soil.** Malaysian Agricultural Journal 49(2):198-207. 1973. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Soil fertility. N. P. K. Fertilizers. pH. Magnesium. Boron. Copper. S. Zn. Molybdenum. Shoots. Tubers. Field experiments. Maize. Groundnut. Malaysia.

The growth of maize, groundnut and cassava in limed peat and of cassava in unlimed peat were compared. Each was subject to nutrient treatments applied to pots following a subtractive technique. Without added N and P growth on virgin peat was extremely poor for all crops and would result in crop failure. Cassava survived in unlimed peat (pH 3.20) and grew relatively well in the absence of Ca; this suggested that the better growth in limed soil was due to beneficial pH effect and not to augmented Ca status. *(Author's summary)* D01

0421-2245 **UNE RICHESSE de Madagascar: le manioc.** *(Cassava: a rich resource in Madagascar).* Bulletin de Madagascar (Tananarive) no. 35:35-40. 1951. Fr.

Cassava. Cultivation. Economics. Trade. Nutritive value. Production. Malagasy Republic.

Cassava notes include climatic and edaphic requirements, necessary manpower, cultural practices in different parts of Madagascar, diseases and pests, utilization in animal feeding. Historical notes on the development of cassava cultivation and the present status of international cassava trade are also briefly discussed. *(Summary by T.M.)* D01 J00

Tarj. Nº 63

See also 0123 0155 0544 0552

D02 Cultivation Practices: Propagation, Planting, Weed Control, and Harvesting

0422-0063 HARPER, R. S. **Chemical weed control in cassava using Paraquat.** Pans 20(2): 185-189. 1974. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. *Manihot esculenta.* **Herbicides. Weeding. Weeds. Pests. Pest control. Plant height. Plant development. Productivity. Tuber productivity. Thailand.**

Paraquat applied as a directed, interrow spray gave economical control of weeds in cassava for a period of 3 months or more. Applications were made at rates of 0.2-0.4 kg|ha postemergence in young cassava of 3 months or more, with 15-20 cm of brown bark at the base of the stems; a repeat application was made after an interval of 10-14 days. Usually, one further spray was required to obtain acceptable weed control until harvesting; weed control was facilitated by the increased shade given by the developing crop canopy. *(Author's summary)* D02

0423-0444 ROSAS S., C. **Tuberíferas; cultivo yuca; comentario a la ponencia del Ing. Juan Brambilla sobre "Producción de semilla de yuca".** *(Tuber crops; cassava culture; commentaries on Juan Brambilla's presentation on "Production of cassava seed"). In* Mesa Redonda sobre Producción de Semillas, Lima. Lima, Estación Experimental Agrícola de la Molina, n.d. 10p. Span.

Cassava. *Manihot esculenta.* **Cassava programs. Development. Production. Peru.**

Five main points for a future national seed production program for cassava *(Manihot esculenta)* in Peru are discussed: (1) organization of cassava seed production according to its uses; (2) varieties to be considered in the establishment of seed;(3) problems in cassava cultivation, including incomplete knowledge of national germplasm and long vegetative periods among others; (4) plant breeding to obtain new varieties; (5) procedures and regulations to consider in the establishment of cassava nurseries. *(Summary by P.A.C.)* D02

0424-2959 CASTELLAR M., J. A. and MOGOLLON B., J. A. **Estudio sobre conservación y viabilidad de semilla vegetativa de yuca (*Manihot esculenta* Crantz).** *[Study on the storing and viability of cassava (Manihot esculenta Crantz) vegetative propagative material].* Agr. Eng. Thesis. Santa Marta, Colombia, Universidad Tecnológica del Magdalena, Facultad de Agronomía, 1972. 121p. Span., Sum. Span., Engl., 13 Refs.

Cassava. *Manihot esculenta.* **Propagation materials. Cuttings. Storage. Plant development. Germination. Developmental stages. Timing. Colombia.**

This experiment was conducted in cooperation with the Programa Nacional de Tuberosas del Instituto Colombiano Agropecuario (ICA) at the Agricultural Experiment Station "Caribia" in Sevilla (Magdalena). The variety H-34 was used for the experiment because of its excellent adaptation in the zone. The principal objectives were the following: (1) to evaluate different methods of storing stem cuttings of cassava (*Manihot esculenta* Crantz); (2) to study the variability in percentage of germination of propagative material after different periods of storage; (3) to study the influence of different diameters and lengths of propagative material in germination. The field test included 6 treatments and 2 replications. The following conclusions were reached: (a) when the propagative material was planted inmediately after cutting, only 2-4% of the stakes had to be replanted at 15 days, regardless of stake length; (b) propagative material treated in hot water at 52°C for 20 min presented high percentages of germination and was free of bacteria, fungi, nematodes and insects; (c) covered with banana leaves, cuttings of 30 and 50 cm can be stored for 40 days with optimun results; (d) viability of stakes (longer than 30 cm) was good when the tips were dipped in wax. Excellent results were also obtained when using the more economical method of planting cuttings in seed beds for a 60-day period before transplanting; (e) for any stake diameter there was a positive and significant correlation between the average number of buds and percentage of germination of the propagative material, no matter where it came from. These are results of precise evaluation of percentages of germination and average number of germinated buds. Statistical analysis of any experimental design was not used; simple and practical procedures were followed. *(Summary by T. M)* D02 C01

0425 0334 HERNAEZ, A. **The root crops in the Philippines with special reference to cassava and camote.** Philippines Journal of Agriculture 19:41-57. 1954. Engl., 9 Refs.

Cassava. Tubers. Pests. Diseases and pathogens. Mycosis. Cultivation. Productivity. Philippines.

On the basis of their food and industrial values the most important root crops in the Philippines are cassava, camote (sweet potato), Irish potato, gabi, ube, ginger, tugue and arrowroot. Data on cassava *(Manihot esculenta* Crantz) include the varieties cultivated; soil and climatic requirements; planting, weeding and cultivation; manuring and fertilization; pests and diseases; harvesting; and uses. *(Summary by P.A.C.)* D02.

0426-1891 BRICEÑO P., R. H. and LARSON, G. **Investigación y desarrollo de una cosechadora de yuca *(Manihot esculenta* Crantz).** [*Research on developing a cassava (Manihot esculenta Crantz) harvester*]. Revista ICA 7(2):139-150. 1972. Span., Sum. Span., Engl., 11 Refs., Illus.

Cassava. *Manihot esculenta.* Cultivation. Production. Costs. Harvesting. Field experiments. Mechanization. Agricultural equipment. Colombia.

Cassava is important in the Colombian economy because of its nutritive value and as a source of starch and other by-products, for use in the paper and textile industries. At present, harvesting is done manually in 2 steps: first, the green top growth is removed and second, the roots are pulled from the soil, cleaned and packed. This operation is slow and expensive, especially where soils are compact. A study was conducted at the Centros Nacionales de Investigaciones Agropecuarias del Instituto Colombiano Agropecuario, ICA, in Tibaitatá and Palmira. The purpose of this study was to develop a cassava barvester; data on its design, construction and testing of the prototype are included. Recommendations are also made on crop practices to facilitate harvesting. Specifications of the implement include the following: a 3-point hitch; 0.95m blade width; 0.40m depth of cut; operating speed, 2-3 km|h; field capacity, 0.29 ha|h. In accordance with the aforementioned conditions, a tractor is required with a draft of at least 4,000 kg. This draft is normally obtained from a tractor with a rated power takeoff of 80 pH. *(Summary by T.M.)* D02.

0427-0399 SÃO PAULO. AGRICULTURAL INSTITUTE OF THE STATE. ROOTS AND TUBER SECTION. **Cultivation of manioc.** São Paulo, n.d. 16p. Engl.

Cassava. Toxicity. Growth. Foliage. Planting. Pruning. Harvesting. Uses. Resistance. Storage. Cultivation. Cultivars. Climatic requirements. Pests. Diseases and pathogens. Disease control. Soil fertility. Rotational crops. Cultivation systems. Nutritional requirements. Fertilizers. Spacing. Inter-cropping. *Xanthomonas manihotis.* Bacterioses. Mycoses. *Manihot esculenta.* Brazil.

A summary based on results of experimentation on cassava *(Manihot esculenta* Crantz), carried out at the Agricultural Institute of the state of São Paulo (Brazil), is presented along with tables summarizing the characteristics of the principal varieties of cassava studied. Data include toxicity; climate and effect on growth; growing cycle; principal diseases and control: *Xanthomonas manihotis* (Arthaud-Berthet) Burk, superbudding caused by virus, cercospora, and hornworm selection of foliages; soils; defense against erosion; crop rotation; planting periods; land preparation; fertilization; planting systems; intercropping; spacing; principal weeds; methods of cultivation; pruning; index for determining yield; harvesting periods and methods; root and foliage production; root storage; and conservation of foliage. *(Summary by P.A.C.)* D02 E01

0428-0162 MOODY, K. and EXUMAH, H.C. **Weed control in major tropical root and tuber crops - A review.** Pans 20(3):292-299. 1974. Engl., Sum. Engl., 63 Refs.

Cassava. *Manihot esculenta*. Cultivation. Weeding. Labour. Economics. Herbicides. Hoeing. Productivity.

The present status of weed control in the major tropical root and tuber crops in reviewed. The importance of early weeding is emphasized, and summaries of the results obtained with herbicides are given. *(Author's summary)* D02

0429-0401 ROSAS S., C. **Influencia de la modalidad de siembra y tamaño de la estaca de yuca, *Manihot esculenta* Crantz.** *(Influence of planting techniques and size of cassava, Manihot esculenta Crantz, cuttings).* La Molina, Perú, Universidad Nacional Agraria, Programa de Agronomía, 1969. 7p. Span., Sum. Span., 11 Refs.

Cassava. Planting. Cuttings. Propagation materials. Cultivation. Productivity. Spacing. Tuber productivity. Peru.

An experiment was carried out at the Universidad Agraria, La Molina (Peru), the purpose of which was to study whether planting techniques (horizontal, slant position, or at 45°) and size of cuttings (10, 20 and 30 cm long) had any influence on the rooting of cassava, on plant morphology, and especially on the yield weight of the storage roots. It was designed in accordance with a factorial experiment with a completely randomized block. A significant increase in weight yields of the storage roots was obtained when 10 cm-long cuttings were used as "seed" and planted in a slant position. *(Author's summary).* D02

0430-0436 KROCHMAL, A. **Labour input and mechanization of cassava.** World Crops 18(3):28-30. 1966. Engl., 2 Refs., Illus.

Cassava. Mechanization. Planting. Cultivation. Labour. Agricultural equipment. Costs. Harvesting. Latin America. Caribbean.

Manual cassava cultivation in Latin America and the Caribbean region requires 375-500 man-hours| ha; much higher figures reported for Africa result from intercropping. Even where labor is cheap, land preparation should be mechanized to improve the quality of tillage. Further mechanization is possible by introducing (1) a Brazilian type of 2-row planter, (2) a power saw to prepare cuttings, (3) chemical weed control to replace labor-intensive hand weeding, and (4) mechanical removal of tops by a tractor equipped with a heavy screen on the front to push the stems down and a rotary mower at the back to cut them off. Any delay in harvesting is not entirely satisfactory, but moldboard plowing can reduce labor. Maximum mechanization will bring down the number of man-hours required to 110| ha. *(Summary by Tropical Abstracts)* D02

0431-2236 COURS, G. **Note sur quelques essais entrepris sur le manioc a la Station Agricole de l'Alaotra.** *(Notes on some tests on cassava carried out at the Agronomy Station in Alaotra).* Bulletin Economique de Madagascar no. 6:162-171. 1936. Fr.

Cassava. Productivity. Pruning. Starch content. Plant Physiology. Composition. Tuber productivity. Tapiocas. Starch productivity. Spacing. Planting. Cultivation. Malagasy Republic.

Brief notes are given on natural and artificial hybridization of cassava varieties. A description is given of the characteristics and utilization of the Reimann scale, to measure the tuber's density and its starch content.

There seems to be some positive correlation between the starch content of some varieties and their tapioca yields. A correlation was found between the size and the density of tubers, the medium-sized tubers having the higher density. The two extremes of the tubers (based and apex sections) are less dense than the intermediate section. A positive correlation was found between density of field plantation and tuber yields, but there was a negative correlation between these items and starch yields. The inner layer of the peel renders poor starch yields. Extreme pruning strongly affects tuber yields. *(Summary by H.J.S.)* *D02 D03*

0432-2171 VERTEUIL, J. DE. **Cassava experiments 1916-1918.** Bulletin of the Department of Agriculture, Trinidad and Tobago 17(4):193-198. 1918. Engl.

Cassava. Cultivars. Cultivation. Spacing. Planting. Cuttings. Propagation materials. Timing. Harvesting. Starch content. Productivity. Starch productivity. Fertilizers. Trinidad and Tobago.

Experiments were carried out to ascertain the best local varieties, the best planting distance, cutting selection, planting season and age and time for harvesting. Fertilizer experiments and breeding experiments were included. *(Summary by J.L.S.)* D02 D03

0433-0135 MEJIA F., R. **El cultivo de la yuca y su explotación industrial.** *(Cassava growing and its industrial uses).* Agricultura Tropical (Colombia) 2(1): 9-13. 1946. Span.

Cassava. Plant anatomy. Uses. Colombia.

Some remarks are given on the origin and morphology of cassava. Cassava is widely consumed as flour. It is considered a good supplement for animal feeding and is used as a raw material in the production of starch, glucose, dextrin, alcohol and beer. *(Summary by A. N.)* D02 I02

0434-2285 FILHO, J.R. **Cultura e utilização da mandioca.** *(Cultivation and uses of cassava).* Ceres (Brazil) 7(38):88-100. 1946. Port., 6 Refs.

Cassava. Cultivation. Uses. Harvesting. Tubers. Storage. Cuttings. Cultivars. Fertilizers. Brazil.

Notes are given on several aspects of cassava including uses, varieties, fertilization, cultivation, harvesting of cuttings and storage of tubers. *(Summary by H.J.S.)* D02

0435-2660 NORMANHA, E. S. and PEREIRA, A. S. **Recomendações para o plantío da mandioca.** *(Recommendations for cassava planting).* Revista de Agricultura (Brazil) 28:263-266. 1953. Port.

Cassava. Cultivation. Planting. Cuttings. Propagation materials. Mechanization. Brazil.

Some useful recomendations on cassava cultivation in the state of São Paulo, Brazil are given for farmers. General data include selection of stems, stalks conservation, land preparation, furrowing, size of stalks and mechanization. *(Summary by A.N.)* D02

0436-2188 SINGH, K. D. *et al.* **Note on the effect of varying stages of harvest on tuber yield and starch content in different strains of cassava.** Indian Journal of Agronomy 15(4):385-386. 1970. Engl., 2 Refs.

Cassava. Cultivars. Productivity. Tuber productivity. Starch productivity. Timing. Hybrids. Harvesting. India.

Three hybrids (H 86, H 97 and H 165) a seedling (S 2371), and the Malayan variety M 4 were grown in 1968-69 and harvested at monthly intervals from the 6th to the 11th month after planting. Tuber yield increased to the 10-month stage and then decreased significantly in all varieties except M4. The hybrids produced between 55.1 and 62.5 tons|ha as compared with 24.4 for M 4. *(Summary by Field Crop Abstracts)* D02

0437-0271 MONTALDO, A. **El cultivo de la yuca.** *(Growing of cassava).* Maracay. Universidad Central de Venezuela. Instituto de Agronomía. Publicación Divulgativa no. 4. 8p. Span., Illus.

Cassava. Cuttings. Planting. Weeding. Cultivation. Harvesting. Soil fertility. Venezuela.

This pamphlet written for farmers describes cultivation practices for cassava growing. Topics include soil conditions, planting times, cuttings to use, planting and harvesting methods. *(Summary by P. A. C.)* D02

0438-2142 FAUCHERE, A. **La culture du manioc.** *(Cassava cultivation).* Bulletin Economique de Madagascar no. 2:141-151. 1910. Fr.

Cassava. Cultivation. Productivity. Taxonomy. Industrialization. Prices. Climatic requirements. Soil fertility. Cassava products. Tapiocas. Cassava flour. Costs. Production. Malagasy Republic.

Notes are presented about cassava. Data given refer to origin, botanical characteristics, climate and edaphic requirements, soil preparation, intercropping development and management of a cassava plantation, yields, prices and industrialization. *(Summary by H.J.S.)* D02 I02

0439-1908 ONOCHIE, B. E., MAKANJUOLA, G. A. and SCHULTE, E. E. **A study to determine the suitability of present cassava varieties to mechanical harvesting.** Ile-Ife, Nigeria, University of Ife, 1973. 16p. Engl., Sum. Engl., 4 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* **Cultivars. Tubers. Harvesting. Mechanization. Agricultural equipment. Stems. Rooting. Nigeria.**

This study shows that the present cassava rooting habit needs drastic remodeling in order to facilitate mechanical harvesting. A desirable objective in cassava harvesting is to attain complete recovery of the root crop with minimum damage to the roots and at minimum cost. Mechanical harvesting and bulk handling of cassava roots can reduce costs only if a plant type with a bunched rooting pattern can be developed. There is need to examine the effect of certain management practices on the rooting pattern. Research at the University of Ife has shown that the mode of placement of the cuttings, depth of planting and even the method of cultivation affect the rooting pattern of cassava. A concerted effort by plant breeders, agronomists and agricultural engineers in achieving a plant type and management system that will facilitate easy and economical harvesting is urgently needed. *(Author's summary)* D02

0440-3904 PIEDRAHITA, W. and DOLL, J. **Herbicidas postemergentes en yuca** *(Manihot esculenta* **Crantz): selectividad, métodos de aplicación e interacción con edad.** *[Post-emergence herbicides in cassava (Manihot esculenta Crantz): selectivity, methods of application and age interaction]* Revista Comalfi 1(3):92-106. 1974. Span., Sum. Span., Engl., 8 Refs.

Cassava. *Manihot esculenta.* **Tuber productivity. Field experiments. Herbicides. Weeding. Cultivation. Productivity. Plant height. Plant development. Agricultural equipment. Timing. Plant physiology. Harvesting. Statistical data. Colombia.**

The herbicides dalapon, glyphosate, paraquat, MSMA, and diuron were evaluated for their postemergence selectivity in cassava (*Manihot esculenta* Crantz). Four methods of application were also tested: with a shield, directed without a shield, and hitting the lower 25 or 50% of the plant. In order to study the interaction between herbicide and plant age, the same products plus 2,4-D amine were applied to 40-65- and 90-day-old cassava, either over the top or to the lower half of the plant. Diuron was the only selective herbicide in over-the-top applications. Selectivity was greatly increased for all the herbicides tested by using a shield and directing the application at the base of the plant. In all three ages, diuron was the most selective product. All the other products were highly toxic for all ages in over-the-top applications. Directing the spray at the lower half of the plant increased the selectivity of all the herbicides. *(Author's summary)* D02

0441-1873 COELHO, J. P. *et al.* **Herbicidas em pré-emergencia na cultura da mandioca: cálculo de dosagens de Karmex-DW e Lorox e sua análise econômica.** *(Pre-emergence herbicides in cassava culture: doses and economic analysis).* Sete Lagoas, Minas Gerais, Brasil. Instituto de Pesquisas Agropecuarias do Centro-Oeste. Boletim Técnico no. 23. 1973. 5p. Port., Sum. Port., Engl., 14 Refs.

Cassava. ***Manihot esculenta.*** **Pests. Weeds. Weeding. Herbicides. Pest control. Costs. Economics. Production. Brazil.**

An experiment was conducted in red-brown latosoil "Cerrado",(phase clay texture, in Sete Lagoas, MG., situated at IPEACO) comparing 3 doses of active ingredients of the herbicides Karmex-DW and Lorox. The treatments used were not statistically significant in relation to production of stems and roots. The economic analysis of the results indicated that herbicide use was not recommended in cassava cultivation and that hoeing presents more rentability by unit of expenditure. *(Author's summary)* D02

0442-1906 MAKANJOULA, G. A., ONOCHIE, B. E. and SCHULTE, E. E. **Preliminary studies on the mechanical harvesting of cassava roots in Nigeria.** Ile-Ife, Nigeria, University of Ife, 1973. 7p. Engl., 5 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Tubers. Harvesting. Mechanization. Agricultural equipment. Field experiments. Research. Nigeria.

Studies were conducted on the lifting of cassava roots using a moldboard ridger and a moldboard plow. The moldboard ridger effectively lifted approximately 75% of the roots, while the moldboard plow lifted 81%. There is a need for developing a new mechanical lifting device. A detailed study of rooting patterns of presently available cassava varieties was undertaken. Observations included radius of root spread, depth of penetration, length in relation to weight and root shape. The study indicated that there is genetic diversity among varieties and that mechanical harvesting of cassava is feasible. *(Summary by D.H. and L.J.)* D02

0443-1907 WHOLEY, D. W. and COCK, J. H. **A rapid method for the propagation of cassava** ***(Manihot esculenta*** **Crantz).** Palmira, Colombia, CIAT, 1973. 9p. Engl., 13 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Propagation. Propagation materials. Cuttings. Shoots. Developmental stages. Plant development. Field experiments. Research. Colombia.

A research program investigating rapid propagation of cassava is under way at CIAT. Results so far show that unlignified shoot tips, when planted under mist, produce roots during the second week after planting. These rooted cuttings may be transplanted into the field after a further 10-day hardening off. Shoot tips can be removed from plants in the field or from stem cuttings planted in an environment of high humidity. More rapid production of shoots occurs in humid chambers than under mist. Propagation by this method is much quicker than by conventional methods. *(Summary by D.H. and L.J.)* D02

0444-2205 KASASIAN, L. **Chemical weed control in tropical root crops.** Tropical Agriculture, Trinidad 44(2):143-150. 1967. Engl., Sum. Engl., 3 Refs.

Cassava. Sweet-potatoes. Colocasia. ***Xanthosoma sagittifolium.*** **Herbicides. Pests. Pest control. Productivity. Starch crops. Weeds. Trinidad and Tobago.**

Herbicidal trials with root crops were conducted on a clay soil in Trinidad, mainly in the wet season. A preliminary trial with 4 crops indicated that sweet potatoes are relatively sensitive to many herbicides, while yams suffer the least damage and **Colocasia** and **Xanthosoma** occupy an intermediate position. Further trials showed that good weed control with little or no crop injury may be obtained by applying (active ingredients per ha) (1) to sweet potatoes, 1.1-2.25 kg amiben plus 5.6 kg TCA or 2.25-4.5 kg. diphenamid before weed emergence and 0.56 kg paraquat (directed) after weed emergence; (2) to yams, **Xanthosoma** or cassava, 5.6 kg TCA plus 3.4 kg diuron or atrazine before weed or crop emergence; (3) to **Colocasia**, 2.25-4.5 kg prometryne before weed or crop emergence. *(Summary by Tropical Abstracts)* D02

0445-0638 COELHO, J. P. and CORREA, H. **Herbicidas em pre-emergencia na cultura da mandioca.** *(Pre-emergence herbicides in cassava cultivation). In* Reunião da comissão Nacional da Mandioca, 5a., Sette Lagoas, Minas Gerais, 1971. Anais. Sette Lagoas, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp.47-50. Port., Sum. Port., Engl., 1 Ref.

Cassava. Herbicides. Weeds. Weeding. Pests. Foliage. Production. Roots. Savannas. Brazil.

This work presents the results obtained from tests carried out on the IPEACO site, Sette Lagoas, (Minas Gerais, Brazil) with the objective of determining the best herbicides for cassava plantations. The variety used was Riqueza IPEACO - 1. The names and doses per hectare of the herbicides applied at the pregermination stage of both cassava and weeds were the following: Cotoran, 2 kg; Karmex-DW, 2 kg; Lorox, 2 kg, Patoran, 3 kg; and Tenoran, 3 kg. Appraisal of the treatments were made through weighing of the dried weeds 30 and 70 days after the application of the herbicides. The herbicides Lorox, Karmex-DW and Patoran produced an expressive weed check according to the Tukey test at a 5% probability after 30 and 70 days. Cotoran was significant only at 30 days and caused the plants to turn yellow and wither; such signs of phytotoxicity, however, disappeared later. The analysis of the total root production showed Lorox and Patoran to be the best herbicides, whereas Lorox and Karmex-DW proved to be the best ones for foliage production. *(Author's summary)* D02

0446-0702 KASASIAN, L. **Chemical weed control in tropical root and vegetable crops.** Experimental Agriculture 4:1-16. 1968. Engl., Sum. Engl., 167 Refs.

Cassava. *Manihot esculenta.* **Weeds. Pests. Starch crops. Vegetable crops. Herbicides. Weeding. Cultivation.**

Chemical weed control in 6 root crops (including cassava) and 14 vegetable crops, commonly grown in the tropics, is reviewed. *(Author's summary)* D02

0447-3811 CARR, A. B. **Improvement in method of planting cassava.** Journal of the Royal Society of Arts 1921:45. November 1921. Engl.

Cassava. Cultivation. Planting.

Mr. A. B. Carr, a director of the Agricultural Society of Trinidad and prominent estate owner, has furnished the United States Consul in Trinidad with the following note on a method he has discovered of shortening, by about half, the time required for the ripening of cassava tubers. "Hitherto the way of planting cassava was in short portions of the stalk, measuring from 6 to 9 inches long; but purely by an accident, it has been found that when the whole length of stalk is planted, the tubers ripen and are fit to eat in 4 1|2 months, against the old method which involves at least 8 months. The manner of planting is simply to insert the lower end of the stalk into the ground, not more than 2 or 3 inches deep; and in order to secure the growing plant against the force of the wind (if in an exposed position),the plant should be tied to a stake. Planting is usually done in the month of May. In new lands as much as 12 to 15 tons of fresh tubers can be obtained, whereas in old, partially worn out lands (unless a liberal supply of manure is allowed),not more than 6 to 8 tons of tubers can be depended on." This, says the Consul, should have great importance in practically doubling the cassava turnover from estates growing it. Concerning the uses of cassava in Trinidad, Mr. Carr writes: "(1) It is eaten as a vegetable, boiled in plain water. (2) It is made into what is known as farine, which is a coarse form of meal. (3) After expressing the juice, the dry tuber is grafted into a meal, which upon being exposed to heat on a flat iron plate,is made into bread. (4) The expressed juice is boiled down and certain condiments are added, thus producing casareep, which is the foundation of many good sauces. (5) Starch is also made from the tuber, the method of manufacture consisting simply of allowing the expressed juice to settle, the heavy matter being precipitated and when dried forming the starch of commerce. It is known that alcohol can be produced from the cassava, which also contains sugar. If the price of sugar remains abnormal for a lengthy period of time,it is likely that scientists will turn their attention to the sugar contents of this tuber." The cassava sauce known as casareep appears to have preservative as well as flavoring qualities and is an indispensable ingredient in the well-known West Indian dish, "pepper pot," which is especially popular in British Guiana, where casareep is manufactured in commercial quantities. In connection with th industrial use of the cassava plant for the manufacture of alcohol, it may be mentioned that an English man was recently in Trinidad and British Guiana, investigating districts most suitable for cassava growing, and it is understood that in British Guiana about 10,000 acres of land were purchased for such purpose on behalf of distillery interests in Scotland. It is reported that large areas of cassava land in Madagascar and in Brazil have also been purchased for the same interests. *(Full text)* D02

0448-3819 SERGIPE. SUPERINTENDENCIA DA AGRICULTURA E PRODUCAO. **Competição de espacamento em mandioca** *Manihot esculenta* **Crantz no Estado de Sergipe.** *(Optimum spacing in cassava, Manihot esculenta Crantz, in the state of Sergipe).* Aracaju, Brazil, 1974. 12p. Port., Sum. Port., Engl., 1 Ref., Illus.

Cassava. *Manihot esculenta.* **Cultivation. Planting. Spacing. Field experiments. Productivity. Tuber productivity. Brazil.**

To determine the best row spacing for cassava (*Manihot esculenta* Crantz), 3 experiments were conducted during 1971-72 in Lagarto, Estancia and Nossa Senhora das Dores in the state of Sergipe, Brazil. The experimental design was random blocks with 5 treatments and 5 replications. Spacing treatments were 1 x 1.4m, 1 x 1.2m, 1 x 1 m, 1 x .8 m, and 1 x .6 m. All cultivars studied were common to the regions. From the results, it was concluded that the best spacing in all regions was 1 x 1 m. *(Author's summary)* D02 D03

0449-0703 BEENY, J. M. **Mechanization for tapioca.** *In* Blencowe, E. K. and Blencowe, J. W., eds. Crop diversification in Malaysia, Incorporated Society of Planter, 1970. pp.167-182. Engl., sum. Engl. 16 Refs.

Cassava. Mechanization. Land preparation. Planting. Harvesting. Processing. Costs. Cultivation.

Mechanized operations for the cultivation, planting and harvesting of cassava have been discussed; and an indication of machinery costs involved is given in the appendix. Considerable savings are possible if the scale of operation is sufficiently large. Suitable machinery for ground preparation is commercially available. Sugar cane planters can be modified to plant cassava either on the ridge or on the flat. Ridge planting is recommended if cassava is to be harvested mechanically. Problems of harvesting cassava due to hard soil, size and disposition of tubers suggest the use of an implement fitted with a vibrator share to reduce draft and make the task manageable by medium| large wheeled tractors. A very brief review of processing methods is given. *(Author's summary)* D02

0450-0359 LORIA M., W. **Influencia del tamaño y posición de la estaca de yuca en el arraigamiento, rendimiento y producción del follaje.** *(Influence of size and positioning of cassava cuttings on rooting, yield and foliage production).* Proceedings of the Caribbean Region. American Society of Horticultural Science 6:20-23. 1962. Span., Sum. Span., 2 Refs.

Cassava. Cuttings. Foliage. Planting. Rooting. Propagation materials. Productivity.

Combinations of horizontal, slanting and vertical positioning of cassava cuttings of 20, 40, 60 and 80 cm in size were studied to observe their influence on rooting, yield and foliage production. The results were as follows: (1) A greater rooting percentage was obtained when 60- and 80-cm cuttings were placed in a slanting position. The size-position interaction was not significant. (2) There were no significant differences in cassava yields. (3) Greater production of foliage was obtained with 60-cm cuttings. (4) Neither positioning nor interactions influenced foliage production. *(Author's summary)* D02

0451-3644 SIVAN, P. and VERNON, A. J. **Research on cassava, sweet potato and yams in Fiji, 1950 to 1970.** Fiji Agricultural Journal 33(1):9-14. 1971. Engl., Sum. Engl., 16 Refs.

Cassava. *Manihot esculenta*. Cultivars. Field experiments. Cultivation. Harvesting. Timing. Spacing. Planting. Nutritional requirements. Fertilizers. N. Ammonium sulphate. Tuber productivity. Productivity. Experiment design. Research. Fiji.

The results of cassava, sweet potato and yam variety trials are presented and discussed, together with the results of cassava manurial trials, in which there was generally a substantial response to nitrogen. *(Author's summary)* D02

0452-2259 FRITZ, J. cnd BOHL, P. **La culture du manioc á Madagascar.** *Cassava cultivation in Madagascar)* La Potasse no. 34:21-2. 1965. Fr., Illus.

Cassava. Cultivation. Harvesting. Productivity. Economics. Marketing. Manures. Industrialization. Fertilizers. Factories. Malagasy Republic.

Brief notes are given on cassava production and processing in Madagascar and include cultural practices, manuring and fertilization, varieties, harvesting, yields and factories for processing the crop. *(Summary by H.J.S.)* D02 I02

0453-2413 FRICOUT, M. R. and FRICOUT, M. G. **Les cultures indigénes en Afrique Equatoriale Francaise.** *(Local crops in French Equatorial Africa).* Agriculture Pratique des Pays Chauds no. 17:850-856. (Cont.). 1931. Fr., Illus.

Cassava. Cultivation. Processed Products. Cassava flour. Cassava pastes. Cassava bread. Chickwangue. Human nutrition. Uses. Africa.

Short notes are given on cassava growing in French Equatorial Africa. Aspects of the use of cassava products in the different regions are discussed. A description of the preparation of cassava products is included. Chickwangue, a paste, is the most popular. *(Summary by J.L.S.)* D02 H01

0454-0645 JAMESON, J. D. *et al.* **Long-term and short-term cassavas.** East African Agricultural Journal 10(1):56-58. 1944. Engl.

Cassava. Cultivation. Timing. Harvesting.

Some comments are made in order to elucidate the disparity in the cultivation and harvesting practices among the various East African territories. *(Summary by J.L.S.)* D02

0455-2258 FAUCHERE, A. **Le culture du manioc à Madagascar.** *(Cassava cultivation in Madagascar).* Agriculture Pratique des Pays Chauds 13(129):343-354. (Concl.). 1913. Fr.

Cassava. Cultivation. Land preparation. Weeding. Harvesting. Cuttings. Cultivation systems. Rotational crops. Productivity. Prices. Economics. Tuber productivity. Malagasy Republic.

Cassava cultivation in Madagascar is very rudimentary; but in some regions, as in the case of the Sambirano Valley, the crop is nationally exploited. For land preparation, natives use the "angady" spade with a narrow, long blade which serves as a hoe, shovel and planting spade. Cassava is planted in pits 20 cm wide x 40 cm long. The distance between pits is 60 cm with rows 1 m apart. Planting, cutting selection, cultural practices, harvesting, and fertilizing are described. Cassava is intercropped with Madagascar peanut or bambarra *(Voandzeia subterranea)*, beans and maize. The rotational period is 3 years: 18 months cassava, 6 months sorghum, maize and rice and 1 year fallowing. Yields of 20 tons| ha are usually obtained in major producing areas, while in other areas 5-6 tons| ha are scarcely reached. Economic and marketing aspects are also discussed. *(Summary by J.L.S.)* D02 k01

0456-2247 LA CULTURE du manioc aux Index Neerlandaises et la fabrication du tapioca. *(Cassava cultivation in the Dutch Indies and the manufacture of tapioca.)* Agriculture Pratique des Pays Chauds no. 5:379-386. 1930. Fr.

Cassava. Cultivation. Trade. Marketing. Gaplek. Tapioca pearls. Economics. Tapiocas. Cassava flour. Cassava products. Processed products. Java.

This paper describes some cultural practices for cassava and the processing of tapioca flour and pearls, gaplek and other cassava products in Java and other islands of the Dutch East Indies. A table giving details of the cassava products exported in 1929 is presented. *(Summary by H.J.S.)* D02 102

0457-0772 BARRIOS, J. R. and GUILLEN, R. D. **La yuca en el oriente de Venezuela.** *(Cassava in eastern Venezuela).* Maracay, Universidad Central de Venezuela, Instituto de Agronomia, 1972. 10p. Span.

Cassava. Field experiments. Cassava programs. Venezuela.

Standards and field sheet forms to perform a cassava agronomic survey are given. *(Summary by H.J.S.)* D02

0458-0519 KLOPPENBURG, T.G.A., SIBIE, D. and BRUIJN, G. H. DE. **Rooting of leaves of cassava** *(Manihot esculenta).* Tropical Root and Tuber Crops Newsletter no. 5:38-39. 1972. Engl., 2 Refs.

Cassava. *Manihot esculenta.* Rooting. Leaves. Petioles. Developmental stages. Propagation materials. Cuttings. Plant-growth substances. Netherlands.

In the Netherlands, rooted cuttings have been obtained by immersing cassava petioles in a sand-peat dust mixture in a mist propagation bin and using naphtalenic acid (0.1 and 0.2%) on a charcoal powder and on a talc powder basis, but also without the use of the growth regulator. The results on a charcoal powder basis were better than those on a talc powder basis. Full grown leaves gave better results than older leaves. After 6 weeks from the beginning of the experiment, tubers were formed on some of the roots. The experiment will be continued. *(Summary by Tropical Abstracts)* D02 C00

0459-1535 CONCEICAO, A.J. DA., SAMPAIO, C.V. and MENDEZ, M. A. **Competição de variedades de mandioca para a produção de ramas para forragem.** *(Cassava variety trials for the production of foliage for feed).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):115-127. 1973. Port. Sum. Port., Engl., 15 Refs., Illus.

Cassava. *Manihot esculenta.* Production. Foliage. Cultivars. Forage. Animal nutrition. Productivity. Tuber productivity. Composition. Vitamin A. Protein content. Fibre content. Soil analysis. Brazil.

A 6-variety trial for forage production was carried on Color a latosoil at the Escola Agronomia da Universidade Federal da Bahia, Cruz das Almas, in 1969-72. he Platina, Graveto, Salangor preta and Mamao varieties were the best varieties for this purpose. *(Author's summary).* D02 H03

0460-0375 LAMBOURNE, J. **A preliminary report on tapioca varieties grown at the Government Plantation, Serdang.** Malayan Agricultural Journal 15:41-59. 1927. Engl., Sum. Engl.

Cassava. Cultivars. Planting. Cuttings. Harvesting. Cultivation. Research. Field experiments. Spacing. Propagation materials. Productivity. Malaysia.

The sources of supply of planting material of the cassava varieties grown at Serdang are given. The literature from Java and the Philippine Islands has been reviewed and comparative yield figures have been extracted and included in this report. Yields of cassava tubers obtained from each variety are given, and the layout of the trials has been described. Descriptions of the varieties grown on the Government Experimental Plantation, Serdang, are also given. *(Author's summary)* D02 D03

0461-2048 BALAKRISHNAN, R. and SUNDARARAJ, J. S. **A note on the optimum stage of harvest in tapioca (*Manihot utilissima* L.).** Madras Agricultural Journal 54(10):539-540. 1967. Engl., 3 Refs.

Cassava. Harvesting. HCN content. Timing. India.

The best time for harvesting cassava was between 12-12.5 months after planting; tubers harvested before or after this period were inferior in quality. *(Summary by Field Crops Abstracts)* D02

0462-1538 CONCEIÇAO, A. J. and SAMPAIO, C. V. **Competição de variedades industriais de mandioca.** *(Competition of spacing in cassava cultivation).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):79-85. 1973. Port., Sum. Port., Engl., 10 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Cultivation. Planting. Spacing. Timing. Productivity. Soil analysis. Brazil.**

Studies on the effect of different spacing on cassava (*Manihot esculenta* Crantz) yield were carried out in Colonia latosoil at the Escola de Agronomia de Universidad da Bahia in Cruz das Almas from 1969-1972. It was observed that there was no statistical difference among treatments, but the ones 1.00 x 0.50 m and 1.00 x 0.60 showed the best results in the region. (Author's summary) D02

0463-3176 LEON D., G. R. and ARISMENDI, L. G. **Herbicidas en el cultivo de la yuca, *Manihot esculenta*, en la Savana de Jusepin.** *(Herbicides in the cultivation of cassava, Manihot esculenta, in the savanna of Jusepin)* Tropical Root and Tuber Crops Newsletter no. 7:29-33. 1974. Span., Sum. Span., Engl., 3 Refs.

Cassava. *Manihot esculenta.* **Herbicides. Weeding. Weeds. Productivity. Field experiments. Pests. Pest control. Venezuela.**

Different doses and mixtures of the herbicides Cotoran, Gesapax, and Gesagard were used in trials of cassava in the savanna of Jusepín (Venezuela). Best yields were obtained with 3 kg/ ha of Cotorán, or 2 or 3 kg/ ha of Gesapax. Best weed control was also obtained with these treatments. *(Author's summary)* D02

0464-0374 OKIGBO, B.N. **The use of covariance in the adjustment for fertility gradient in a cassava pre-planting cultivations experiment.** Nigerian Journal of Science 1(1):55-64. 1966. Engl., Sum. Engl., 4 Refs.

Cassava. Statistical analysis. Plant fertility. Productivity. Field experiments. Cultivation. *Manihot esculenta.* **Nigeria.**

An experiment was conducted to study the effect of preplanting cultivations on the yield and general performance of cassava, *Manihot utilissima* Pohl. A fertility gradient was observed to run from east to west of what appeared as a uniform experimental area. Observations on guard rows were used to obtain fertility indices which constituted the values of the covariate for an analysis of covariance. Despite the increased precision gained with the covariance technique, no significant differences were observed among cultivations. *(Author's summary)* D02 D03

0465-0746 THOMPSON, R. L. and WHOLEY, D. W. **A guide for cassava field trials.** Palmira, Centro Internacional de Agricultura Tropical, 1972. 39p. Engl., 9 Refs.

Cassava. Field experiments. Developmental research. Development. *Manihot esculenta.* **Colombia.**

Uniform plan and report forms for cassava *(Manihot esculenta)* trials are presented to promote experiments conducted under more uniform, standardized designs and evaluation systems. Recommendations on experimental considerations include plot size —a minimum of 16-32 sample plants; missing plants— planting of extra stakes is advisable when the original planting is made; border rows —at least 2 border rows are desirable around the outside of an experimental area and 1 row around plants to be sampled in an experimental block; experimental design —a minimum of 4 replications in simple experimental design; recording of data— simple systems with a number or letter denoting characteristic and no more than 3 significant figures in reporting yield data from small sample plots are recommended; plot area for yield determinations should be easily converted to a universally acceptable large unit (hectares); reporting of results —because of wide variations in growing periods, yields are more easily compared if reported in kilograms of dry matter per hectare per day (kg| ha| da) instead of unit weight per unit land areas (kg| ha). Sample data sheets are provided and include background information, experimental details, experimental layout, production system and climatic data. Also included are a conversion table from calendar date to day number, a sample plant data sheet and a climatic data sheet. *(Summary by P. A. C.)* D02

0466-2265 ESSAIS DE **pinces arracheuses de manioc.** *(Trials with a cassava grip lifter).* Bulletin d'Information de l'INEAC 3 (6):343-345. 1954. Fr., Illus.

Cassava. Harvesting. Tubers. Cultivation. Agricultural equipment. Mechanization.

Two trials were carried out to prove the effectiveness of a new grip lifter for digging cassava tubers. Although this method does not shorten the period of harvesting, the tubers are not damaged with this device, so losses will decrease. *(Summary by J.L.S.)* D02

0467-1537 CONCEIÇAO, A. J. DA. and SAMPAIO, C. V. **Competição de tamanhos de manivas.** *(Sizes of cuttings).* Cruz das Almas, Brasil Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):87-99. 1973. Port., Sum. Port., Engl., 11 Refs., Illus.

Cassava. *Manihot esculenta.* **Propagation materials. Cuttings. Stems. Shoots. Productivity. Tuber productivity. Statistical analysis. Brazil.**

Results of studies showed the effect on yield of different sizes of cassava (*Manihot esculenta* Crantz) cuttings. The authors report on a trial carried out in Colonia latosoil at the Escola de Agronomia da Universidade Federal da Bahia in Cruz das Almas from 1969-1972. Different sizes of cuttings were tested, but the ones with 0.20; 0.25 and 0.30 m gave the best results. Those cuttings originated from 12-month-old plants and were planted horizontally in the row. *(Author's summary)* D02 D03

0468-1696 LUGTMEIJER, H. I. **Landbouwscholing in de Hooglanden van Madagascar.** *(Agricultural instruction in the highlands of Madagascar).* Landbowkundig Tijdschrift 81(11-12):369-372. 1969. Dutch., 1 Ref., Illus.

Cassava. Cultivation systems. Development.

Boarding schools in the Tanety region instruct farm boys, previously taught only to tend the family rice plot, in the broader arts of agriculture so that they can produce general crops and raise cattle. The practice of burning off natural surface growth has destroyed humus and biological life, causing severe erosion. To combat this, soil is fertilized and cultivated with millet and guatemala grass, which is fed to previously unconfined herds of cattle. Thus manure can be more conveniently collected and utilized for rice production. Crop alternation is introduced, comprising cassava, beans, corn and legumes; pigs are raised on cassava and corn. *(Summary by Biological Abstracts)* D02

0469-1749 PACHECO, C., CHAVARRIA, P. L. and MATA, R. H. **Herbicidas pre-emergentes en el cultivo de la yuca** *(Manihot esculenta* **Crantz).** *(Preemergence herbicides in cassava, Manihot esculenta Crantz, cultivation).* Costa Rica. Estación Experimental Agrícola Fabio Baudrit M. Boletín técnico no.1. 1974. 12p. Span., Sum. Span., 5 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Weeds. Pests. Weeding. Pest control. Herbicides. Productivity. Costa Rica.**

An experiment was carried out at the Agricultural College of Santa Clara (Costa Rica) to evaluate the effect of various herbicides in cassava cultivation. Nine herbicides were applied at concentrations of 1.5 and 3.0 kg| ha and were compared with a control weeded at 15 and 45 days after planting and another nonweeded control. The evaluation made 67 days after these applications showed that 3.0 kg| ha concentration of diuron, ametryne, linuron, and metobromuron controlled 94, 86, 83, 81, and 12% of the weeds, respectively. The application of 1.5 kg a.i.| ha concentration of ametryne and 3.0 kg a.i.| ha concentration of metobromuron, linuron, diuron and atrazyne increased production by 19, 17, 10, and 2% as compared to the weeded control, whose production was 18% higher than the nonweeded control. *(Author's summary. Trans. by J.L.S.)* D02

0470-0371 FERNANDO, M. and JAYSUNDERA, E. S. **Cultural experiments with cassava (*Manihot utilissima* Pohl-I).** Tropical Agriculturist 98(3):3-8. 1942. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Planting. Propagation materials. Tuber productivity. Cuttings. Productivity. Spacing. Research. Field experiments. ***Manihot esculenta.*** **Cultivation. Tillering. Shoots.**

A trial was set down at the Experiment Station, Anuradhapura, for the purpose of determining the effect of length and orientation of cutting, spacing and tiller number on the yield of 2 varieties of cassava. Plants derived from 18-in cuttings significantly outyielded plants derived from 6-in cuttings. The superiority of vertical planting over horizontal planting was significant at the odds of 99 to 1. Apart from depressing the yield per plant, the latter method resulted in lower percentage survival. There were no significant differences in yield between the 2 varieties ((A 3.7 and B 4.1) and between the two spacing (3 ft x 3 ft and 3 ft x 2 2 ft). The thinning of tillers to 1 per plant did not affect yield significantly. *(Author's summary)* D02 D03

0471-1536 CONCEIÇAO, A. J. DA and SAMPAIO, C.V. **Competição de variedades industriais de mandioca.** *(Variety trials of industrial, late-maturing cassava, Manihot esculenta Crantz.)* Cruz das Almas, Brazil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):101-114. 1973. Port., Sum. Port., Engl., 10 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Cultivars. Productivity. Identification, Tuber productivity. Starch productivity. Climatic requirements. Rainfall data. Soil analysis. Brazil.**

The authors present results of 8 late-maturing, local cassava varieties Salangor preta, Cigana, Sutinga, Graveto, Jacomoá, Salangorzinha, Jaçaré and Platina, carried out in 1969-72, at the Escola de Agronomia da Universidade Federal da Bahia, Cruz das Almas, in Colonia latosoil tertiary sediment of Barreiras series on flat lands ("tabuleiro"), in a humid tropical climate, with an annual rainfall of 1,196 mm, medium annual temperature of 24.4°C. The best results were obtained with the varieties Salangor preta, Cigana, Sutinga and Graveto, which yielded 20.47, 23.56, 20.51 and 21.13 tons| ha, respectively. *(Author's summary)* D02 D03

0472-3350 OBIHARA, C. H. **Effect of *Acioa barteri* fallows on the fertility of an acid sandy soil in Nigeria.** Publ. Comm. Techn. Cooper Africa 98:462-470. 1967. Engl., Sum. Engl., 21 Refs.

Cassava. Yams. Maize. Shifting cultivation. Fertilizers. Soil fertility. Cultivation systems. Fallowing. Nigeria.

Field experiments covering a total area of 35 acres were carried out on 2 sites on the acid sandy soils of southern Nigeria, near Benin City. The effect on soil fertility of a fallow of the naturally regenerated bush was compared to that of similar planted fallows of the local dominant shrub, *Acioa barteri.* The effects of varying lengths of the *Acioa barteri* were also compared. The effects of these fallows on soil fertility were measured by a 2-year cropping period of intercropped yams, cassava and maize, which followed each fallow in a repeating rotation. The results showed conclusively that the *Acioa barteri* fallow did not restore soil fertility better than the natural bush fallow. The productivity of the soil improved with increasing length of fallow.

The optimum fallow period appeared to be 3-4 years after a 2-year cropping period. This pattern of variation is obtained whether one considers the effect of the fallows on the individual crops or on the total overall productivity of the land after a fallow phase. The experimental treatments had 8 replications and conclusions are based on the consistent results obtained over the past 3 years. *(Author's summary)* D02 K01

0473-1865 CORREA, H. *et al.* **Influencia da época de plantio na produção de raízes e ramas na cultura da mandioca (*Manihot esculenta* Crantz).** *(The influence of time of planting on the production of roots and stems of cassava, Manihot esculenta Crantz).* Sete Lagoas, Minas Gerais, Brasil. Instituto de Pesquisas Agropecuarias do Centro-Oeste. Boletím técnico no. 19. 1973. 6p. Port., Sum. Port., Engl., 14 Refs., Illus.

Cassava. *Manihot esculenta*. Cultivation. Planting. Timing. Roots. Stems. Productivity. Brazil.

Results of 4 experiments conducted at the Instituto de Pesquisas Agropecuárias do Centro-Oeste, IPEACO in Sete Lagoas, state of Minas Gerais (Brazil), in a brown red latosol, clayish texture, "cerrado" phase, showed that the planting of cassava (*Manihot esculenta* Crantz) in the period from Oct. 5-Dec. 20 gave the best production of roots; planting in the period from Sept. 20-Jan. 20 gave the best production of branches. The data suggest that the increase in rain during the first rainy period did not influence the production of roots and branches; however, during the second rainy period, this increase was significant. The increase in rain during the dry periods contributed towards the greatest production of roots. *(Author's summary)* D02 D03

0474-1871 DOLL, J. D. and PIEDRAHITA, W. **Margen de selectividad de varios herbicidas en la yuca.** *(Margin of selectivity of various herbicides in cassava).* Revista Comalfi 1(1):14-19. 1974. Span., Sum. Span., Engl., 8 Refs.

Cassava. *Manihot esculenta*. Herbicides. Weeding. Cultivation. Research. Field experiments. Colombia.

Twenty-six herbicides were evaluated at 3 rates each in cassava (*Manihot esculenta* Crantz). For the 21 preemergence herbicides, planting was done before application in half the plot and then in the other half. After incorporating the 5 preplant-incorporated products, half the plot was ridged before planting while the remainder was planted without ridging. The recommended rate for heavy soils was applied, plus the double and quadruple of this rate, to establish the margin of selectivity. Injury ratings taken 30, 45, 60, 90 and 110 days after planting showed that the herbicides linuron, norea, fluometuron, chlorbromuron, diuron, fluorodifen, nitrofen, pronamide, methazole, butachlor, alachlor, DNBP, chloramben, cyanazine, benthiocarb, trifluralin and nitralin were highly selective in cassava. Ametryne, prometryne, terbutryne and butilate had marginal selectivity; and atrazine, bromacil, karbutilate, EPTC and Vernolate were toxic even at the lowest rate. There was no increased toxicity by planting before rather than after the application of the preemergence products nor by planting in ridged or in unridged soil after incorporating the preplant-incorporated compounds. *(Author's summary)* D02

0475-0775 NORMANHA, E. S. and PEREIRA, A. S. **Melhores épocas de plantio para mandioca.** *(The best times for planting cassava).* Revista de Agricultura (Brazil) 23:237-248. 1948. Port., Sum. Port.

Cassava. Planting. Climatic requirements. Temperature. Harvesting. Cuttings. Tuber productivity. Canopy. Cultivation. Productivity. Timing. Brazil.

The customary method of growing cassava in the Brazilian state of São Paulo is to plant in October at the beginning of the rainy season and to harvest either after one growing season of 8 to 10 months (when the crop is for domestic use) or in the second year after 18-22 months or 2 growing seasons (when the crop is to be processed for commercial purposes). Harvesting dates may range from April to August and even September, but starch and bulk yield are best with June-July harvesting. In 1946-47, experiments in 4 different parts of the state tested (a) sowing on the 15 th of each months from May-October and (b) harvesting in the following year on the 15th of April, June and August, respectively. There were 720 plants per treatment per locality. Vassourinha, the variety most commonly grown in São Paulo, planted by the normal regional method, 6-in mature stems being placed horizontally at the bottom of 4-in deep furrows and completely covered with earth. Mean temperature is a few degrees below 20°C from May-August, rising a little in September and October. Rainfall is moderate in May, good in June-July, absent in August, good in September and October. The May-June plantings gave the highest yields; namely, double that of the October plantings. The date of planting had little effect on the percentage of shoots or density of stand. The time of harvesting was of influence in so far as root yield rose from April-June in every case; but in August (compared to June) root yield was either higher, lower or the same, according to locality. The use of 8-in stems for planting is recommended; May-August is regarded as the optimal planting season and June and July as the ideal harvest months for this region. Earlier planting may make tillage more difficult since, the ground is harder, dried and stubble-covered; but the use of tractors and disk harrows can overcome this difficulty. *(Summary by Field Crops Abstracts)* D02

0476-0611 DENTAN, R. K. **Some Senoy Semai planting techniques.** Economic Botany 25:136-150. 1971. Engl., 5 Refs., Illus.

Cassava. Planting. Cuttings. Storage. Ecology. Cultivation. Malaysia.

This is an anthropological study on planting techniques of the Senoi Semai, aboriginal Austroasiatic-speaking swidden horticulturists of central Malaya. Cassava is not a major crop. Information is given on storage, preparation and planting of cuttings. *(Summary by H.J.S.)* D02

0477-0357 SMITH, B. G. C. **Variety trials with Amani cassava in Seychelles.** East African Agricultural and Forestry Journal 35(3):319-320. 1970. Engl., 4 Refs.

Cassava. Research. Field experiments. Cultivars. Productivity. Human nutrition.

A series of experiments were carried out to compare the yield of 6 imported and 2 local cassava varieties on two different soil types in Seychelles. The most palatable and suitable varieties for human consumption proved to be the local varieties, Shophie and Droite. *(Author's summary)* D02

0478-0433 SANCHEZ DE B., C. A. and RODRIGUEZ, N. F. **Conservación invernal de tallos de mandioca destinados a estaca-semilla en la provincia de Misiones.** *(A study of three methods to store cassava stem cuttings during the winter in the province of Misiones).* Revista de Investigaciones Agropecuarias (Serie 2) 4(17):331-349. 1967. Span., Sum. Span., Engl., 12 Refs.

Cassava. Cuttings. Propagation materials. Storage. Stems. Argentina.

A comparison was made of several methods for storing cassava stem cuttings during the winter. In the province of Misiones (Argentina), cuttings made from one-year-old stems are harvested in the fall when they are mature and are stored during the winter until the spring planting period. The methods were evaluated statistically, according to an analysis of variance, with significant results. Three main variants were used: placing stem cuttings in a straw hut, in the forest and in an open field. In addition, several subvariants were studied: placing cuttings vertically, horizontally, and covering cuttings completely with soil or straw (or both). At the end of the storage period, a recount was made to ascertain the number of healthy viable stems that could be planted. It was found that the best method was storing the cuttings in a horizontal position in an open field, completely covered with soil and under the cover of a straw roof. This method yielded an average of 98.7 viable stems and 91.5 sprouted cuttings. By comparison, the most common method used in Misiones (storing the cuttings in vertical or horizontal positions in the forest and covering them with straw or soil) produced low percentages ranging from 20.3-37.3% viable stems and 46.5-48.8% sprouted cuttings. An exception to this was the subvariant in which stem cuttings were stored in the forest, covered with soil and kept beneath a straw roof. This method produced almost as good results as the best treatment. The method of placing stem cuttings in a straw hut was rejected because results were not as good and the other methods are easier to use. *(Summary by T.M.)* D02

0479-0418 KROCHMAL, A. **Propagation of cassava.** World Crops 21(3):193-195. 1969. Engl., 10 Refs., Illus.

Cassava. Propagation. Planting. Cuttings. Spacing. Cultivation.

Methods of propagating cassava *(Manihot utilissima)* in different tropical countries are reviewed. Taking into account local conditions, best results are usually obtained from horizontal planting of 22.5 to 30 cm-long cuttings in 80 to 100 cm rows. The cuttings should be selected from basal or midsection wood, having no less than 3 buds each, and should habe been stored for no longer than 8 weeks in a relatively cool, well-ventilated storage area. *(Summary by Tropical Abstracts)* D02

0480-0405 CHANT, S. R. and MARDEN, J. A. **A method for the rapid propagation of cassava cuttings.** Tropical Agriculture (Trinidad) 35(3):195-199. 1958. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Propagation materials. Shoots. Roots. Plant growth substances. Plant development. Propagation. Cuttings.

A technique is described for the rapid multiplication of cassava by means of excising the young green shoots from the parent cutting. This stimulates the development of dormant buds; and if care is taken in handling the excised shoots, they will produce roots and grow normally. Hormone treatment facilitates root production although an adverse effect on the survival of the cuttings may be produced when the hormones are used in concentrations above 10 ppm. *(Author's summary)* D02

0481-0572 CHESQUIERE, J. **Amélioration de la méthode de plantation du manioc.** *(Improved method of planting cassava).* Bulletin Agricole du Congo Belge 19(4):602-604. 1928. Fr., Illus.

Cassava. Planting. Cuttings. Field experiments. Propagation materials. Plant reproduction. Cultivation. *Manihot esculenta*. Zaire.

Until recently, cassava *(Manihot esculenta)* was planted using small cuttings of 15-22 cm; it was accidentally discovered that by planting the entire shoot, roots matured after 4 1|2 months, as compared with at least 9 months with the old procedure. Cuttings (3 cm in diameter) should be as straight as possible, optimum slanting is about 60° so that there are buds all along the cutting. Plant the cuttings so that they will be intertwined. *(Summary by P.A.C.)* D02

0482-0390 BOLHUIS, G. G. **Ongekeerd geplante stekken van cassave.** *(Cassava cuttings planted inversely).* Landbouw (Java) 15:141-151. 1939. Dutch., Sum. Engl., 4 Refs., Illus.

Cassava. Propagation. Propagation materials. Cultivation. Cuttings. Planting. HCN. Productivity. Cultivars. Field experiments. Indonesia.

As early as 1908, Van der Stok conducted an experiment with cuttings from the cassava varieties Manis, Begog and Penang, planted normally and inversely. He found that at an age of about 5 months, the cuttings planted inversely showed a marked decrease in stem, leaf and root weight and in the number of roots per plant as compared to those planted normally. The number of stems per plant, however, had increased. In 1938 this experiment was repeated with other varieties (the former were no longer available) in order to investigate (a) whether the results obtained by Van der Stok were also valid at the age of about 9 months; (b) whether, in view of the greater number of stems on the cuttings planted inversely, this might be a possible method for quick propagation of valuable material; (c) whether the opinion prevailing among the native population is correct that roots of cuttings from poisonous varieties of cassava planted inversely are more bitter (and consequently more poisonous) than those from cuttings planted normally. From the results of 2 experiments, (one harvested at the age of 9 mo and the other at the age of about 6 mo), the following conclusions were drawn: (1) Cuttings planted inversely produce many more stems than cuttings planted normally, but this had an unfavorable effect upon the number of useful cuttings. (2) Since the inverse planting of cuttings greatly reduced root yield, a control of recently planted cuttings to the right method of planting might prove to be of economic value. (3) The natives' opinion that roots of cuttings of poisonous cassava varieties planted inversely must be more poisonous than the roots of cuttings planted normally, was confirmed. The effect of inverse planting upon roots of cuttings from nonpoisonous or only moderately poisonous varieties was very small. *(Author's summary)* D02

0483-0349 KUMAR, H. **Mechanization of cassava planting.** Ghana Farmer 6(3):102-104. 1962. Engl., Illus.

Cassava. Planting. Harvesting. Mechanization. Agricultural equipment. Ghana.

The Government of Ghana has directed its agricultural policy toward mechanization and establishment of large-scale state farms. Accordingly, experiments were carried out at the Pokoase Agricultural Station to attempt the mechanization of cassava (*Manihot esculenta* Crantz), used in Ghana as a food and also as a source of starch and tapioca. These experiments proved that cassava stalks could be cut successfully by a midmounted mower; thereafter, the roots could be lifted mechanically by using a midmounted disc-terracer. An acre can be harvested in 1 1|2 tractor hours, for which ordinarily 5 man-days are required. Attempts were also made to plant the crop mechanically. After the basic cultivation operation of plowing and harrowing,it was possible to plant this crop mechanically by (1) modifying a Massey-Ferguson ridger to work as ridger-cum-planter (two operations in one) and (2) by modifying a duck-foot cultivator to work as a 6-row planter after the area has been ridger. It takes an average of 2 h 10 min to ridge and plant 1 acre, as compared to 4 man-day| acre for planting alone. Collecting and cutting sets for planting and hand harvesting showed savings of about 7% in favor of mechanization. *(Summary by P.A.C.)* D02

0484-4924 COELHO, C. **A influencia do espacamento na cultura de mandioca.** *(The influence of planting distances in cassava cultivation).* Boletim da Secretaria de Agricultura, Industria e Comercio (Pernambuco, Brazil) 1(2):119-121. 1945. Port.

Cassava. Spacing. Tuber productivity. Starch productivity. Field experiments. Brazil.

Trials using 27 randomized block treatments were conducted in També, state of Pernambuco (Brazil) to determine optimum planting distances. Variations studied between rows ranged from 0.60-1.60 m; the difference between plants was from 0.10-0.30 m less than the distance between rows. At 18 mo, the production ranged between 10,402 kg| ha (1.40 m x 1.30 m) and 20,555 kg| ha (0.60 m x 0.30 m), yielding 2.24 and 0.642 kg| plant, respectively. After calculations were made of these stakes| ha, it was decided to conduct a 3rd trial (1.20 m x 1.50 m), using fewer stakes| ha, which permitted mechanized weeding up to 3 mo. The highest percentage of starch was obtained in this treatment. Planting distances did not noticeably affect starch formation according to samples analyzed. *(Summary by L.C. Trans. by T.M.)* D02

0485-0581 HOSSNE, G., A. J. **A study of mechanizing the harvesting of cassava (*Manihot esculenta* Crantz)** Thesis. Silsoe, Bedford, England, National College of Agricultural Engineering, 1971. Engl., 48 Refs., Illus.

Cassava. *Muanihot esculenta.* **Tubers. Harvesting. Cultivation. Agricultural equipment. Mechanization. Production. Costs. Productivity. Economics. Field experiments. Research.**

The objectives of this work were to gather all possible information about systems and machines used at present in the harvesting of cassava and to specify all the requirements that must characterize such a machine. Plant characteristics and culture are reviewed in detail. The proposed machines (sketches included) for the harvesting of cassava tubers are a land-clearing blade; a groundnut digger-shaker and windrower for harvesting in friable soils, a highly promising root crop harvester with a vibratory system which allows the loosening of the tubers; a modified beet or potato harvester and the pulling up of tubers with a modified pair of belts or an inclined spring-loaded belt used in the harvesting of beets. Economic assessment of mechanizing cassava harvesting with the use of the existing machinery and the proposed machinery is given. *(Summary by J.L.S.)* D02 J00

0486-0762 BRANDAO, S. S. **Ensaio sobre sistemas de plantio da mandioca.** *(A trial on planting systems for cassava).* Revista Ceres 11(61):1-7. 1959. Port., Sum. Port., Engl., 7 Refs., Illus.

Cassava. Cultivation. Planting. Cuttings. Productivity. Tubers. Roots. Rooting. Harvesting. Propagation materials. Field experiments. Developmental stages.

Two systems of planting cassava were compared in fine textured soil ("masape"): (1) Cuttings of 40 cm length, planted vertically. The lower 10 cm were placed into the soil. (2) Cuttings of 20 cm length, planted horizontally, 10 cm deep in the soil (the prevailing practice). The following conclusions were reached: Treatment 1 gave a yield increase of about 30% over treatment 2. The cassava roots in treatment 1 penetrated about 5 cm deeper than those of treatment 2. Figures are given to illustrate the different distribution of the root system in the 2 treatments. Harvesting is easier in the case of treatment 2. *(Author's summary)* D02 C01

0487-0356 ESPINO, R. B. **Effects of 2,4-D on some common plants.** Philippine Agriculturist 32:60-64. 1948. Engl.

Cassava. Herbicides. ***Manihot esculenta.*** **Weeds. Pests. Weeding. Cultivation. Philippines.**

Among the 7 garden or farm weeds sprayed with 2,4-D solution at the rate of 2.3 g of 2,4-D powder to make a liter of solution, no apparent harmful effect was observed on *Cyperus rotundus, Imperata cylindrica* and *Paspalum conjugatum. Elephatopus scaber* and *Mimosa invisa* recovered from wilting. *Synedrella nodiflora* was killed outright. One group of *Amaranthus spinosus* was killed, but another group was not. Among the ornamental and food-producing species, no harmful effects whatsoever were observed on *Canna indica, Oryza sativa* and *Zea mays. Momordica charantia* recovered from the wilting temporarily caused by the weed killer. The 2,4-D solution was rather harmful to *Manihot utilissima* and fatal to *Phaseolus lunatus.* From the results, it is obvious that this weed killer in the concentration tested cannot kill the 5 most common and most troublesome garden and farm weeds in the Philippines. Other concentrations may be tried later. *(Author's summary)* D02

0488-0328 ENYI, B.A.C. **The effect of age on the establishment and yield of cassava setts (*Manihot esculenta* Crantz).** Beitrage zur Tropischen und Subtropischen Landwirtschaft und Tropenveterinarmedizin 8(1):71-75. 1970. Engl., Sum. Engl., Germ., Fr., Span., 3 Refs., Illus.

Cassava. Propagation. Propagation materials. Cuttings. Timing. Composition. Mineral content. N. K. Tuber productivity. Stems. Ca. Magnesium. P. Water content. Rooting. Dry matter. ***Manihot esculenta.***

The chemical composition of cassava setts varied in different sections of the stem. Tuber yield increased with an increase in the age of the sett. Positive linear relationships between the dry matter of the setts, the N and K content in the setts and tuber yield were established. Best planting setts for high tuber yield were those taken from the oldest sections of the stem. *(Author's summary)* D02 C03

0489-0755 BERTONI, M. S. **Conservación de la rama de mandioca.** *(Preservation of cassava cuttings).* Cartilla Agropecuaria (Paraguay) nos. 81-83:31-33. 1945. Span.

Cassava. Cuttings. Temperature. Storage. Paraguay.

Cassava cuttings should be stored in a dry place. Under such conditions, cuttings maintain their viability after 5 months storage. A sample of cuttings which showed signs of a rotting disease ("urupé") were useful as plantings after more than 6 months of storage in a wood house during the dry season. *(Summary by H.J.S.)* D02

0490-3071 THE CULTURE of **cassava.** Agricultural and Industrial Life 19(9):6-7, 35. 1957. Engl.

Cassava. Cultivation. Stems. Cuttings. Propagation. Propagation materials. Production. Philippines.

Notes are given on land preparation, planting and pests. Information given deals with the following: propagation. planting, entire stalk versus ordinary cuttings, effect of the age of cuttings, the effect of monthly planting, on yield and production costs, weeding and cultivation, fallowing, manuring and fertilization. *(Summary by H.J.S.)* D02

0491-3059 SYKES, J. T. and HARNEY, P. M. **Rapid clonal multiplication of manioc from shoot and leaf-bud cuttings.** Journal of the Royal Horticultural Society 97(12):530-534. 1972. Engl. 12 Refs.

Cassava. *Manihot esculenta.* **Clones. Cultivars. Propagation materials. Cuttings. Shoots. Plant-growth chambers. Propagation. Rooting. Plant development.**

A description is given of methods of propagation using lignified and nonlignified stem cuttings and leaf-bud cuttings, which were successful for 3 clones of *Manihot esculenta.* In CMC9 and CMC84, hardwood cuttings having several buds produced a threefold increase in the number of roots when treated with indole-3-butyric acid, but this effect was less pronounced in CMC39. *(Summary by Plant Breeding Abstracts)* D02

0492-3050 ARISMENDI, L. G. **Epoca de siembra y tiempo de cosecha del cultivo de la yuca en Sabana de Jusepin.** *(Planting and harvesting time of cassava in the Savanna of Jusepin).* Tropical Root and Tuber Crops Newsletter no. 7:25-28. 1974. Span., Sum. Span., Engl., 6 Refs.

Cassava. *Manihot esculenta.* **Planting. Harvesting. Timing. Cultivation. Productivity. Field experiments. Venezuela.**

In experiments in the Savanna of Jusepin, the best time to plant the cassava variety Pata 'E Negro was the month of May; the time to harvest was 11-12 months after planting. Yields varied from 16.3 to 28.8 tons| ha. *(Author's summary)* D02

0493-0431 RODRIGUEZ, N. F. and SANCHEZ DE B., C. A. **Importancia del tipo de estaca para la producción de mandioca en Misiones.** *(The importance of the type of cutting for cassava production in Misiones).* Revista de Investigaciones Agrícolas 17(3):289-302. 1963. Span., Sum. Span., Engl., 29 Refs.

Cassava. Cuttings. Tuber productivity. Propagation. Propagation materials. Starch productivity. Productivity. Planting. Cultivation. Argentina.

An experiment studying 3 types of cuttings for cassava production was carried out in Loreto (Misiones, Argentina) during the years 1954-57. The trials were planted on terraces built on contour levels provided with good drainage because of the hilly ground characteristic of the area. This system is satisfactory for conserving the soil, but in rainy years a small percentage of roots were damaged by the excess moisture that accumulated in the terraces. The results of the trials were compared by analysis of variance; it was found that it was better to use 25-30 cm cuttings, planted horizontally and covered with earth (variant "b"), instead of using short cuttings of 8-10 cm (control), as is usually done in this region. Results obtained with variant "b" were highly significant, yielding 24.8 and 23.6 tons| ha of roots and 5.0-4.8 tons| ha of starch. The control yielded 16.7 and 3.1 tons| ha of roots and starch, respectively. The significant difference was found to be 4.628 tons| ha (5%) and 6.278 tons| ha (1%); the coefficient of variability was 9.1%. Variant "b" not only outyielded the control but also facilitated harvesting greatly; and a greater percentage (95.8%) of the cuttings were viable. Variant "b" produced 120,000 roots| ha, as compared to 75,000 for the control. Variant "b" cuttings produçed 79,000| ha with a diameter bigger than 2 cm, as compared to 63,000 for the control. Variant "a" (long cuttings planted at an angle and 2| 3 covered with earth) also had a high percentage of viable cuttings (99.1%). Variant "a" plants produced the most uniform root and starch yields which were very similar to "b". Because of the red clay soil, some difficulty was encountered in harvesting the roots, which were deeper; this also increased harvesting costs. Variant "b" is the most advantageous for this area; in the deep, sandy soils of other regions, variant "a" may be more convenient. The short cuttings (control method) should be used only when there is a scarcity of cuttings. *(Author's summary)* D02 D03

0494-2119 KOCH, L. **Het plantn van cassave volgens de methode van Heemstede Obelt vergeleken met de gewone bij de bevolking in swang zijnde methoden.** *(Planting cassava according to the Heemstede Obelt method as compared to popular methods).* Teysmannia 27:240-245. 1916. Dutch.

Cassava. Planting. Cultivation. Productivity. Propagation materials. Propagation. Cuttings.

The Heemstede Obelt method consists of planting cassava stakes in ridges, with about a 12-cm-long bamboo splint in the bottom part of the cassava stake to prevent it from falling over. It is said that by treating the bamboo, termite and cutworm damage is reduced. the method, however, did not increase yields, either of germinated shoots or total dry weight. Planting stakes horizontally produced less yield and increased lodging as compared with stakes planted vertically or at an angle. *(Summary by A. van S.)* D02

0495-3330 CONDE T., M. L. **El cultivo de la yuca.** *(Cassava cultivation).* Revista de Agricultura, Industria y Comercio (Puerto Rico) 35:166-169. 1944. Span., Sum. Span., Illus.

Cassava. Cultivation. Harvesting. Planting. Spacing. Cultivars. Puerto Rico.

Brief notes are given on cassava cultivation. Data deal with soil requirements, characteristics of several local (Puerto Rico) varieties, land preparation, planting, manuring, weeding, diseases and pests and harvesting. *(Summary by H.J.S.)* D02

0496-3309 DIMACALI, A. **The sugar cane cassava planter.** Agricultural and Industrial Life.26(8):12. 1964. Engl., Illus.

Cassava. Planting. Cultivation. Agricultural equipment. Philippines.

The sugar cane-cassava planter makes furrows in the soil, drops fertilizer and cuttings, covers back the cuttings as it forms a mound on it, and presses the soil pat. All these functions are accomplished in just one passing. It comes in a single-row unit, but one or two units can be hitched to a tractor at one time, leaving 90-120 cm between rows. A single unit alone can plant a hectare of sugar cane in about 7 hours and can be used on any kind of terrain. The factory is located in Caloocan (Philippines). *(Summary by H.J.S.)* D02

0497-3414 LOZANO T., J. C. and WHOLEY, W. **A technique for the production of bacteria-free planting stock of cassava** *(Manihot esculenta* **Crantz).** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1973. 7p. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Propagation. Rooting. Shoots. Cassava bacterial blight. Cultivation. Diseases and pathogens. Pests. Bacterioses. Pest control. Colombia.

A method of rooting shoot tips is described, whereby plants free from cassava bacterial blight were produced. The use of this method, in addition to cultural practices, is proposed for producing pathogen-free foundation stock for a planting material certification program. *(Author's summary)* D02 E02

0498-2241 ENYI, B.A.C. **The effects of spacing on growth, development and yield of single and multi-shoot plants of cassava (*Manihot esculenta* Crantz). II. Physiological factors.** East African Agricultural and Forestry Journal 38(1):27-34. 1972. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. Spacing. Growth. Dry matter. Leaf area. Productivity. Shoots. Tuber productivity. Plant assimilation. Plant physiological processes. Plant physiology. Leaves. Plant development.

Experiments were designed to study the effects of spacing on the development and yield of cassava plants Wider spacing encouraged greater dry matter production per plant but total dry matter produced per hectar decreased with increased spacing distance. The portion of total dry matter diverted into the root tubers wa greater in single- than in multishoot plants, the reverse being true with regard to the portion diverted into th stems. There appeared to be an inverse relationship between stem: tuber ratio and tuber production in thi cassava variety. Single-shoot plants had greater net assimilation rate (E) and mean bulking rate (B) thar multishoot plants; in the latter "E" increased with increased spacing distance. Multishoot plants had greate leaf area index (L) than single shoots; and in both, "L" increased with increasing plant density. Th relationships between leaf area, net assimilation rate, bulking rate and root tubers are discussed. *(Author's summary)* D02 C00

0499-0629 MENEZES, D. M. DE. **Epocas de plantio e colheita da mandioca.** *(Cassava planting and harvesting seasons).* *In* Reunião da Comissão Nacional da Mandioca, 5, Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp. 59-62. Port.

Cassava. Planting. Harvesting. Productivity. Climatic requirements. Cultivation. Brazil.

Field trials were carried out to determine the best planting and harvesting seasons (months) of two local cassava varieties. Work was conducted under normal growing conditions; i.e., without irrigation, drainage or manuring. Yields varied greatly according to planting season. Influence of winds, as well as of monthly rain and temperature variations, were analyzed in relation to differences in yields. Yields were affected only if rain and temperature decreases occurred before the 4th-6th month after planting. *(Summary by H.J.S.)* D02

0500-0288 RODRIGUEZ, N. F. and SANCHEZ DE B., C. A. **Tipo apropiado de estacas para la plantación de la yuca.** *(Appropriate type of cuttings for the propagation of cassava).* Tierra 20(4):287, 325. 1965. Span.

Cassava. Cultivation. Cuttings. Propagation materials. Field experiments. Productivity. Research. Argentina.

Cuttings 25-30 cm long, planted (1) at an angle and covered two-thirds with earth and (2) horizontally, were compared with cuttings 8-10 cm long, planted horizontally and completely covered with earth. Results showed the advantage of using long cuttings. Yields of roots| starch in tons| ha are relatively higher. Long cuttings, planted horizontally, yielded 6.9 tons more| ha than short cuttings and are recommended since some difficulties were encountered in harvesting plants from cuttings planted at an angle. *(Summary by J.L.S.)* D02 D03

0501-0445 MACHADO S., A. **Enraizamiento de la yuca. I.** *(Cassava rooting. I.).* Colombia. Centro Nacional de Investigaciones de Café. Boletín Técnico 1(4):23-40. (Cont.). 1949. Span., Sum. Span., 15 Refs., Illus.

Cassava. Cuttings. Planting. Spacing. Propagation materials. Cultivation. Harvesting. Productivity. Colombia.

This is a literature review on the cultivation of cassava, *Manihot dulcis* (G.F. Mild) M. Three field experiments were carried out in 2 sites planned as randomized blocks with 2 treatments (vertical and inclined cuttings) with 5 replicates each. Cuttings were planted at 1.2m in plots of 5 columns and 6 rows. The 18 peripheral cuttings were not used for experimental measures. Soil fertility differences were controlled, using blocks of equal fertility. Tubers were harvested, weighed, counted and measured, and classified as commercial or noncommercial. Diameter was measured at 10 cm above the ground to establish a correlation between tuber weight and stem thickness. Results are presented in tables, photographs and drawings. Variance analysis and significance tests were performed. Linear and curvilinear coefficients were calculated, as well as the difference and significance level. *(Author's summary)* D02

0502-2333 LAN, M. J. **Le manioc a la Station de Thanh-Ba, 1907-1908.** *(Cassava in the Station of Thanh-Ba, 1907-1908).* Bulletin Economique de l'Indochine no. 74:532-538. 1908. Fr.

Cassava. Cultivation. Planting. Spacing. Cuttings. Propagation materials. Cultivars. Field experiments. Inter-cropping. Cultivation systems. Productivity. Costs. Fertilizers. Manures.

A trial was carried out to compare 2 local varieties (sweet and bitter) to 1 variety (Manioc Soso or Manioc Bouquet), introduced from Reunion. The influence of a legume crop *(Mucuna utilis)* intercropped with cassava was also studied. Cuttings 5-10 cm long were planted flat in sandy-clay soils in holes 10-15 cm deep and covered with 5 cm earth. Manioc Bouquet was planted in Nov., 1906 and harvested from April-May, 1908; the local varieties were planted in March, 1907 and harvested from Feb.-March, 1908. Highest root yields were obtained from Manioc Bouquet, 12,445 kg|ha; sweet cassava yielded 7,461 kg|ha and bitter cassava, 6,275 kg|ha. No significant influence of *Mucuna utilis* on cassava was observed. Production costs are discussed. *(Summary by J.L.S.)* D02 K01

0503-3283 CORREA, H. **Produção e composição química de raízes e ramas de mandioca em diversas épocas de colheita e o efeito da poda na produção de raízes.** *(Production and chemical composition of cassava tubers and branches during several harvesting seasons and the effect of pruning on tuber production).* M.S. Thesis. Viçosa, Brasil, Universidade Federal de Viçosa, 1972. 49p. Port., Sum. Port., 30 Refs.

Cassava. Stems. Tubers. Productivity. Pruning. Tuber productivity. Starch productivity. Foliage. Protein content. Composition. Brazil.

Pruning at 6, 9 and 12 mo reduced tuber yields; by 57.2%, 56.3% and 47.4%; pruning at 15 mo did not affect tuber yields. Higher branch yield took place at 15 mo and higher tuber yield at 18 mo. Higher protein content in the branches occurred at 6-12 mo and at 6-9 mo in the tubers. *(Summary by H.J.S.)* D02 D03

0504-2951 SANTOS, G.A.L. DOS., *et al.* **Controle químico de ervas daninhas na cultura da mandioca** *(Manihot utilissima* **Pohl).** *(Chemical control of noxious weeds in cassava fields).* Biológico 39(8):195-198. 1973. Port., Sum. Engl., 5 Refs.

Cassava. *Manihot esculenta.* **Weeding. Herbicides. Weeds. Pests. Pest control. Brazil.**

This paper reports 2 experiments performed during 1971-1973 by the Biological Institute of São Paulo (Brazil), where several herbicides were applied. Preplanting: Karbutilate at 1.00 kg|ha and 2.00 kg|ha; trifluralin at 1.00 kg and 2.00 kg and trifluralin + diuron at 1.00 kg + 2.00 kg, respectively. Preemergence: Karbutilate at 1.00 kg and 2.00 kg|ha and diuron and fluometuron at 2.00 kg and 2.50 kg|ha. The weeds were represented by *Digitaria sanguinales (L) Scop., Brachiaria plantaginea* (Link) Hitch., *Richardia brasiliensis* Gomez, and *Sounchus oleraceus* L. The best results were obtained with trifluralin at 1.00 kg and 2.00 kg, and trifluralin + diuron, in preplanting, and with Karbutilate in preemergence. Under the described conditions of these 2 field experiments, the products did not cause any injuries to the cassava crop. *(Author's summary)* D02

0505-3315 SCAIFE, A. **The effect of a cassava "fallow" and various manurial treatments on cotton at Ukiriguru, Tanzania.** East African Agricultural and Forestry Journal 33(3):231-235. 1968. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Fertilizers. Cultivation. Cotton. Weeding. Economics. Productivity. Costs. Soil fertility. Fallowing. Manures. Dung. Rotational crops. Cultivation systems. Production. Field experiments. Tanzania.

This experiment was designed (1) to compare the effects of 2 or 3 seasons of a cassava "fallow" crop on the following 3 cotton crops, (2) to estimate the contribution of weed growth in cassava to its fallowing effect, and (3) to assess total production from cassava|cotton rotations and compare this with the total production from continuous cotton. It was found that a 3-year cassava break is profitable for unmanured cotton on granitic sandy soils. Cassava yields are a bonus, as land would lie fallow otherwise. This system enables the same amount of cotton to be obtained from smaller acreage, thus reducing costs of cultivation, weeding and spraying. "Minjingu" phosphate (ground fossil guano) was a valuable fertilizer. *(Summary by T.M.)* D02 K01

0506-0834 MACHADO, A. **Enraizamiento de la yuca. II.** *(Cassava rooting. II.)* Colombia. Centro Nacional de Investigaciones de Café. Boletín Técnico 1(5):3-16. (Cont.). 1951. Span., Sum. Span., Illus.

Cassava. Field experiments. Fertilizers. Planting. Spacing. Cuttings. Productivity. Tuber productivity. Starch productivity. Timing. Cultivation. Colombia.

This experiment was carried out to measure the differences in yield, tuber quality and starch content of cassava when grown under different planting systems with variations in distance, quantity of cuttings per hole and fertilizer application. The distances used were 1.20 x 1.20 m; 1.00 x 1.00 m and 0.80 x 0.80 m. In relation to the quantity of seeds per hole, trials were made planting 1 or 2 seeds per hole, each hole being separated by 10 cm in all the above distances. Fertilizers were applied 6 months after planting. Each plant received an application of 30 g potassium nitrate and 30 g superphosphate of 20% concentration. The experiment responded to the 2 x 2 x 2 factorial system with 3 replications; the varieties used in this experiment were Yuca Amarilla and Siete Cueros and were harvested at 16 months. The cuttings used were 15 cm long. The cultivation was made on the basis of the "single stems" process to standardize the different treatments; as in view of the good vegetative development, it was necessary to cut the shoots of the main stems. The roots were classified in two groups (a) commercial—more than 10 cm long and more than 4 cm average diameter; (b) noncommercial—those not meeting these standards. Harvesting was made in the center of each plot and on a quantity of plants varying from 18.5% to 35.7% of the whole plot excluding the guard rows. After the classification of the roots, the harvested material was weighed. From every plot, 3 kg of roots were taken and the starch content was determined using rural procedures. The average yield of starch|ha was 8,433 kg; the average yield of roots reached 41,483 kg|ha. One kilogram starch was obtained from 5 kg roots. With the best experimental combination (1.20 x 1.20) and just one "seed" per hole without fertilization, 36,982 kg of commercial roots per hectare were obtained under experimental conditions. *(Author's summary)* D02 D03

0507-0497 MACHADO S., A. **Enraizamiento de la yuca. III.** *(Cassava rooting. III).* Colombia. Centro Nacional de Investigaciones de Café. Boletín Técnico 1(12):17-28. (Concl.). 1950. Span., Sum. Span., Illus.

Cassava. Rooting. Cuttings. Planting. Harvesting. Productivity. Cultivation. Propagation materials. Developmental stages. Colombia.

This part of the research done on cassava rooting compared propagation systems using long (100 cm) and short (15-20 cm) stem cuttings, planted vertically and at an angle, respectively. The variety Yuca Amarilla or Siete Cueros was used. The possibility of obtaining mature, high-yielding roots in half the normal time (about 8 mo) was also studied. Main conclusions were as follows: (1) At 16 mo the use of short or long cuttings was relative; roots were equal in length, diameter and quality. At 8 and 12 mo, plants from long cuttings had developed more roots, but they were not fully developed so there was no real advantage in using this system. (2) There were disadvantages to using long cuttings because it was difficult to obtain propagation material and plants were not resistant to lodging. *(Summary by T. M.)* D02

0508-3355 MOGILNER, I. *et al.* **Influencia de la parte aérea de** ***Manihot flabellifolia*** **en la formación de raíces reservantes de** ***Manihot esculenta*** **utilizado como pie.** *(The influence of Manihot flabellifolia as a scion in the formation of storage roots by Manihot esculenta as a stock).* Bonplandia 2(10):137-142. 1967. Span., Sum. Span., Engl., Illus.

Cassava. *Manihot flabellifolia.* **Grafting. Tubers. Leaves. Tuber development. Propagation. Productivity.** *Manihot esculenta.*

In reciprocal grafts of *Manihot flabellifolia* and *Manihot esculenta,* it was demonstrated that the graft *M. flabellifolia*| *M. esculenta* (Mf| Me) produces a greater quantity of storage roots with greater dry weight than *M. esculenta.* The graft *M. esculenta*| *M. flabellifolia* (Me| Mf) does not form storage roots; its radicular system is identical to *M. flavellifolia's.* In the graft Mf| Me and in *M. esculenta* the following determinations were made at 60, 75, 90, 110, 130 and 155 days after grafting: foliar surface; aerial part, absorption roots and storage roots dry weight and foliar respiratory intensity. Results indicate that *M. esculenta* forms a greater foliar surface and has more photosynthetic intensity than the graft Mf| Me, which translocates a greater quantity of photosynthesized substances to the storage roots than *M. esculenta.* These results are statistically significant. The greater number of storage roots formed by the graft Mf| Me may be due to a better photosynthesis efficiency by the aerial part *(M. flabellifolia)* than *M. esculenta. (Author's summary)* D02 C01

0509-3814 MONTEIRO, F. P. **Valor economico da mandioca e trabalho mecanizado no cultivo.** *(The economic value of cassava and mechanized cultivation systems).* Rural (Brazil) 511(43):16. 1963. Port.

Cassava. Planting. Productivity. Mechanization. Weeding. Insect control. Brazil.

Cassava production tends to improve economically; in the state of São Paulo; it is one of the principal crops as far as area cultivated and production are concerned. Farmers have tried to improve their yields and have been forced to mechanize their work. At the agricultural school Luiz de Queiroz in Piracicaba, several tests have been carried out with the purpose of totally mechanizing agricultural practices. Cassava can be planted almost perfectly with a stake planter, whose efficiency has already been proven and which plants 10 ha| day, using only 8 people. Preemergence applications of herbicides are recommended at planting. The school at Piracicaba is engaged in determining an optimal dose of insecticides to combat pests that attack cassava, as well as in controlling diseases. *(Summary by L.C. Trans. by T.M.)* D02

0510-4785 ONOCHIE, B. E. **Critical periods for weed control in cassava in Nigeria.** Pans 21(1):54-57. 1975. Engl., Sum. Engl., 6 Refs.

Cassava. Weeds. Weeding. Hoeing. Productivity. Timing. Nigeria.

The effects of weed competition on cassava yield were assessed in 2 sets of treatments. In the first set, plots were kept weed free for specified periods and then weeds were allowed to grow. In the second set weeds were allowed to grow initially for specified periods and were then eradicated. Effects were assessed from fresh weights of cassava roots, and weed species commonly found in the plots were identified. The work was done in the rain forest zone of western Nigeria. The predominant weed species were mainly annual broad-leaved species, and competition from weeds at any period of growth after rooting reduced yield. The most damaging effect on yield was noted during early canopy formation and early tuberization (3rd mo after planting) and a less damaging effect from the 4th mo until harvest. Where labor is a limiting factor in cassava production, labor input should be applied during the 3rd mo after planting to control weed growth. Weeding during this period was as effective in ensuring a high yield of cassava roots as weeding throughout the entire period of growth. *(Author's summary)* D02

0511-2024 REYNVAAN, J. **Over het planten van cassave.** *(On the planting of cassava).* Landbouw Nieuws 1954:9-12. 1954. Dutch., Illus.

Cassava. Land preparation. Soil fertility. Cuttings. Planting. Cultivation. Surinam.

Directions are given for planting cassava in Surinam, with remarks on the choice of soils, soil preparation and of planting material. *(Summary by Tropical Abstracts)* D02

0512-4640 BOLHUIS, G. G. **Plantmateriaal en plantmethoden van cassave.** *(Cassava planting material and planting methods).* Landbouw 23(1|2|3):97-107. 1951. Dutch., Sum. Engl., Jav., 25 Refs.

Cassava. Planting. Cuttings. Storage. Field experiments. Propagation. Indonesia.

A compilation is given of available literature on experiments with planting material of cassava, with an additional chapter on some unpublished experiments on storage of cassava cuttings in Bogor (Java). The following conclusions were reached: (1) Cuttings from the middle and the base of the branches are better planting material than those from the top end. (2) Planting material imported from regions having no long dry season into regions with a pronounced dry season will, when planted several years in succession on the same soil, not degenerate, but will deteriorate, owing to cultivation under less favorable conditions. (3) Cuttings from plants older than 18 mo should not be used. (4) The recommended length for cuttings is 20-25 cm. (5) In accordance with the method described by Carr and Chesquiére, planting of cuttings having a length of about 1 m seems to have some advantages for root yield, but the amount required with this method is prohibitive in regions where shortages of planting material are frequent. (6) Extra tillage of cassava plots, e.g., hilling up, is not economical under Bogor conditions. (7) Selective thinning of so-called "double-planted" cuttings(2|hill)had no advantage over normal planting. (8) Oblique or horizontal planting of cuttings did not affect yield. (9) Cuttings yielded considerably less than those planted in the normal manner. Contrary to general native belief, the poison content of roots from inverted cuttings of nonpoisonous varieties was not increased. (10) The very laborious methods used by Ban Heemstede Obelt for treating cuttings showed no advantage over normal planting. (11) Storage of cassava cuttings upside down had no advantage over storage in the normal way. (12) Storage of planting material seldom led to reduction in yield. In the case of some varieties, however, heavy losses of planting material occurred. (13) As the percentage of loss from storage of planting material is evidently not correlated with the nature and number of the shoots formed during storage, other factors inherent to the specific characters of the clones must be taken into account. (14) Cuttings made in the first months of the west monsoon had better keeping qualities than those made later in the same season. *(Author's summary)* D02

0513-3240 **NOTE SUR le mode de plantation des boutures de manioc.** *(Notes on methods of planting cassava cuttings).* Bulletin Agricole du Congo Belge 28(1):131-134. 1937. Fr., 3 Refs.

Cassava. Planting. Cuttings. Productivity. Branching. Propagation. Propagation materials. Stems. Developmental stages.

Cuttings were planted horizontally, vertically and obliquely. Yield differences were not significant. When planting vertically, the planter might invert the cutting, which can reduce yields. When planting horizontally, the number of thin branches, which are useless as cutting sources, increases; thus oblique planting seems to be the best method. *(Summary by H.J.S.)* D02

0514-3257 STUART, T.,H. **Good planting materials will give better cassava harvest.** Agriculture at Los Baños 12:16. 1972. Engl.

Cassava. Planting. Propagation materials. Cuttings. Cultivation. Stems. Propagation.

Cassava is propagated by cuttings. While any part of the cassava stem can be used, the best part is its mature portion. For backyard planting, old and new stems may be used including the stump but not for large or commercial planting. Cuttings 25-35 cm long may be taken from plants that are at least 10 mo. old. Remove the top portion of the stem and divide the remaining part into pieces about 30 cm each. Sometimes, though, you may need more planting materials than the few good cuttings you have. What you can do is to plant these few good cuttings in a small plot. When they have grown some, cut them into pieces 25 cm long. Then you can plant these cuttings in the field as parent plants. Bottom cuttings are better than those in the middle, but the middle cuttings are also better than top cuttings. Avoid planting cuttings that have a forked top or those that have developed vegetative buds. Never use cuttings that have been cut 10 days before planting. Cut the stems shortly befor planting. If you are forced to keep the stems for some time, tie them into bundles and coat both ends of the stems with tar. Cut the stems in the field when they are to be planted. *(Full text)* D02

0515-5036 PIEDRAHITA C., W., MESIA P., R. and DOLL, J. **Control integrado de malezas y uso de herbicidas PSI en yuca** (*Manihot esculenta* **Crantz**). *Integrated weed control and the use of PPI herbicides in cassava. Manihot esculenta Crantz).* Revista Comalfi (Colombia) 2(2):89-103. 1975. Span., Sum. Span., Engl., 4 Refs.

Cassava. Weeding. Herbicides. Planting. Timing. Field experiments. Weeds. Productivity. Colombia.

Two studies were conducted to determine the best integrated weed control system for cassava (*Manihot esculenta* Crantz), in addition to the selectivity of preplant incorporated (PPI) herbicides and their interactions with the planting system. Three preemergence treatments followed by hand weeding or a directed application of paraquat were compared to systems in which the hand weeding was done first and then the preemergence herbicides were directed in cassava 40 days old. Three hand weedings or 3 directed paraquat applications were also included. Best results (highest yields) were obtained when diuron was applied either before or after a hand weeding and when the traditional system of 3 hand weedings was used. The application of a pre- or postemergence herbicide alone was not effective in controlling weeds. Regarding the selectivity of PPI herbicides, EPTC, butylate and trifluralin were applied and incorporated at normal and 2 x rates; the cassava was planted either in ridges or level ground. Butylate was more selective than EPTC. Planting in ridges reduced the selectivity of the thiocarbamates but not of trifluralin, which was selective at the 2 x rate. Ridging left the area between ridges with less herbicides, thereby reducing weed control. *(Author's summary)* D02

0516-3909 BATES, W.N. **Root crops. Cassava** *(Manihot utilissima). In*________. Mechanization of tropical crops. London, Temple Press Ltd., 1957. pp.268-273. Engl., Illus.

Cassava. Planting. Harvesting. Mechanization. Productivity. Agricultural equipment. Production. Java.

This chapter refers to cassava, yams and sweet potatoes. As regards cassava, cultivation in Java is described briefly in terms of the bitter and sweet types, propagation, yields, food value of the leaves, and the processing of flour and tapioca. *(Summary by L.C. Trans. by T.M.)* D02

0517-3455 ORT, J. K. **The influence of preceding crops on subsequent crops following bush fallow in Umudike, eastern Nigeria.** *In* Symposium on the Maintenance and Improvement of Soil Fertility, Khartoum, 1965. Proceedings. Khartoum, OAU|STRC, 1965. pp. 434-436. (Publication no. 98) Engl., 3 Refs.

Cassava. Yams. Maize. Fallowing. Productivity. Soil fertility. Nigeria.

In crop sequence experiments conducted with yams, maize and cassava on deep, readily permeable, moderately to strongly leached, acid soils in eastern Nigeria, the highest yields were obtained when these crops were grown after a bush fallow, which was cut down and burned in the year of cropping. When the bush fallow was cut down and left uncropped in the previous year, yields of the succeeding crops were slightly less, suggesting a possible loss of nutrients as a consequence of the delayed cropping. Yields of a 2nd crop of yams, maize or cassava, grown in succession to the 1st crop, were significantly reduced to 67.5%, 82.7% and 59.8%, respectively, of those of the 1st crops. *(Summary by Tropical Abstracts)* D02

0518-4540 OKIGBO, B.N. **Effect of planting date on the yield and general performance of the cassava** (*Manihot utilissima* **Pohl**). Nigerian Agricultural Journal 8(2):115-122. 1971. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Planting. Timing. Cuttings. Tuber productivity. Plant height. Tuber development. Photoperiod. Shoots. Rainfall data. Field experiments. Plant physiology. Nigeria.

An experiment was conducted at Nsukka (Nigeria) to determine the effects of planting date on the yield and general performance of cassava. Ten planting dates at 3-weekly intervals were used from April to Oct., 1965. Harvesting was carried out a year after planting in each treatment. Various observations indicated that fresh and dry weight of tops, number of storage roots| plant, number of main branches| plant, fresh weight of original cuttings and tops| roots ratio decreased with the lateness of planting date during the year, while fresh and dry weights of roots increased at the later planting dates. Reasonably high linear correlation coefficients were calculated between these variables and week of planting. *(Author's summary)* D02 D03 C02

0519-0493 VEGA F., E. *et al.* **Calendario para el cultivo de la yuca.** *(Calendar for cassava cultivation). In* Caja de Crédito Agrario Industrial y Minero. Calendario Agrícola. Bogotá, 1968. pp.126-133. Span., Illus.

Cassava. Planting. Harvesting. Timing. Cultivation. Colombia.

This paper is part of a calendar showing the months for planting and harvesting different crops in the "departamentos" (political division) of Colombia. Planting and harvesting of cassava takes place throughout the year. *(Summary by H.J.S.)* D02

0520-0622 **EPOCA DE plantio da mandioca em Sete Lagoas.** *(Cassava planting season in Sete Lagoas). In* Reunião da Comissão Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp.28-32. Port.

Cassava. Planting. Harvesting. Production. Tuber productivity. Foliage. Productivity. Timing. Pruning. Brazil.

Trials were carried out in red latosols, of the "cerrado" type, which had been previously plowed and manured. The rainy season is favorable for planting. An experiment was performed to test the effects of branch pruning and tuber production. Higher yields took place at 18 months harvesting (34 tons| ha of tuber). There were no differences between root and branch production at 6- and 12-month harvesting, but pruning affects tuber production. *(Summary by H.J.S.)* D02 D03

0521-3256 BOLIAN, C. E. **Cultivation in periodically flooded areas.** New York, University of New Hampshire, 1971. 9 p. Engl., 4 Refs.

Presented at: The Symposium, "Manioc in Lowland South America," New York, 1971.

Cassava. Cultivation. Storage. Human nutrition. Ecology. Cultivation systems. Colombia. Brazil. Peru.

The main objective was to study how the Tukuna (Tikuna or Ticuna) Amerindians handled the problem of cultivating periodically flooded fields. The Tukunas occupy the lands around Leticia (Colombia) in the "Trapecio Amazónico." They cultivate cassava in periodically flooded areas and in dry areas. Cassava tubers will completely rot if submerged for 10 or 12 days but will survive virtually undamaged if submerged for a period of only 3 to 5 days. Strategies for avoiding famine when the major crops are destroyed by floods include the storage of cassava, both raw and cooked (tubers are buried in the ground), and using rapidly maturing varieties that produce a crop in about 6 months. Nevertheless, yields at so early a stage are low. Growing maize and rice is also possible. *(Summary by H.J.S.)* D02

0522-3024 NORMANHA, E.S. and BOOCK, O.J. **Ensaios de variedades de mandioca na estação experimental de Ubatuba.** *(Cassava variety trials at the Ubatuba Experiment Station).* Bragantia 2:521-559. 1942. Port., Sum. Engl., 3 Refs., Illus.

Cassava. Cultivars. Soil requirements. Climatic requirements. Planting. Harvesting. Timing. Tuber productivity. Field experiments. Brazil.

A study was made of 11 varieties of **Manihot** from the Ubatuba area on the northern coast of the state of São Paulo (Brazil) to compare root and meal production of each variety to that of the variety Vassourinha. Varieties No. 1 (Vassourinha) and 120 (Santa) were the best. Comparing these 2, it was found that No. 1 was better. There was no relationship between stem and root production for any of the varieties. Analyses are given for meal obtained from each from 1 and 2 vegetative cycles. *(Author's summary)* D02 D03

0523-2147 LERTORA C., J. and BRAMBILLA A., J. **Determinación de la época de siembra en yuca, *Manihot esculenta* Crantz, para las condiciones de la Costa Central.** *(Determination of planting time for cassava, Manihot esculenta Crantz, suitable for the conditions of the Central Coast).* Tropical Root and Tuber Crops Newsletter no. 7:19-24. 1974. Span., Sum. Span., Engl., 8 Refs.

Cassava. *Manihot esculenta*. Planting. Timing. Cultivation. Productivity. Field experiments. Peru.

The effect of different planting times on yields cassava for the Central Coast of Peru was studied at the Universidad Nacional Agraria, La Molina. The study was carried out in a complete randomized block design. The results obtained show that planting cassava in July was statistically superior to June, September or October. There were no significant differences between July and August. Planting in August was statistically superior to October. Results of plantings in June, September or October were not significantly different from each other and showed the lowest yields. *(Author's summary)* D02.

0524-3306 CELIS, E. **Material de propagación y siembra de yuca.** *(Cassava planting and propagation material).* Cali, Colombia, Centro Internacional de Agricultura Tropical, 1973. 8p. Span., 20 Refs.

Cassava. Cultivation. Propagation. Cuttings. Seeds. Spacing. Propagation materials. Timing. Colombia.

Cassava can be propagated by true seeds and vegetative material. Obtaining true seeds is difficult and resulting plants have longer life cycles, rendering lower tuber production. Thus cuttings are preferred. Recommendations on the optimal length of cuttings vary greatly. Factors involved in using cuttings are plant age, planting sanitation, length of cuttings, planting distance, cutting viability and orientation of cuttings when planted. *(Summary by H.J.S.)* D02

0525-4841 SHANMUGAVELU, K. G. *et al.* **Effect of time of planting and irrigation frequencies on the yield of tapioca (*Manihot esculenta* Crantz).** Indian Journal of Agricultural Sciences 43(8):789-791. 1973. Engl., Sum. Engl., 9 Refs.

Cassava. *Manihot esculenta*. Planting. Timing. Irrigation. Production. Costs. Tuber productivity. India.

An experiment was conducted with cassava (*Manihot esculenta* Crantz) from 1968-70 to find the optimum planting time and irrigation schedules for the variety Malavella. It was found that planting in September increased yields by 107.9%, as compared with planting in June. Irrigated crops, irrespective of the frequency of irrigation, recorded significantly higher yields than the control (unirrigated crop). Although a frequency of 4 and 8 days was superior to other treatments, irrigation at 8-day intervals gave the highest net profit. *(Author's summary)* D02

0526-0138 LOPEZ H., J. **Resultados preliminares sobre las investigaciones en yuca.** *(Preliminary results of experiments with cassava).* Revista Nacional de Agricultura (Colombia) 42(532):25-32. 1949. Span., Sum. Span., Engl., 8 Refs.

Cassava. Cassava programs. Plant breeding. Cultivation. Harvesting. Fertilizers. Propagation materials. Cuttings. Development. Colombia.

This gives a brief outline of a cassava (**Manihot** sp.) improvement program being developed at Palmira, Colombia. A description of methods and materials of the breeding program, as well as details of experiments now under way, is given. The second part, to be issued separately, will include preliminary results. *(Author's summary)* D02 G01.

See also *0099 0108 0351 0412 0529 0542 0545 0563 0573 0905 0919 1803 1855 1856*

0527-0855 ZANZIBAR. DEPARTMENT OF AGRICULTURE. **Variety trials with hybrid cassava.** *In* ———— Agriculture Report 1954. Supplement. p 5. Engl.

Cassava. Productivity. Tuber productivity. Backcrossing. Plant breeding. Cultivars. Hybrids. *Manihot esculenta. Manihot glaziovii.* **Tubers. Palatability. Tanzania.**

Nine cassava varieties were tested for their tuber yield. Yields varied from 11.4 to 1.3 tons per acre. Data are given on the palatability of the tubers and the degree of virus infection. Three of the varieties are third backcrosses of cassava with *Manihot glaziovii. (Summary by H.J.S.)* D03 G01

0528-0850 KENYA. DEPARTMENT OF AGRICULTURE. **Cassava variety trial (expt 4| 1| 3).** *In* ————. Annual Report 1952. Nairobi, 1953?. v.3. pp. 195-196. Engl.

Cassava. Productivity. Cultivars. Field experiments. Kenya.

Results are given of a trial to test the yield of 6 mosaic-resistant cassava varieties from Uganda at 7 different harvesting dates. Mosaic resistance and the palatability of each variety were also studied. Data of monthly and annual average rainfall are also given. *(Summary by H.J.S.)* D03 G01

0529-0065 BRUIJN, G. H. de and DHARMAPUTRA, T.S. **The Mukibat system, a high-yielding method of cassava production in Indonesia.** Netherlands Journal of Agricultural Science 22(2): 89-100. 1974. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. *Manihot esculenta. Manihot glaziovii.* **Cultivation. Propagation. Grafting. Propagation materials. Cuttings. Planting. Spacing. Crotolaria. Green manures. Cultivation systems. Roots. Productivity. Leaf area. Plant physiology. Indonesia.**

Grafting or budding *Manihot glaziovii* onto a stock of *M. esculenta* enormously increased production of tuberous roots. This growing system, introduced by a Javanese farmer, Mukibat, outyields ordinary cassava by more than 100%. Average yields are about 96 tons| ha| yr. A description is given on the preparation of plant material, planting method, planting time, intercropping, manuring, plant care, growing period, yield and root quality. Practical significance, potential production and the physiological basis of the system are also discussed. *(Author's summary)* D03 D02

0530-0039 WANG, H. F. and MA, Y. C. **A comparison of yield of different varieties of cassava.** Journal. Agricultural Association of China, 35: 24-49. 1961. Chin., Sum. Engl., 4 Refs.

Cassava. *Manihot esculenta.* **Research. Field experiments. Cultivars. Productivity. Roots. Soil requirements. Tuber productivity. Taiwan.**

This presents the results of field experiments on comparative yield of different cassava varieties during the period Sept. 1959 to Feb., 1961. The experiment was conducted on a sandy loam soil at Fungli Farm of the Puli By-product Factory, which is under the supervision of the Taiwan Sugar Corporation. A randomized block design with four replications was used. Nine varieties were tested: 4 from Brazil, 2 from Vietnam, 1 from Indonesia, 1 from Thailand, and a native variety as check. The results were as follows: (1) The total growing period of the plants was 508 days. (2) Different varieties showed great variation in agronomic characteristics, especially in plant height, plant type, wind-resistant character, etc. (3) Highly significant differences were found in root tuber yield. (4) Only two varieties outyielded the local check namely (San Trung-Tam from Vietnam and Valenca from Indonesia). (5) Although the starch content is determined mainly by the character of the variety itself, there seemed to be a relationship between yield and starch content: the higher the yield, the greater the starch content. *(Author's summary).* D03

0531-2257 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. **Cassava.** *In* ———— Statistiques mondiales des culture; superficie, production et rendement 1948-64. (World crop statistics; area, production and yield). Rome, 1966. pp.132-141. Fr.

Cassava. Production. Productivity. Statistical data. Economics. South America. West Indies. Africa. Asia. Australia.

The table gives statistical data for most tropical countries. World totals were 6.3 million ha, 52.7 million metric tons and 8.4 ton|ha in 1948; and 9.0, 83.2, 9.2, respectively in 1964. *(Summary by H.J.S.)* D03

0532-0134 GALLARDO, A. L. **Cultivo e industrialización de la yuca.** *(Cultivation and industrialization of cassava).* Revista Nacional de Agricultura (Colombia) 32(400):1342-1352. 1937. Span.

Cassava. Cultivation. Cultivars. Composition. Water content. Starch content. Fertilizers. Production. Costs. Economics. Cassava products. Cassava meal. Tapiocas. Cassave. Cassava bread. Cassava starch. Processing. Cuba.

A botanical description of the local varieties, cultivation, planting, land preparation, fertilizers, diseases and pests, and harvesting are discussed. The starch content of 4 varieties (Helada no. 7, Bruja, Cartagena and Cristalina). Yields range from 12.5 to 18.75 ton|ha. Cassava roots are mainly consumed as "cazabe," which is known as "farine" in the West Indies. Cassava is also considered a good supplement for animal feeding and a good raw material for the production of dextrins, dextrose and glucose. The production of cassava flour and starch is outlined. *(Summary by A.N.)* *D03 I02*

0533-0475 LORIA M., W. **Rendimiento de variedades de yuca en la región de Esparta, Costa Rica.** *(Productivity of cassava varieties in Esparta, Costa Rica).* Alajuela, Costa Rica. Estación Experimental Agrícola "Fabio Baudrit M." Boletín Técnico 4(1):1-4. 1971. Span., Sum. Span.

Cassava. Cultivation. Cultivars. Productivity. Research. Field experiments. Harvesting. Timing. Costa Rica.

This trial was conducted at Esparta, an area which lies in the Pacific climatic zone of Costa Rica, where cassava is widely grown. First, an exploratory trial was made with 52 cassava varieties, 30 of which were selected and cultivated according to a statistical design. Harvesting was made 11 months after planting; best yields were obtained from the following varieties: Valencia, Mangi and Vagana. The Valencia and Mangi varieties are of excellent quality for culinary purposes. *(Author's summary)* D03

0534-3432 OPUTA, C. O. and WATERWORTH, J. V. **Cassava trials (1965).** Nigeria. Ministry of Agriculture and Natural Resources. Midwest Region. Experiment Report no. 89. 1967. 3p. Engl., Sum. Engl.

Cassava. Cultivars. Field experiments. Productivity. Nigeria.

The 1963-64 cassava variety trials at Ilele and Obior were repeated with slight modifications in 1964-65 to check earlier results. At Effurun the comparison of a collection of local varieties to introduced varieties was continued. As in previous results, 60444 and 60471 were quite outstanding at Obior and Ilele,respectively, closely followed at both sites by a new local acquisition from Benin. At Ilele, however, the new introduction 60447 significantly outyielded 60471 and all other varieties, at 13.7 tons|acre, giving 65% more yield than Ilele local. At Obior this variety was also the best yielder (but not significantly higher than 60444 or Benin local), yielding 100% more than the Obior local. It must be tested for one more year before it can be distributed. In a joint analysis of 2-year results (1963-65) at Effurun,four local varieties significantly outyielded 60444 and 60471, but not 53101 and should be further tested. *(Author's summary)* D03

0535-3740 SEEMANTHANI, K. B. **Two new double yielding tapiocas.** Indian Farming 12(1):10. 1962. Engl., Illus.

Cassava. Cultivars. Productivity. India.

The new varieties Malavella and Anaikomban are briefly described. Malavella has given yields of 12.5 tons|acre whereas Anaikomban has produced over 7 tons|acre. Ammonium sulfate at 250 lb|acre applied as top dressing may be beneficial for poor or moderately fertile soils. *(Summary by J.L.S.)* D03

0536-2151 **REPORT ON economic and other experiments.** *In* St. Kitts-Nevis. Botanic Station. Report 1910-11. pp. 9-11. Engl.

Cassava. Productivity. Cultivars. Selection. Cultivation. West Indies.

Experiments with various economic and food-producing crops have been carried out with a view of distributing the best varieties among the farmers. Data are given on yields of 10 cassava varieties. *(Summary by H.J.S.)* D03 G01

0537-2108 COUSINS, H. H. **Cassava trials in 1905.** Bulletin of the Department of Agriculture, Jamaica 3:152-153. 1905. Engl.

Cassava. Productivity. Starch productivity. Tuber productivity. Cultivars. Jamaica.

Brief notes are given on cassava trials. Data given deal with tuber yields of 28 native varieties, control of pests and starch content. *(Summary by H.J.S.)* D03

0538-2104 MAIN, F. M. **Le rendement du manioc.** *(Cassava yields).* Journal d'Agriculture Tropicale no. 55:17-18. 1906. Fr., 2 Refs.

Cassava. Tuber productivity. Starch productivity. Productivity. Jamaica. Malagasy Republic.

Notes are given about yields of cassava tubers in Jamaica (12-20 ton|ha) and Madagascar (15-30 ton|ha) and of cassava starch yields in Madagascar (28% - 36%). *(Summary by H.J.S.)* D03

0539-2003 ROJAS S., A., SAIAS S., J. and LORIA M., W. **Variedades de yuca en Venecia de San Carlos.** *(Cassava varieties in Venecia, San Carlos).* Alajuela, Costa Rica. Estación Experimental Agrícola "Fabio Baudrit M." Boletín Técnico 5(7):1-8. 1972. Span., Sum. Span., 5 Refs.

Cassava. Cultivars. Starch productivity. Productivity. Tuber productivity. Costa Rica.

A collection of cassava varieties was planted in Venecia, San Carlos, on May 6, 1970. Rainfall in the area was 5,717 mm in 1970. The area is located 430 m above sea level, and soils are well drained. Harvesting was performed 10 months and 10 days after planting. Despite the intensity of the rains, the yields of roots and starch were satisfactory. The highest yielding variety (Mangi) produced 23.89 ton|ha of roots and 5.73 ton|ha of starch. Starch content varied between 18 and 24%. *(Author's summary)* D03

0540-2002 ALBUQUERQUE, M. DE. **Efeito da selecão de cultivares no rendimiento dos mandiocais em zonas mandioqueiras do Pará.** *(Effect of variety selection on cassava yield in the cassava-growing areas of Pará).* Belem, Brasil. Instituto de Pesquisa Agropecuaria do Norte. Comunicado no. 16. 1972. 8p. Port.

Cassava. Productivity. Cultivars. Selection. Starch productivity. Human nutrition. Brazil.

This study was developed to reduce the number of varieties through selection. Trials were carried out at IPEAN headquarters in Belem, Brazil. The best yielding being cultivated for culinary purposes were Mameluca, Jumara, Hamburguesa and Pretinha. Best starch varieties were Mameluca, Jurara, Itauba, Bubao, Cahimbo, Tataruaia, Hamburguesa and Pretinha. It is recommended that no more than 3 or 4 varieties be used. Results suggest an increase of 2 ton| ha may be expected with proper selection of varieties and technical assistance *(Summary by J.L.S.)* D03

0541-0639 MACHADO, E. L. **Comportamento de almas variedades (e cultivares) recebidas em 1969 de diversos Estados da Federação e multiplicadas na Estacão Experimental Fitotecnia de Taquari.** *(Behaviour of some cassava varieties (and cultivars) received in 1969 from various states of Brazil and multiplied at the Estação Experimental Fitotecnia de Taquari). In* Reunião da Comisão Nacional da mandioca, 5a, Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp. 55-58. Port.

Cassava. Cultivars. Cuttings. Tuber productivity. Productivity. Adaptation. Brazil

Data are given on the behavior of the following varieties: cultivar Mameluca (Pr 1); Riqueza (MG 93); Vassorinha SEL-514 (MG 95); Sutinga (B 40); Irace. a (SP 30); Mantiqueira (SP 31); Lagoa (Pb 1); Mico (SC 50); and Engama Ladrao (P 37). Data refer to number of cuttings, initial stand, final stand, stems collected, general aspects, resistance to bacterioses, root weight, yield per plant, weight of 3 kg in water (Reiman's scale) and adaptation. *(Summary by J.L.S.)* D03

0542-2240 ENYI, B.A.C. **The effects of spacing on growth, development and yield of single and multi-shoot plants of cassava** (*Manihot esculenta* Crantz). I. Root tuber yield and attributes. East African Agricultural and Forestry Journal 38(1):23-26. 1972. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Spacing. Growth. Planting. Leaf area. Productivity. Shoots. Cultivation. Tuber productivity. Roots. Tubers. Plant development. Leaves. Tuber development. Kenya.

Single-shoot cassava plants outyielded multishoot plants, the difference increasing with a decrease in spacing distance. Maximum yield of tubers was achieved in the single- and multishoot plants at a spacing of 90 x 90 cm (12,600 plants| ha) and 90 x 120 cm (9,450 plants| ha), respectively; and yield per plant increased with increasing spacing distance. Individual root tuber size and mean bulking rate were greater in single- than in multishoot plants. The single-shoot system and spacing of 90 x 90 cm are recommended in the cultivation of this cassava variety in order to obtain the highest yield of tubers per hectare. The removal of the extra shoots after planting should be carried out soon after emergence. *(Author's summary)* D03 D02

0543-1919 OBIGBESAN, G. O. and AGBOOLA, A. A. **An evaluation of the yield and quality of some Nigerian cassava varieties as affected by age.** Ibadan, Nigeria, University of Ibadan, 1973. 14p. Engl., Sum. Engl., Fr., 19 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Plant development. Growth. Timing. Productivity. Tuber productivity. Fertilizers. Dry matter. Starch content. Composition. N. P. K. HCN content. Field experiments. Research. Nigeria.

Results of field experiments on the influence of age, nitrogen and potash on some varieties of cassava cultivated in the tropical rain forest of western Nigeria indicated that (1) Dry matter and starch content was highest 15 months after planting while cyanogenetic glucoside (HCN) consistently decreased with age. (2) Fresh tuber yield varied between 9-16 tons|acre and was not parallel to dry matter yield. (3) Varieties responded differently to N application; while N increased the HCN and starch content of one particular variety, it reduced the dry matter, starch (slightly) and HCN content of another variety. (4) Increasing levels of potash raised the dry matter yield and improved the starch content, but reduced the HCN only very slightly. *(Author's summary)* D03 C03

0544-1918 SOLORZANO H., A. **Rendimiento comparado de ocho cultivares de yuca (*Manihot esculenta* C.) en Tarapoto.** *(Comparative yield trials of eight cassava (Manihot esculenta C.) cultivars in Tarapoto).* Tarapoto, Perú, Centro Regional de Investigaciones Agropecuarias "El Porvenir", 1973. 9p. Span., Sum. Span., Engl., 8 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* Field experiments. Research. Tuber productivity. Starch productivity. Productivity. Soil fertility. Cultivars. Cultivation. Climatic requirements. Developmental stages. Germination. Flowering. Plant height. Plant development. Peru.

Under dry conditions, 8 cassava cultivars (*Manihot esculenta* C.) were studied in a randomized block experiment to evaluate root and starch yields. The study was carried out at the Regional Center of Agricultural Research "El Porvenir," Tarapoto (Peru) on a fertile, clayish soil. The cultivars Auquina Amarilla and Humisha Blanca obtained the highest yields (19 and 17 metric tons|ha), respectively, after 8 months of growth. There was no significant difference in the yield of these 2 cultivars, but they yielded significantly better than the rest. The Palo Colorado II cultivar produced the highest starch value (14%). *(Author's summary)* D03 C01 D01

0545-2984 DE COCK, R. *et al.* **Diversificación y aumento de la producción agrícola en el Valle del Cibao, República Dominicana. La yuca y la batata en el Valle del Cibao.** *(Diversification and increase of agricultural production in Valle del Cibao, Dominican Republic: cassava and sweet potatoes).* Santiago, Dominican Republic. Organización de las Naciones Unidas para la Agricultura y la alimentación. AGP: DP DOM 69 509. Informe Técnico no. 12. 1974. 34p. Span., Sum. Span., 19 Refs., Illus.

Cassava. Cultivars. Cultivation. Production. Costs. Economics. Maps. Field experiments. Nutritional requirements. Productivity. Timing. Harvesting. Sweet-potatoes. Dominican Republic.

Cassava (*Manihot esculenta* Crantz) is a very important crop; demand for 1975 is estimated at 200,000 to 210,000 metric tons. Demand for sweet potatoes (*Ipomoea batatas* (L) Lam.) is estimated at 95,000 to 98,000 metric tons. In studies of local varieties of cassava, a high degree of phenotypic variability and a great variation in yield for the same variety were observed from region to region. The evaluation of several imported varieties, as compared to local varieties (Hoja Rosa, Sanjuanera and Machetazo) showed that the sweet varieties C-1 and C-6 and the bitter varieties D-1 and C-9 outyielded local varieties. To increase cassava production in a short term, it is recommended to zone the culture and to improve cultural practices, since neither fertilization nor diseases and pests are limiting factors. Production costs for irrigated and nonirrigated cassava per "tarea" (629 m^2) was estimated at RD$ 14.65 and RD$ 12.40, respectively. *(Author's summary. Trans. by J.L.S.)* D03 D02 J00

0546-0362 HUERTAS, A. S. **A study of the yield of cassava as affected by the age of cuttings.** Philippine Agriculturist 28(9):762-770. 1940. Engl., Sum. Engl., 3 Refs.

Cassava. Cuttings. Propagation materials. Tuber productivity. Timing. Starch productivity. Productivity. Philippines.

The percentages of germination from base or old cuttings (nos. 6 to 9) were the highest whereas middle cuttings (nos. 4 to 5, respectively) were next. The lowest percentages of germination were obtained from the young or top cuttings (nos. 1 to 3). The old cuttings gave higher percentages of stand than the young ones. Insignificant differences were found in number of stalks per hill produced by the base, middle and top cuttings. The old cuttings gave significantly higher root yields per hectare than the young cuttings. The medium and old cuttings (groups 3-9) exceeded the younger ones (groups 1-2) in the yield of starch per hecta.e. A significant difference was found between the yields of starch per hectare of the oldest and the youngest cuttings; the percentages of starch obtained from roots harvested from young cuttings were higher. *(Author's summary)* D03

0547-0365 JEYASEELAN, K. N. **Studies in growth and yield of cassava. I. Yield in relation to size and type of set.** Tropical Agriculturist 108(3):168-171. 1951. Engl., 2 Refs.

Cassava. Cuttings. Planting. Productivity. Propagation materials. Economics. Tuber productivity. Growth. Plant development.

This series of trials investigates possible methods of increasing cassava yields economically. The results are given of an experiment involving the type (from apical or basal end of stem) and size (6 or 12 in) of cuttings and the method of planting (horizontal or vertical). Better yields were obtained by using longer, basal cuttings planted vertically. *(Summary by P. A. C.)* D03 C01

0548-2274 CONGO BELGE. INSTITUT NATIONAL POUR L'ETUDE AGRONOMIQUE DU CONGO. **Manioc.** *(Cassava). In*________. Rapport annuel 1955. 13p. Fr.

Cassava. Productivity. Tuber productivity. Clones. Zaire.

Brief notes about research on cassava are given, interspersed with information on other crops. Most data given refer to tuber yields of cassava clones on trial. *(Summary by H.J.S.)* D03

0549-2273 CONGO BELGE. INSTITUT NATIONAL POUR L'ETUDE AGRONOMIQUE DU CONGO. **Manioc.** *(Cassava).* In________. Rapport annuel 1957. pp. 95-96. Fr.

Cassava. Clones. Productivity. Tuber productivity. Zaire.

There are 37 cassava clones at the Institute. Yields gathered from 20 clones on trial range from 30.4 ton| ha to 9.6 ton| ha. *(Summary by H.J.S.)* D03

0550-2264 **ESSAIS DE culture de manioc á Hué.** *(Cassava cultivation trials in Hué).* Bulletin Economique de l'Indochine no. 60:160-161. 1907. Fr.

Cassava. Field experiments. Stems. Tuber productivity. Productivity. Starch productivity. Vietnam.

Field trials carried out with 2 local cassava varieties are described. Data concern height of the stems and weights of stems and tubers. Yields of tuber pulp and starch are also given. *(Summary by H.J.S.)* D03

0551-0854 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. **Cassava.** *In* Annual Report 1952-53. Nairobi, 1954?. Part 2. pp.25-26. Engl.

Cassava. Productivity. Cuttings. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Cultivars. Tuber productivity. Nigeria.

Short reports are presented on three trials in progress: effect of mosaic on yield, variety yields, and length of planting material. Varieties yielded 4,800 to 19,400 lb| acre. Higher yields were gathered using cuttings 12 in long. *(Summary by H. J.S.)* D03 E04

0552-2470 OFORI, C. S. **The effect of ploughing and fertilizer application on yield of cassava,** ***Manihot esculenta*** **Crantz.** Ghana Journal of Agricultural Science 6(1):21-24. 1973. Engl., Sum. Engl., Fr., 11 Refs.

Cassava. ***Manihot esculenta.*** **Cultivation. Ploughing. Fertilizers. Productivity. N. P. K. Ghana.**

Research on the effect of plowing on cassava yield on a sendentary granite-derived soil in a forest area showed significant yield increases when the soil was plowed as compared to the traditional hoe and cutlass cultivation. Deep plowing beyond 30 cm had no advantage over medium plowing of 23 cm. Nitrogen applications significantly increased tuber yield, but the effect of K was not significant. At the level of application in this experiment, P reduced both tuber number and yield. *(Author's summary)* D03 D01

0553-1600 ROGERS, D. J. and APPAN, S. G. **Cassava,** ***Manihot esculenta*** **Crantz, the plant, world production and its importance in world food supply.** *In* Hendershott, C. H. *et al.* A literature review and research recommendations on cassava. Athens, Ga., University of Georgia, 1972. pp.1-14. Engl., 51 Refs.

Cassava. ***Manihot esculenta.*** **Human nutrition. Production. Energy productivity. Productivity. Uses. Food products. Food energy. Ecology. Plant anatomy. Developmental research.**

Cassava is the seventh largest staple food crop in the world. Cassava originated in the new world tropics and was probably first domesticated in the lowlands of southern Mexico, Guatemala and Honduras. World production has increased from 62.5 million metric tons in 1955 to 85.6 million in 1968. The interpretation of actual statistics for cassava is difficult because is still grown largely as a subsistence crop. Cassava is consumed in varying forms as a primary and supplementary food. Cassava starch and flour are used by several food industries for the manufacture of a variety of food preparations. Advantages of cassava as a staple food crop are reviewed. *(Summary by J.L.S.)* D03 H00

0554-2065 BULOW, J. F. W. VON. **Comportamento de variedades de mandioca** ***(Manihot esculenta)*** **na baixada fluminense durante os anos de 1966 a 1970.** *(Evaluation of cassava varieties (Manihot esculenta) in the Baixada Fluminense from 1966 to 1970).* Pesquisa Agropecuaria Brasileira. Série Agronomia 6:209-213. 1971. Port., Sum. Engl., Port., 6 Refs.

Cassava. Uses. Forage. Harvesting. Production. Cultivars. ***Glomerella cingulata.*** **Mycoses. Diseases and pathogens. Cultivation. Timing. Productivity. Field experiments. Pests. Brazil.**

Cassava varieties, considered good for direct human consumption (nontoxic) and varieties considered good for industrialization (toxic) or for direct animal feeding (nontoxic), were tested from crop year, 1966-67 to 1969-70. Results reported are from 3 regions within the Baixada Fluminense: Paracambi, RJ, 2 experiments; Itaquai, RJ, 5 experiments; and Santa Cruz, GB, 2 experiments. A total of 33 varieties were tested. One trial of the industrial and forage varieties was planted in a split plot design for harvesting after 1 cycle (11 months) and after 2 cycles (22 months). The variety Saracura was the most productive in 4 of the 5 experiments of varieties for direct human consumption. Saracura and Dourado at the Santa Cruz location were less susceptible to anthracnose (*Colletotrichum gloesporioides* f. sp. *Manihotis*). Of the industrial varieties, Grelo Roxo was in the most productive group in all 4 experiments in which it was included. Variety Mantiqueira (IAC 24-2) was in the first group in 3 and the variety Uvar in 2 of the 4 experiments in which it was entered. In alluvial clay soil of the lowlands and with a complete cutting of aboveground plant parts after the first cycle, there was no significant production difference between the 2 cycles, and no significant interaction effect was observed. *(Author's summary)* D03 E03

0555-0369 LAMBOURNE, J. **Tapioca varietal trials.** Malayan Agricultural Journal 25(3):107-112. 1937. Engl., Sum. Engl., 3 Refs.

Cassava. Research. Field experiments. Productivity. Tuber productivity. Cultivars. Toxicity. Uses.

Two yield trials with the cassava varieties in the collection at the Central Experiment Station, Serdang, were carried out to eliminate all but the 10 best-yielding varieties. It is shown that there is a wide difference in yield of roots among varieties grown under similar conditions and that by making use of these high-yielding varieties, the planter may be able to increase considerably his output per acre. The high-yielding varieties which contain a comparatively high percentage of the toxic principle are largely used in Java for the manufacture of tapioca and a certain amount of dried "hampas" is exported chiefly to Europe and sold as feed for stock. In Malaya where "hampas" is used in the moist state direct from the factory, the question of toxicity and palatability needs to be investigated. It is emphasized that cassava roots should be freshly dug, peeled and boiled before eating, since even those varieties with a low toxic content are liable to be poisonous if allowed to become stale before cooking. *(Author's summary)* D03

0556-3639 AHMAD, M. I. **Potential fodder and tuber yields of two varieties of tapioca.** Malaysian Agricultural Journal 49(2):166-174. 1973. Engl., Sum. Engl., 12 Refs.

Cassava. ***Manihot esculenta.*** **Field experiments. Nutritional requirements. Fertilizers. N. P. K. Experiment design. Minerals. Analysis. Leaves. Plant physiology. Growth. Tuber productivity. Productivity. Pruning. Composition. HCN content. Costs. Economics. Forage. Animal nutrition. Malaysia.**

A split-plot factorial experiment using two cassava varieties (Medan and Black Twig) was conducted to assess leaf and tuber production with different fertilizer mixtures and under different cutting treatments. Successive leaf harvest yielded an average of 21.8 metric tons of fresh fodder per year from Medan and 34.2 tons from Black Twig. Tuber losses as a result of leaf harvests gave a mean of 18.4 tons| ha with Medan and 23.1 tons| ha with Black Twig. An analysis of costs and returns showed that Black Twig was superior to Medan for the dual purpose of tuber and fodder production. The cost of producing Black Twig variety cassava fodder (in terms of tuber losses as a result of leaf harvests) was found to be 1.5 cents| kg of fresh fodder. The study suggests that there are good prospects for cultivating cassava for tuber as well as fodder production in situations where such an enterprise could be conveniently integrated with animal production. *(Author's summary)* D03 H03

0557-0662 COLOMBIA. MINISTERIO DE AGRICULTURA. **Yuca.** *(Cassava). In* Programa de fomento agropecuario para 1971. Bogotá, 1971. pp.88-90. Span.

Cassava. Productivity. Cassava programs. Tuber productivity. Development. Colombia.

A program is presented for the increase of cassava production in Colombia. The goal is an average tuber yield of 10 tons| ha and a total national production of 1,250,000 tons. *(Summary by H.J.S.)* D03

0558-0732 VRIES, C. A. DE, FERWERDA, J. D. and FLACH, M. **Choice of food crops in relation to actual and potential production in the tropics.** Netherlands Journal of Agricultural Science 15:241-248. 1967. Engl., Sum. Engl., 19 Refs., Illus.

Cassava. Cereals. Starch crops. Rice. Colocasia. Productivity. Maize. Sorghums. Sweet potatoes. Bananas. Food energy.

In view of the urgent need to increase food production more rapidly, an investigation was made to determine which tropical and subtropical root and grain crops give the highest production per unit of surface and of time. Average world productions are compared to maximum productions obtained in certain experimental stations in the tropics. Production is also related to edible as well as total dry matter. Root crops are thought to contain less proteins than grain crops. To determine food quality, however, the composition of energetic food value was calculated per 100 calories edible portion. Thus differences in protein content between root and grain crops are considerably smaller. Grain crops store better. Most root crops have edible leaves with considerable protein content; this is especially important in the case of cassava. Grain crops (especially rice and maize) are close to potential yields, whereas root crops show more promise. More attention in breeding and selection should be given to root crops as regards higher production and higher protein content;

cultivation practices should also be improved. Sweet potatoes and cassava already compare favorably with most grain crops. Provided climatic conditions are right and there are no storage and transportation problems root crops are to be preferred to grain crops. *(Summary by T.M.)* D03 H00

0559-3454 HENDRIKS, J. A. H. **Opbrengsten van acht cassave varieteiten.** *(Yields of eight cassava varieties).* Surinaamse Landbouw 1(2):84-86. 1953. Dutch.

Cassava. Productivity. Field experiments. Soil fertility. Fertilizers. Cultivars. Surinam.

An outline is given of experiments with cassava in Surinam. With the aid of fertilizers and soil treatment yields from sweet varieties ranged from 35-40 tons| ha. *(Summary by Tropical Abstracts)* D03.

0560-3302 **LE MANIOC dans la Péninsule malaise.** *(Cassava in the Malaysian Peninsula).* Bulletin Economique de l'Indochine no. 26:446-447. 1900. Fr.

Cassava. Productivity. Tuber productivity. Starch productivity. Malaysia.

Brief notes are given on cassava yields. Reported tuber yields varied from 22 ton| ha in the province of Wellesley (Malaya) to a maximum of 75 ton| ha in Florida (USA). Starch yields varied from 16% to a maximum of 39%. *(Summary by H.J.S.)* D03

0561-3285 MATTOS, P. L. P. DE. **Melhoramento da mandioca,** *Manihot esculenta* **Crantz; Competição de variedades de mandioca para produção de masa verde.** *(Cassava, Manihot esculenta Crantz, breeding; competition of cassava varieties for the production of green matter).* Brasil. Instituto de Pesquisas e Experimentação Agropecuarias do Leste. Comunicado Tecnico no. 56. 1972. 5p. Port.

Cassava. Dry matter. Composition. Productivity. Leaves. Stems. Cultivars. Brazil.

Five cassava varieties were tested to compare their production of green and dry matter. Plants were cut at 15 cm from the ground every 4 mo. Average yields of green matter varied from 14.5 ton| ha to 24.5 ton| ha; average yields of dry matter varied from 2.64 ton| ha to 5.20 ton| ha. *(Summary by H.J.S.)* D03

0562-3341 ESTEVAO, E. DE M. *et al.* **Produção de raizes e de ramas e relação entre caracteres da parte aérea e produção de raizes, em variedades de mandioca.** *(Tuber and branch production and relation between characteristics of the aerial part and the production of roots in cassava varieties).* Revista Ceres 19(105):311-327. 1972. Port., Sum. Port., Engl., 17 Refs., Illus.

Cassava. Foliage. Tubers. Productivity. Stems. Cultivars. Tuber productivity. Plant anatomy. Harvesting. Cultivation. Brazil.

Ten cassava varieties were studied in Viçosa during the growing seasons of 1966-67 and 1967-68. Root yield and fresh weight of the aerial parts of the plants were determined. The relationship between some plant aerial characteristics and root yield at harvest were also calculated. The 10 varieties performed differently in relation to top fresh weight and root yield and were separated into two groups according to their root yield level and aerial fresh weight. Root yield increased with the increase of aerial fresh weight. There was no correlation between root yield and each of the following characters: plant height, height of the first branch and stem diameter. *(Author's summary)* D03

0563-3310 SANTOS, R. B. **Yield of cassava under different methods of land preparation.** Agricultural and Industrial Life 29(7):22, 26. 1967. Engl.

Cassava. Cultivation. Germination. Productivity. Land preparation. Developmental stages. Field experiments. Plant development. Tuber productivity.

The percentage of germination and yields of cassava were significantly influenced by the method of land preparation. The ordinary method, consisting of harrowing-plowing-harrowing and making furrows prior to planting, gave the highest percentage of germination and the highest yields (17.6 tons| ha). The harrowing-plowing-planting treatment followed (14.93 tons| ha). Next were the plowing-planting and the harrowing-punching hole treatments, yielding 12.53 and 10.60 tons| ha, respectively. *(Author's summary)* D03 D02

0564-3433 OPUTA, C. O. and WATERWORTH, J. V. **Cassava variety trials (1964).** Nigeria. Ministry of Agriculture and Natural Resources. Midwest Region. Experiment Report no. 72. 1967. 3p. Engl., Sum. Engl.

Cassava. Cultivars. Field experiments. Productivity. Nigeria.

The series of cassava variety trials, begun at Ilele and Obior in 1960, were continued with modifications in 1964. At Ilele, an introduced variety (60471) significantly outyielded the local variety by 2 tons (27%); it was recommended that multiplication of this variety be begun. Although 60444 appeared promising for the forest area (Obior), a change was not yet recommended because 53101 has given comparable yields. At Effurun the two most promising high-yielding local varieties, Oyibo (Aboh) and Ovwierekovwe, yielded 30% and 23% more, respectively, than the highest yielding introduced variety. Further trials with these varieties are recommended. *(Author's summary)* D03

0565-2137 COUSINS, H. H. **Cassava trials. III. Final results of tests of 23 varieties.** Bulletin of the Department of Agriculture, Jamaica 4:73-76. 1906. Engl., Sum. Engl.

Cassava. Cultivars. Productivity. Starch productivity. Jamaica.

Under conditions obtained at the Hope Experimental Station (Jamaica) and without irrigation, yields were recorded of 10 1|2 tons tubers at 12 months, 15 1|2 tons at 15 months and nearly 22 tons tubers| acre at 21 months. The indicated yield of starch| acre rose from 3 1|2 tons at 12 months, to 5 1|2 tons at 15 months and 7 1|4 tons starch at 21 months. Studies of costs indicate that cassava starch could entirely replace potato starch in the British market. Cassava can give large yields on a soil and with a rainfall that would not give good crops of sugar cane without irrigation. Large areas of land, at present producing little or nothing, could be profitably used for the growth of cassava for starch manufacture. This is an industry that can be confidently recommended to capitalists and land owners as one of the most promising means of increasing our exportable produce without trenching upon land at present producing other paying crops. *(Author's summary)* D03

0566-3491 REYNVAAN, J. **Cassave varieteiten.** *(Cassava varieties).* **Landbouw Nieuws (Suriname) 1954:5-7. March 1954. Dutch.**

Cassava. Cultivars. Productivity. Surinam.

A description is given of some cassava varieties from Surinam and some varieties (Valenca and Mangi) introduced from Indonesia, which are higher yielding. *(Summary by Tropical Abstracts)* D03

0567-0516 ENYI, B. A. C. **Cassava varietal assessment.** Tropical Root and Tuber Crops Newsletter no. 5:7-11. 1972. Engl., 4 Refs.

Cassava. ***Manihot esculenta.*** **Cultivars. Cultivation. Tuber productivity. Spacing. Productivity. Resistance. Tanzania.**

In Tanzania, 4 cassava *(Manihot esculenta)* varieties were planted at 3 different spacings. The percentage of plants showing symptoms of the mosaic virus disease 72 days after planting was highest in the var. Liongo (45.4) and Aipin Valenca (10.7) and lowest in Msitu Zanzibar (6.1) and Amani 4026| 16 (4.0). The root yields (kg| ha) were 63,420; 62,540; 56,635 and 39,605 for Liongo, Aipin Valenca, Msitu Zanzibar and Amani

40⅄ ' 16, respectively. There were no significant differences between yields of the first 2 varieties, and both varieties significantly outyielded the last ones. Msitu Zanzibar significantly outyielded Amani 4026| 16. On the average, the highest root yield was obtained at a spacing of 90 x 90 cm, followed by 90 x 120 and 90 x 60 cm spacings. The leaf area index, stem| root ratio and plant heights are also discussed. *(Summary by Tropical Abstracts)* D03

0568-3284 MATOS, P.L.P. DE., MENDEZ, L.G. and AZEVEDO, J.T. DE. **Processos de cultivo em mandioca,** *Manihot esculenta* **Crantz.** *(Cassava, Manihot esculenta Crantz, cultivation process).* Brasil. Instituto de Pesquisas e Experimentação Agropecuarias do Leste. Comunicado Tecnico no. 51. 1972. 7p. Port.

Cassava. Production. Pruning. Cultivation. Economics. Productivity. Tubers. Tuber productivity. Starch productivity. Costs. Prices. Production. Brazil.

Experiments were carried out to determine which of 2 cassava varieties (one early- and one late-maturing) could be produced more economically. The late-maturing variety gave the highest root and starch yields. A cost analysis is made. *(Summary by H.J.S.)* D03 J00.

0569-3282 **ESTADISTICAS DE producción en Brazil.** *(Statistics of production in Brazil).* Palmira, Colombia, Centro Internacional de Agricultura Tropical, 1973. 4p. Span.

Cassava. Production. Productivity. Prices. Economics. Brazil.

Statistical data are given on cassava, rice, common beans, corn, cotton and sugar cane production in Brazil from 1969-70. A total of 2,029,373 ha were planted to cassava, yielding 30,073,943 tons. Data are broken down for 8 states. *(Summary by H.J.S.)* D03 J00

0570-1843 **RAICES COMESTIBLES.** *(Edible roots). In* El Salvador. Centro Nacional de Agronomía. Progreso técnico de la agricultura durante 1950. San Salvador, 1950. pp.70-71. Span.

Cassava. Cuttings. Plant-growth substances. Productivity. Propagation. Rooting. El Salvador.

Previous experiments have shown a better root yield from planting 10-in cassava cuttings at a slanted angle and applying hormones. In this test, 40 cuttings were planted, 20 of which were treated and 20 controls. There was 40% rooting, development was normal and vigorous, and no difference was found between the treatments. Four varieties of cassava were introduced: Amarilla, EPC No. 3, Bayuna and Nativa. Amarilla had a lower percentage of germination, making it necessary to replant some cuttings. *(Summary by L.C. Trans. by T.M.)* D03 C01

0571-3192 ARISMENDI, L. G. **Evaluación del rendimiento de 15 clones de yuca dulce y de diez clones de yuca amarga en la Sabana de Jusepin Venezuela** . *(Yield evaluation of 15 clones of sweet cassava and 10 clones of bitter cassava in the Jusepin Savanna Venezuela).* Tropical Root and Tuber Crops Newsletter no. 6:16-23. 1972. Span., Sum. Span., 16 Refs.

Cassava. Clones. Field experiments. Tuber productivity. Research. Cultivation. Sweet cassava. Bitter cassava. Soil fertility. Savannas. Productivity. Venezuela.

At the Universidad de Oriente in Jusepin (Venezuela), an experiment was carried out to determine the root yield of the following clones of sweet cassavas: Ceiba Llanera, Canaria, Pan de Pobre, Pata de Negro, Mantequilla, Algodoncilla, Caureña, Paveta, Samura, Corcovada, Pata de Pipe, Cogollo Rosada, Cubana, Catira y Cogollo de Ceiba. Root yield was also determined for the following bitter cassava clones: Querepa, Juliana, José María, Piñona, Teta de Indio, Lancetilla, Mulata, Catira, Muerteña and Bonifacia. *(Author's summary)* D03

0572-4754 IDUSOGIE, E. O. and OLAYIDE, S. O. **Role of roots and tubers in Nigerian nutrition and agricultural development.** Acora, Ghana, FAO Regional Office for Africa. 1973. 23p. Engl. Sum. Engl., 17 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* **Production. Energy productivity. Tuber productivity. Human nutrition. Developmental research. Nigeria.**

Many agree that the widespread incidence of protein calorie malnutrition in developing countries today is mostly the result of an inadequate quantity of food and the critical factor is energy intake and not protein. Therefore, one of the most practical means of combating hunger and malnutrition in a developing country like Nigeria would be to increase the production and consumption of local root and tuber staples such as cassava, yams, cocoyams and sweet potatoes, which are rich in energy and also furnish very high amounts of energy per unit of land. Root and tuber crops are also in demand in neighboring West African countries and overseas, both for food and industrial uses and they could therefore become good sources of foreign exchange earnings. There is, therefore, a compelling need to give greater prominence to root and tuber crop development in national agricultural planning to meet both the nutritional and socioeconomic needs of the people and the nation. *(Author's summary)* D03 H01

0573-3210 CORREA, H. *et al.* **Efeito da poda de ramas de mandioca na produção de ramas e raizes.** *(Effect of pruning on cassava stem and root production).* Revista Ceres 20(109):148-157. 1973. Port., Sum. Port., Engl., 13 Refs.

Cassava. Cultivation. Pruning. Stems. Tuber productivity. Production. Rainfall data. Timing. Productivity.

The effect of pruning stems on cassava root production was studied at the Instituto de Pesquisa Agropecuaria de Centro-Oeste, Sete Lagos, Minas Gerais (Brazil) during 1969-70 and 1970-71. Pruning was begun 6 months after planting and was repeated at 3 monthly intervals for 18 months. Cutting stems at 6, 9, and 12 months significantly decreased root production by 57.2, 56.3 and 47.4%, respectively. Pruning at 15 months had no effect on root production but gave the only significant increase in stem production, averaging over 47 tons| ha. *(Author's summary)* D03 D02

0574-3213 VASCONCELOS, D. DE M. **Competição de variedades de mandioca.** *(An evaluation of cassava varieties).* Boletim da Secretaria de Agricultura, Industria e Comercio, Pernambuco 6:164-173. 1940. Port., Illus.

Cassava. Productivity. Cultivars. Field experiments. Research. Tuber productivity. Brazil.

A field experiment was carried out to test the root yields of 7 cassava varieties. Statistical analyses of the results are presented, as well as explanations on the statistical parameters (variance) measured. *(Summary by H.J.S.)* D03

0575-0492 DIAZ D., R. O. comp. **Estadísticas sobre producción de yuca en Colombia.** *(Statistical data on cassava production in Colombia).* Cali, Centro Internacional de Agricultura Tropical, 1970. 15p. Span., 5 Refs.

Cassava. Production. Productivity. Colombia.

A compilation is presented of the area planted to cassava, production and yields in Colombia between 1960 and 1969. *(Summary by H.J.S.)* D03

0576-0036 BUCHANDA, V. **How to step up cassava yield .** Kasikorn 37(5):415-419. 1964. Thai., Sum. Engl.

Cassava. *Manihot esculenta.* **Cultivation. Productivity. Thailand.**

Cassava has been cultivated in Thailand for many centuries. Since prices of cassava products have increased a great deal in the last few years, more and more farmers are growing cassava. As a result of growing cassava year after year, yields have gradually decreased: To improve yield the following steps are recommended: (1) use better varieties with characteristics adapted to the region and with resistance to disease and insect pests; (2) prepare good seed beds; (3) plant at the proper time, correct spacing, with food weed control; (4) apply fertilizers either in organic or inorganic form; (5) control disease and insect pests. *(Author's summary)* D03.

See also *0005 0056 0080 0095 0097 0098 0105 0106 0108 0140 0243 0252 0268 0287 0310 0352 0354 0355 0358 0359 0361 0362 0365 0373 0391 0393 0403 0405 0407 0416 0431 0432 0448 0460 0464 0467 0470 0471 0473 0493 0500 0503 0506 0518 0520 0522 0726 0772 0918 0919 0927 0933 0961 1843 1854*

E00 PLANT PATHOLOGY

0577-3200 HANSFROD, C.G. **Plant diseases: cassava.** *In* Uganda. Department of Agriculture. Annual report of the plant pathologist 1936. Kampala, Uganda, 1937. pp. 47-49. Engl.

Cassava. Diseases and pathogens. Pests. Bacterioses. ***Erwinia cassavae.*** **Mycoses. Uganda.**

A bacterial leaf spot and stem disease was found at Bukalasa. The causal bacterium was isolated and inoculated into young shoots of cassava cuttings, on which it reproduced the disease. The bacterium was identified as *Bacterium cassavae* Hansford. A wilt disease of cassava due to *Verticillium dahliae* is described in connection with cotton wilt. The fungus penetrates all parts of infected plants, including the tubers, in which a dry rot occurs. The rest of the plant pathology chapter is devoted to cotton, tobacco, sugar cane and beans. *(Summary by J.L.S.)* E00 E02 E03

0578-2183 BOURIQUET, G. **Les maladies du manioc a Madagascar.** *(Cassava diseases in Madagascar).* Bulletin Economique de Madagascar no. 65:72-75. 1932. Fr., 4 Refs.

Cassava. ***Cercospora henningsii. Gloeosporium manihotis.*** **Viroses. Disease control. Diseases and pathogens. Pests. Cassava mosaic virus. Mycoses. Analysis. Etiology. Virus transmission. Malagasy Republic.**

Historical notes, data about symptoms, transmission and evolution, damage and control of a mosaic disease are given. Brief notes on *Cercospora henningsii, Gloeosporium manihotis* and of a root-rotting disease are also given. *(Summary by H.J.S.)* E00

0579-2460 AMARAL, J. F. DO. **Principais doenças das plantas cultivadas no Estado de São Paulo e seus respectivos tratamentos.** *(The main diseases of plants cultivated in the state of São Paulo and their respective treatments).* Biologico 17:179-188. 1951. Port.

Cassava. Cereals. Starch crops. Diseases and pathogens. Vegetable crops. Pests. Disease control. Cassava common mosaic virus. Viroses. Bacterioses. ***Xanthomonas manihotis.*** **Brazil.**

Control methods are briefly described for 130 diseases and pests attacking 44 crops in the state of São Paulo (Brazil). For cassava, two diseases are reported: bacteriosis, caused by *Xanthomonas manihotis*, can be controlled by crop rotation and utilization of resistant varieties. Witches'-broom disease can be controlled by burning the plants and taking sanitary measures to select healthy cuttings for planting. *(Summary by H.J.S.)* E00

0580-2489 DRUMMOND-GONÇALVES, R. and AMARAL, J. F. DO. **Doenças das plantas.** *(Plant diseases).* O Biológico 7:360-361. 1941. Port.

Cassava. Diseases and pathogens. Disease cotrol. Pests. Pest control. Inter-cropping. Mycoses. Brazil.

Answer is given to a question on control of rhizotoniosis (**Rhizoctonia** sp.) in cassava and root rot *(Diplodia natalensis)* in the tung tree ("tungue") which was interplanted with cassava. Advice is to burn the plants affected and not to intercrop. Cassava needs the soil to be plowed which could destroy the permanent roots of the tung tree or allow **Diplodia** to attack the plants. *(Summary by H.J.S.)* E00

0581-3384 CRANDALL, B. S., ABREGO, L. and PATIÑO, B. **A check list of the diseases of economical plants of El Salvador, Central America.** Plant Disease Reporter 35(12):545-554. 1951. Engl.

Cassava. *Cercospora henningsii.* **Diseases and pathogens. Pests. Mycoses. El Salvador.**

Causal agents of diseases affecting 130 economic plants are listed. For cassava the following organisms are listed: *Cercospora henningsii* (leaf spot), *Oidium manihotis* (powdery mildew), **Phyllosticta** sp. (leaf spot) and a virus (mottling). *(Summary by H.J.S.)* E00

0582-3099 MULLER, A. S. **Brazil: preliminary list of diseases of plants in the state of Minas Gerais.** International Bulletin of Plant Protection 8(9):193-198. 1934. Engl.

Cassava. Diseases and pathogens. Pests. Mycoses. Viroses. Brazil.

Diseases of 83 plants are listed, including 25 field crops, 30 vegetable crops and 28 fruit trees and other plants. For **Manihot** spp. the following diseases are listed: *Cercospora caribaea, C. henningsii, Oidium manihotis, Thizopus nigricans* and mosaic virus. *(Summary by H.J.S.)* E00

0583-0238 WOLF, F. A. and LLOYD, F. E. **Oedema on Manihot.** Phytopathology 2(4):131-134. 1912. Engl., 12 Refs., Illus.

Cassava. *Manihot glaziovii.* **Manihot. Diseases and pathogens. Pests. Leaves.**

Edema or intumescences have been observed in leaves, stems or trunks of various plants. A disease condition similar to edema appeared on some **Manihot** species (Ceara) growing in greenhouses in Alabama. External signals are described as well as cytophysiological characteristics of the phenomena. *(Summary by H.J.S.)* E00

0584-2493 HANSFORD, C. G. **Uganda plant diseases.** East African Agricultural Journal 10:147-151. 1945. Engl.

Cassava. Diseases and pathogens. Pests. Viroses. Mosaic diseases. Mycoses. Bacterioses. Uganda.

Brief notes are given on 6 cassava diseases: mosaic disease, fungal leaf spot *(Cercospora henningsii)*, bacterial leaf spot *(Bacterium cassavae)*, wilt disease *(Verticillium dahliae)*, tuber rot *(Armillaria mellea)*, tuber disease (probably **Helicobasidium** sp.). Data given refer to symptoms, resistance and economic importance. *(Summary by H.J.S.)* E00

0585-3073 BUYCKX, E. J. E. **Les ennemis des plantes amylacées. Maladies et insectes nuisibles du manioc,** *Manihot utilissima* **Pohl.** *(The enemies of starch crops; cassava, Manihot utilissima Pohl., diseases and injurious insects).* *In* Brussels. Institut National pour l'Etude Agronomique du Congo; Précis des maladies et des insectes nuisibles rencontrés sur les plantes cultivées au Congo, au Rwanda et au Burundi. Bruxelles, 1962. pp.471-480. Fr., 7 Refs., Illus.

Cassava. Diseases and pathogens. Mycoses. Bacterioses. Pests. *Phytophthora dreschsleri.* **Entomology.** *Cercospora caribaea.* **Bemisia. Phytophthora. Injurious insects.**

Symptoms and control methods are given for the following cassava diseases and pests: translucent angular spots on the leaves *(Bacterium cassavae)*; small white spots on leaves *(Cercospora caribaea)*; angular brown, well-defined spots on leaves, stems uninjured *(Cercospora henningsii)*; spotlike with canker on the stems and petioles *(Glomerella manihotis)*; yellow, mosaic zones on the blade and leaf distortion; presence of small, whitish, motile insects on leaves (**Bemisia** spp.); cankers on the stems and petioles *(Glomerella manihotis)*; presence of superficial white rhyzomorphs that become orange in the light *(Fomes lignosus)*; presence of blackish stromata and whitish mycelia on the root peels *(Amarillariella mellea)*; lack of characteristic rhyzomorphs on the root peels, but the rotten tissues become blackish gray *(Phytophthora cryptogea). (Summary by H.J.S.)* E00 F01

0586-3066 DRUMMOND, O. DE A. **Da etiologia das rajas pretas das raizes da mandioca:** *(Etiology of brown streaks in cassava roots). In* Congreso Nacional da Sociedade Botanica do Brasil, 4, Recife, 1953. Anais. Recife, Brasil, 1953. pp.57-60. Port., Sum. Engl., Illus.

Cassava. ***Manihot esculenta.*** **Roots. Deterioration. Diseases and pathogens. Pests. Etiology.**

The author describes the type of spoilage of the cassava roots, (*Manihot utilissima* Pohl, *M. aipi* Pohl) characterized by radial black stripes. These stripes occur after the roots are dug from the soil. It was found that they were due to a process of oxidation, starting from the surrounding walls of the parenchymatic cells and xylem vessels or from the thin layer of cytoplasm nearby. The lack of air around the roots is enough to avoid the process. *(Author's summary)* E00

0587-2004 ALBERTO, J. **A mandioca. II. Doenças, pragas e animais selvagens.** *(Cassava. II. Diseases, pests and wild animals).* Gazeta Agrícola de Angola 2(1):504-506. 1957. Port.

Also available in English, translated by Tropical Products Institute.

Cassava. Diseases and pathogens. Pests. Injurious insects. Noxious animals. Cassava mosaic virus. Cassava flour. Cassava meal. Storage. Viroses. Mycoses. Disease control. Pest control. Angola.

The principal diseases and pests of cassava are briefly described: (1) Chestnut root rot. The pulpy part of the mature root becomes hard, turning chestnut colored, without symptoms on the aboveground parts of the plant. Control is by burning. (2) Black rot. This is also a fungus disease, occurring after mechanical damage to the roots. (3) Yellow rot. Mature plants are infested, the whole root system rots, and the plant falls over. This is possibly associated with excessive moisture. (4) Mosaic. This disease is very widespread, attacking nearly all varieties although there are some that are resistant. (5) Crickets. The adults penetrate the plant near the base, opening deep galleries to the roots, where they feed. Their location is easily recognized by the mounds of soil they leave; and they should be destroyed by digging along the galleries to find them. They can be crushed or placed in tins containing gasoline or oil. (6) Grain weevils. These insects attack stored flour and meal. (7) Bruchids also destroy dry, stored cassava products; DDT is recommended for control. (8) Further damage is done by buffaloes, antelopes, goats and wild boars; control measures are given. *(Summary by A. van S.)* E00 F01

0588-3079 BERTHET, J. J. A. **Inimigos da mandioca.** *(Enemies of cassava).* Boletim de Agricultura (Brasil) 17:37-38. 1916. Port.

Cassava. Mycoses. Injurious insects. Diseases and pathogens. Noxious animals. Pests. Disease control. Brazil.

Answer is given to a question on the control of a cassava disease. It was found that a **Fusarium** was the causal agent and that a Coleopterus (Curculionidae?) was also present on the samples. It was advised to burn the infested plants and to use healthy and fresh cuttings for planting. *(Summary by H.J.S.)* E00

See also 0244 0272 0898 0930 0942 0962

0589-0839 LEHMAN, P.S. **Insects and diseases of cassava.** *In* Hendershott,C. H. *et al.* A literature review and research recommendations on cassava. Athens, Ga., University of Georgia, 1972. pp.76-9?. Engl., 150 Refs.

Cassava. ***Manihot esculenta.*** **Pests. Diseases and pathogens. Injurious insects. Injurious mites. Noxious animals.** ***Tetranychus telarius. Aonidomytillus albus.*** **Insect control. Pest control. Disease control.** ***Silba pendula. Erinnyis ello. Erinnyis alope.*** **Cassava mosaic virus. Viroses. Mycoplasmoses. Bacterioses.** ***Xanthomonas manihotis.*** **Pseudomonas. Mycoses.** ***Cercospora henningsii. Cercospora caribaea. Glomerella cingulata.*** **Uromyces. Oidium.** ***Fomes lignosus.*** **Rosellinia. Nematodes. Productivity. Resistance. Insecticides.**

It has often been stated that cassava has fewer diseases and insect pests than other crops; nevertheless,it has been found that disease incidence is 5 to 10 times greater in the tropics. Since this poses a greater threat to agricultural production in the tropics, it is imperative that any program designed to increase cassava yields through genetic improvement or altering cultural practices should also be designed to continually evaluate the changes in host susceptibility to disease and insects. A survey of literature (847 references) indicates at least 40 different organisms that affect cassava. Prevalent insect problems, effects on yield and recommended control practices for insect pests are discussed. These same aspects are also dealt with in reference to diseases caused by viruses, mycoplasma, bacteria, fungi and nematodes. An investigation of methods for controlling losses of cassava during storage and marketing is strongly recommended, and some considerations for developing such a program are offered. International cooperation to compare cassava viruses and virus strains found in various countries is needed, as this is a prerequisite for an effective breeding program. Changes in plant breeding, use of fertilizer, and extensive and intensive planting generally increase the vulnerability of cassava, as well as other plants, to disease and insect epidemics. Research is needed to understand if or why cassava is more resistant to certain diseases and insect attack. For example, cassava contains a cyanogenic glucoside that may serve as a chemical defense against some diseases and insects; on the other hand, low HCN content is generally considered by plant breeders to be a desirable characteristic to make cassava safe for both human and animal consumption. When such objectives are adopted in any breeding program, an attempt should be made concurrently to monitor the effect that a decreased HCN content has on host susceptibility, for history clearly indicates that any breeding improvement program that overlooks the natural breeding program of microorganisms and insects is courting disaster. *(Summary by T.M.)* E01 F01

0590-0585 CORREA DE R., M. and ALCONERO, R. **Origen de una enfermedad foliar de la yuca,** ***Manihot esculenta*** **Crantz en Puerto Rico.** *(Etiology of a cassava, Manihot esculenta Crantz,leaf disease in Puerto Rico).* Tropical Root and Tuber Crops Newsletter no. 6:36-37. 1973. Span:

Cassava. Leaves. Pests. Diseases and pathogens. Etiology. Laboratory experiments. Antisera. Analysis. ***Manihot esculenta.*** **Puerto Rico.**

Symptoms of the diseases are similar to mosaic symptoms. The following tests were made: mechanical, graft and mite transmission; electronic microscopy; serology; purification. Mechanical and graft transmission did not produce any virus symptoms. Mites produced symptoms similar to those of mosaic. Serology, purification and microscopic observations gave negative results. It was concluded that symptoms observed previously had been caused by mites, possibly by means of secreted toxins. *(Summary by H.J.S.)* E01

0591-0069 TOLLER, R. W., CUELLAR, R. and FERRER, J. B. **Preliminary survey of plant diseases in the republic of Panama, 1955 - 1958.** Plant Disease Reporter 43(11):1201-1203. 1959. Engl.

Cassava. Pests. Diseases and pathogens. Mycoses. Panama.

This report includes the most important destructive diseases in Panama. The following fungi were recorded in cassava: **Phytophthora** sp., *Cercospora caribaea*, **Gloeosporium** sp. and *Rhizoctonia solani*. *(Summary by J.L.S.)* E01

0592-1542 CONCEIÇÃO, A. J. DA. **Molestias da mandioca (*Manihot esculenta* Crantz).** *(Diseases of cassava).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):31-40. 1973. Port., Sum. Port., Engl., 16 Refs.

Cassava. ***Manihot esculenta.*** **Pests. Diseases and pathogens. Bacterioses.** ***Xanthomonas manihotis.*** **Mycoses.** ***Cercospora caribaea. Cercospora henningsii.*** **Phyllosticta.** ***Uromyces manihotis.*** **Oidium.** ***Sclerotium rolfsii.*** **Rosellinia.** ***Diplodia theobromae.*** **Rhizopus. Viroses. Cassava common mosaic virus. Cassava mosaic virus. Cassava vein mosaic virus. Disease control. Etiology. Brazil.**

The main cassava diseases that occur in Brazil, especially in the northeastern region, are dealt with by the author as regards their etiology, symptomatology and certain control measures (especially quarantine procedures) to avoid the introduction of diseases from outside the region. *(Author's summary)* E01

0593-3136 LOZANO, J.C. and BOOTH, R.H. **Diseases of cassava (*Manihot esculenta* Crantz).** Pans 20(1):30-54. 1974. Engl., Sum. Engl., 125 Refs., Illus.

Also in: Centro Internacional de Agricultura Tropical. Folleto Técnico no. 5 1974. 48p.

Cassava. ***Manihot esculenta.*** **Pests. Diseases and pathogens. Bacterioses.** ***Xanthomonas manihotis.*** **Pseudomonas. Viroses. Cassava mosaic virus. Cassava common mosaic virus. Cassava brown streak virus. Mosaic diseases. Mycoses.** ***Cercospora henningsii. Cercospora caribaea.*** **Phyllosticta.** ***Oidium manihotis.*** **Cassava superelongation.** ***Glomerella cingulata. Phytophthora drechsleri.*** **Rosellinia.** ***Sclerotium rolfsii.*** **Disease control. Etiology.**

The paper reviews literature relating to the major bacterial, viral and fungal diseases of cassava and presents additional information gained by the authors. The importance of these diseases in reducing yields is stressed. However, while a great deal of information is presented on symptoms and the nature of the pathogens, little data is available on control measures. The authors emphasize the need for more active research, in particular to identify and describe sources of disease resistance and find other simple means of disease control. *(Author's summary)* E01

0594-3048 DESLANDES, J. A. **Doenças da mandioca no Nordeste.** *(Cassava diseases from the northeastern region).* Campo (Brazil) 11(11):9-14. 1940. Port., 8 Refs., Illus.

Cassava. Mycoses. Bacterioses. Entomology. Diseases and pathogens. Pests. Viroses. Injurious insects. Noxious animals. Disease control. Pest control. Brazil.

In northeastern Brazil, all types of cassava diseases are locally referred to as "tamanjva". This presents a problem for plant pathologists. Descriptions are given of 8 diseases: bacterioses *(Phytomonas manihotis, Bacillus manihotis)*; wither-tip (**Colletotrichum** sp); leaf spot (**Cercospora** sp. *Helminthosporium manihotis*); root rot (**Diploidia** sp.); cinza or oidio (**Oidium** sp.); mosaic (chlorosis); leaf distortion or but prolife-ation *(Tetranychus tanajoa)*; and root knot nematode *(Heterodera marioni)*. A liana called gold thread *(Cuscuta corymbosa)* is also described. Symptons, causal agents and control methods are also dealt with. *(Summary by H.J.S.)* E01 F00

0595-0393 DRUMMOND—GONCALVES, R. **Bacteriose da mandioca.** *(Bacterioses of cassava).* Biológico 14:145-146. 1948. Port., 5 Refs.

Cassava. Pests. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.* **Disease control. Brazil.**

The bacteria is caused by *Phytomonas manihotis.* To cure it (1) use land that has not been planted with infected yuca for 4-5 years; (2) use only healthy cuttings; (3) use resistant varieties. *(Summary by J.H.C.)* E02

0596-0206 VARON R., F. H. **Enfermedades de la yuca.** *(Diseases of cassava) In* Instituto Colombiano Agropecuario. Curso intensivo del cultivo de yuca. Palmira, Colombia, Centro Nacional de Investigaciones Agropecuarias, 1972. pp.20-29. Span., 4 Refs.

Cassava. Pests. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.* **Mycoses. Rosellinia.** *Phytophthora drechsleri.* **Fusarium.** *Glomerella cingulata. Gloeosporium manihotis.* **Phyllosticta.** *Cercospora henningsii. Cercospora caribaea.* **Nematodes. Noxious animals. Viroses. Cassava common mosaic virus. Cassava mosaic virus. Disease control.**

Symptoms and control measures of the main diseases of cassava are presented. Among these are mentioned bacterial blight, wilting, root rot, anthracnose, leaf spot, powdery mildew, rust, root-knot nematode, common mosaic virus and witches'-broom disease. *(Summary by J.L.S.)* E01

0597-0447 JOHNSTON, A. **Host list of fungi and insects recorded in the South East Asia and Pacific region:** *Colocasia antiquorum,* **Dioscorea spp. and** *Manihot utilissima.* FAO Regional Office for Asia and the Far East. Technical Document no. 33. 1963. 8p. Engl.

Cassava. Pests. Diseases and pathogens. Viroses. Mycoses. Bacterioses. Pests.

A list of fungi and insects (classified by host) found in Southeast Asia and the Pacific region is presented for taro *(Colocasia antiquorum),* yam (**Dioscorea** spp.) and cassava *(Manihot utilissima).* The damage to the host is described. Among those mentioned for cassava are (1) fungi causing leaf spot, black mold, dieback, anthracnose, powdery mildew, wilt, collar and root rot; (2) bacteria causing blight, leaf spot and wilt; (3) mosaic virus; and (4) insects; hemispherical scale, red spider mites and stemborers. *(Summary by P.A.C.)* E01

0598-0553 MONTALDO, A. **Reacción de variedades de yuca** *(Manihot esculenta)* **al rayado marrón de la raíz.** *(Reaction of cassava, Manihot esculenta, varieties to brown streak root disease).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1970. pp. 87-103. Span., Sum. Span., 7 Refs.

Cassava. Temperature. Storage. Tubers. *Manihot esculenta.* **Cultivars. Deterioration. Etiology. Enzymes. Resistance. Diseases and pathogens. Harvesting. Timing. Venezuela.**

A study of the reaction of 68 cassava (*Manihot esculenta* Crantz) varieties to brown streak disease at environmental conditions of 25°C (Maracay, Venezuela) is presented, as well as the reaction of 1 additional variety stored at 0°C, 5°C and 10°C. The brown streak disease, being of possible enzymic nature, occurs in the pulp of cassava roots. In their first stage of development, the roots become ash-blue in color and subsequently turn brown. As a result of this change, the roots cannot be used for culinary and industrial applications. Out of 68 of the total number of varieties studied, 53% were classified as "fairly resistant" to "very resistant." This means that the brown streak disease is not as serious a problem as had been thought. Further information is required in order to know the relation between root size and brown streak disease, since medium and small-size roots appeared to be more sensitive to the disease after being stored for 21 days. *(Summary by J.L.S.)* E01

0599-2006 BURTON, C. L. **Diseases of tropical vegetables on the Chicago market.** Tropical Agriculture (Trinidad) 47(4):303-313. 1970. Engl., Sum. Engl., 11 Refs.

Cassava. Arracaia. Yams. Temperature. Marketing. Diseases and pathogens. Mycoses. Bacterioses. Laboratory experiments. Storage. Pests. *Xanthosoma sagittifolium.* **Sweet-potatoes. Vegetable crops.**

A general study was made of several tropical vegetables that were not found on the Chicago market a few years ago and that have become important in the variety-specialty field. A 2-year survey showed extensive losses due to decay. Ten microorganisms were found attacking cassava; among them were **Diplodia** sp., **Fusarium** sp., **Penicillium** sp. and **Phomopsis** sp. Inoculation studies with isolates on parent commodities at 13-29°C demonstrated a range of pathogenicity and identified those organisms most liley to cause losses during transit and marketing. Certain chemical treatments (SOPP + DCNA, SOPP + DCNA and hot wax and chlorine solution and hot wax) applied in Chicago somewhat reduced decay, but not sufficiently to recommend them for use at the terminal market. The studies showed that control of decay must be initiated prior to shipping. The first step that should be taken to obtain disease-free produce is to establish a system of standardization and inspection at the shipping point. Careful handling at harvest to avoid cuts and bruises, the possible curing of certain commodities to heal wounds before shipping, and holding produce at low, but not chilling temperatures should also contribute considerably to the improvement of quality and disease control during transit and marketing. *(Summary by T.M.)* E01

0600-2270 GOLATO, C. **Casi fitopatologici osservati in Ghana.** *(Plant pathology cases observed in Ghana).* Rivista di Agricoltura Subtropicale e Tropicale 63:139-174. 1969. Ital., 16 Refs., Illus.

Cassava. Diseases and pathogens. *Cercospora henningsii.* **Pests. Mycoses. Viroses. Cassava mosaic virus. Cassava brown streak virus. Ghana.**

Three cassava diseases are described: cassava mosaic virus, brown streak virus and leaf spot *(Cercospora henningsii).* The rest of the paper refers to diseases on cacao, bananas, **Phaseolus** sp., *Citrus sinensis,* coffee, cotton, peanuts, *Hevea brasiliensis,* sugar cane and two palms. *(Summary by H.J.S.)* E01

0601-3111 GALL, F. *et al.* **Doenças da mandioca,** *Manihot utilissima* **Pohl.** *(Cassava diseases, Manihot utilissima Pohl). In* __________. Manual de Fitopatologia. São Paulo, Agronomia Ceres, 1968. pp.298-305. Port.

Cassava. Diseases and pathogens. Pests. *Xanthomonas manihotis.* **Bacterioses. Viroses.** *Cercospora henningsii. Cercospora caribaea.* **Cassava common mosaic virus. Cassava mosaic virus. Etiology. Disease control.** *Sclerotium rolfsii.* **Oidium. Phyllosticta. Brazil.**

Nine cassava diseases are described.Causal agents are *Xanthomonas manihotis, Cercospora henningsii, C. caribaea, Oidium manihotis, Sclerotium rolfsii, Phyllosticta manihotis;*witches'-broom disease, cassava common mosaic and cassava nerve mosaic are caused by viruses. Data given concerns general aspects, symptoms, etiology and control. *(Summary by H.J.S.)* E01

0602-3017 REINKING, O. **Philippine plant diseases.** Phytopathology 9:114-140. 1919. Engl.

Cassava. Diseases and pathogens. Pests. Mycoses. Ceara rubber. *Cercospora henningsii.* **Philippines.**

At least 10% of the crops are destroyed by fungi in the province of Laguna.Factors contributing to the spread and destructiveness of various pathogens are the lack of proper cultivation methods, sanitary controls, pruning and spraying. Diseases affecting 45 species are briefly described. Information given for **Manihot** spp. is the following: (1) *Manihot dichotoma* (sic), ceara rubber. Rubber trees are not grown commercially on the Island of Luzon, consequently little work has been done with diseases affecting them. However, *Phyllosticta manihoticola* Syd, is a common leaf spot of ceara rubber trees and may sometimes cause severe damage. (2) *Manihot utilissima,* cassava or camoting cahoy *Cercospora henningsii* Allesch. is present on cassava, but not abundant enough to cause any great damage. Diseased spots are irregularly circular in shape and brown. Other fungi found on dead and dying branches of cassava are *Diplodia manihoti* Sacc., *Guignardia manihoti* Sacc. and *Colletotrichum lussoniense* Sacc. *(Summary by H.J.S.)* E01

0603-2421 BARAT, H. *et al.* **La pourriture du coeur du manioc.** *(The rotting of the core of the cassava root).* Institut de Recherches Agronomiques de Madagascar, Bulletin no. 3:79-80. 1959. Fr., Illus.

Cassava. Tubers. Deterioration. Plant physiology. Malagasy Republic.

A description is given of the disease, which is not caused by **Fusarium** or **Diplodia.** The author believes that the rotting has a physiological origin, connected with some kind of deficiency. The Agronomy Station of Lake Alaotra will carry out research on this subject. *(Summary by H.J.S.)* E01

0604-3436 **DISEASES OF CASSAVA.** East African Agricultural Journal 10:149-150. 1945. Engl.

Cassava. Diseases and pathogens. Cultivars. Cassava mosaic virus. Pests. Bacterioses. Mycoses. Resistance. *Cercospora henningsii.* **Viroses. Uganda.**

Four diseases of cassava in Uganda are briefly described: leaf spot (*Cercospora henningsii* and *Bacterium cassavae),* wilt disease *(Verticillium dahliae),* root rots (*Armillaria mellea* and probably **Helicobasidium** sp) and mosaic disease. Symptoms and distribution data are also given. *(Summary by H.J.S.)* E01

0605-3096 **PODRIDAO NA raiz poe a perder a mandioca.** *(Root rot may cause the loss of the cassava crops).* Dirigente Rural 3(11):24-26. 1964. Port., Illus.

Cassava. Tubers. Diseases and pathogens. Pests. Tubers. Productivity. Deterioration. Brazil.

In an area of 1,200 ha in the state of São Paulo (Brazil), cassava yields were seriously reduced by a dry, odorless rot, which attacked the roots of the plant first and then spread to the stem and leaves. This disease was found mainly in poor, sandy soils. It even attacked the Branca de Santa Catarina variety, widely grown for its good yielding characteristics and tolerance to bacterial disease. Several fungi and bacteria, isolated from the diseased plants, are being examined in order to determine the causal agent. *(Summary by S. S. de S.)* E01

0606-3445 LAL, B. and TANDON, R. N. **Some new leaf spot diseases caused by Colletotrichum.** Proceedings of the National Academy of Sciences of India (Section B) 36(2):223-232. 1966. Engl.

Cassava. Diseases and pathogens. Pests. Mycoses. Leaves. *Manihot esculenta.*

A survey was made of leaf spot diseases, during which the authors found the conidial stages of *G. cingulata* from *A. hetrophylla, B. venusta, C. variegatum.* var. **pictum,** *D. peregrina, D. baraquiniana, H. multiflorus, H. rubra, M. utilissima, P. edulis* and *S. macrophylla; C. capsici* from *G. variegatum* var. **pictum,** *M. utilissima, M. platycladus* and *S. melongena.* and *C. dematium* from *P. aureas* and *P. edulis.* All the pathogens reported are new host records for the country, and the pathogenicity of each has been established. *(Author's summary)* E01

0607-3134 KRUIJFF, E. DE. **Het wortelrot van de cassave.** *(Cassava root rot).* Teysmannia 21:147-149. 1910. Dutch.

Cassava. Diseases and pathogens. Pests. Cultivars. Roots. Deterioration.

In 1904, cassava root rot first appeared in Java. Affected plants lose their leaves and the roots rot. Infected plants turn black but do not die. Rottings start at the root tip with a violet-red epidermal color. The causal organism appears to be a bacterium, which could be isolated; but it was not possible to infect healthy plants artificially, indicating that the bacteriosis may be a secondary infestation. The disease attacks young and old plants in dry or wet seasons, drained or waterlogged fields. Fertilization had no influence; heavy lime applications reduced infestation in some locations. Some varieties seem more resistant. *(Summary by A. van S.)* E01

0608-2271 GOLATO, C. **Casi fitopatologici osservati in Nigeria.** *(Phytopathological cases observed in Nigeria).* Rivista di Agricultura Subtropicale e Tropicale 56(10-12): 525-543. 1962. Ital., Sum. Ital., Engl., 16 Refs., Illus.

Cassava. *Cercospora henningsii.* **Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Mycoses. Nigeria.**

Brief descriptions are given of symptoms of diseases affecting cacao, the oil palm, sorghum, rice, cassava and other crops in Nigeria. Diseases caused by mosaic virus and *Cercospora henningsii* are reported for cassava. *(Summary by H.J.S.)* E01

0609-2374 FRANCHINI, G. **Amibes et autres protozoaires de plantes à latex du Muséum de Paris.** *(Amoebas and other protozoa of plants containing latex at the Paris Museum; preliminary note).* Bulletin de la Societé de Pathologie Exotique 15:197-203. 1922. Fr., 3 Refs.

Manihot dichotoma. **Diseases and pathogens.**

The examination of fresh plants at the Paris Botanical Garden permitted the identification of some microorganisms present in plants containing latex. *Manihot dichotoma* and other **Euphorbiaceae** are included. Culture media were prepared and inoculated into live animals. Discussions are presented about the origin of the microorganisms and some aspects of their life cycle, including the vectors. *(Summary by H.J.S.)* E01

See also 0009 0221 0294 0329 0427 1151

0610-2325 PEREIRA, A.L.G. and ZAGATTO, A. G. **Etiologia da "mancha angular" na folha da mandioca,** *Manihot utilissima. (Etiology of angular leaf spot of cassava, Manihot utilissima).* Arquivos do Instituto Biológico (Brasil) 34(3):153-160. 1967. Port., Sum. Port., Engl., 8 Refs.,Illus.

Cassava. Bacterioses. Resistance. Leaves. Stems. *Xanthomonas manihotis.* **Pests. Petioles. Diseases and pathogens. Brazil.**

An experiment was conducted to establish the etiology of the cassava leaf spot present in the regions of Piracununga, Aguai and Moji-Guacu, State of São Paulo (Brazil), affecting the Branca de Santa Catarina variety which was resistant to bacterial disease. A study was carried out comparing the bacteria isolated from leaf spots to the bacteria from stem tissues with typical symptoms of the disease. No obvious differences were found in the morphological, cultural, biochemical, physiological and pathogenic characters in both cases. The two organisms were classified as *Xanthomonas manihotis* (Arthaud-Berthet) Starr. It was also verified that the leaf spot disease, located at first in the leaf, can extend to the petiole and later to the stem. *(Author's summary)* E02

0611-0289 DRUMMOND-GONCALVES, R. **A bacteriose da mandioca no Vale do Paraiba.** *(Cassava bacterioses in the valley of Paraiba).* Biológico 5:117-118. 1939. Port.

Cassava. Bacterioses. Pests. Leaves. Diseases and pathogens. Disease control. Brazil.

Brief notes are given on the symptoms and control measures of cassava bacteriosis. Leaves are atrophied and wither progressively; then fungi *(Gloeosporium* and **Fusarium)** attack the petioles. Vessels of the petioles darken; and a viscous cream exudation, different from the normal latex, can be seen on the petioles. Control measures concern crop rotation, sanitary practices of propagation material and utilization of resistant varieties. *(Summary by H.J.S.)* E02

0612-0097 LOZANO, T., J. C. and wholey, D. W. **The production of bacteria-free planting stock of cassava.** World Crops 26(3):115-117. 1974. Engl., 11 Refs., Illus.

Cassava. Pests. Cassava bacterial blight. Bacterioses. Disease control. Propagation materials. Shoots. Cuttings. Diseases and pathogens. Colombia.

A method of rooting shoot tips is described whereby plants free from cassava bacterial blight were produced. The use of this method in addition to cultural practices is proposed for producing pathogen-free foundation stock for a planting material certification program. *(Summary by World Crops)* E02

0613-2473 WILLIAMS, R. J., AGBOOLA, S. D. and SCHNEIDER, R. W. **Bacterial wilt of cassava in Nigeria.** Plant Disease Reporter 57(10):824-827. 1973. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. *Manihot esculenta.* **Pests. Diseases and pathogens. Bacterioses. Etiology.** *Xanthomonas manihotis.* **Nigeria.**

A bacterial wilt of cassava was observed in several areas of Nigeria in 1972. Symptoms and pathogen characteristics are similar to those of a cassava disease in South America caused by *Xanthomonas manihotis* The disease is likely to be economically important in West Africa. *(Author's summary)* E02

0614-3114 FREIRE, J. R. J. **A bacteriose da mandioca.** *(Cassava bacterioses).* Granja (Brazil) 18(189):64. 1963. Port.

Cassava. Bacterioses. Diseases and pathogens. Pests. Disease control. Brazil.

In the state of São Paulo, cassava bacterioses are more severe in plants growing on poor, leached soils. Symptoms of the disease are described, and control methods are suggested. *(Summary by H.J. S.)* E02

0615-0848 COSTA, A. S. and KITAJIMA, E. W. **Cassava common mosaic virus.** London, Commonwealth Agricultural Bureaux, 1972. 4p. (Description of Plant Viruses no. 90). Engl., 12 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Cassava common mosaic virus. Viroses.

A description is given of cassava common mosaic virus (synonym, Brazilian common mosaic virus) with information on disease, host range and symptomatology, strain, vectors, serology, stability in sap, purification, particle structure and composition, relation to cells and tissues. *(Summary by J.L.S.)* E02

0616-2462 AMARAL, J. F. DO. **Doenças vasculares das plantas causadas por bacterias.** *(Plant vascular diseases caused by bacteria).* Biológico 11(9):250-253. 1945. Port., 1 Ref., Illus.

Cassava. Bacterioses. Diseases and pathogens. Pests. *Xanthomonas manihotis.* **Brazil.**

General notes are given about the way that **Phytomonas** spp. infect cassava and other crops. Once the bacteria reach the vascular tissue, they multiply rapidly and obstruct the vessels, causing a withering similar to that occurring when there is a lack of water in the soil. In cassava, besides obstructing the vessels, the bacteria hydrolyze the starches converting them into sugars. As some bacterioses are specific to a certain plant, it is possible to identify some bacterial diseases through artificial infection. *(Summary by H.J.S.)* E02

0617-1816 LEU, L. S. and CHEN, C. T. **Bacterial wilt of cassava** *(Manihotis utilissima* **Pohl.) caused by** *Xanthomonas manihotis* **(Arthaud-Berthet) Starr.** Plant Protection Bulletin (Taiwan) 14(1):17-26. Engl., Sum. Engl., Chin., 21 Refs., Illus.

Cassava. *Manihot esculenta.* **Diseases and pathogens. Bacterioses.** *Xanthomonas manihotis.* **Cultivars. Resistance. Disease control. Pests. Taiwan.**

Bacterial wilt is a systemic disease recently found in many cassava-growing areas in Taiwan. This disease is economically important because it causes the death of plants and in severe cases can cause total losses in newly planted fields. The disease occurs year-around on plants of all ages, but plantlets are most susceptible. Gummy substances excreted on the stem of the diseased plants become spongy when water is available. Bacteria within this substance, a secondary source of inoculum, could thus be carried by rain splashing or wind to healthy plants. Stem cuttings from the diseased stalks are the primary source of infection. Bacterial suspensions induced into the plants by dipping the cuttings, injecting near the apical meristem, spraying on the leaves, and pouring into the root section of the young plants could induce the disease 10-30 days after application. The infected plants wilt and convexed lesions appear on the stipules and stem, where bright yellow-brown gummy substances are soon excreted. Vessels and surrounding tissues are initially invaded; later the tissues and other areas (except for the pith) are dissolved. The pocket which is formed expands; its epidermis finally ruptures, excreting the gummy substances. Comparing morphology, physiology, symptomatology and its pathogenicity limited to **Manihotis** spp., the bacteria studied were most closely related to, if not the same as *Xanthomonas manihotis.* For controlling the disease, stem cuttings must be prepared from disease-free fields. The field should be inspected every few days after budding. Diseased plants should be rogued and put in a plastic bag; they should then be burned, buried or allowed to decay in the bag. The areas with the rogued plants could be replanted without any treatment. Rotation is recommended; but if this is not feasible, crop refuse should be burned, or chopped and plowed deep; later, any volunteer plants should be destroyed before replanting. *(Author's summary)* E02

0618-0292 AS ZONAS **infestadas pela bacteriose da mandioca e as medidas de vigilancia sanitaria vegetal do Ministerio da Agricultura.** *(Areas infected by cassava bacteriosis and sanitary control measures taken by the Ministry of Agriculture).* Biológico 7:135-136. 1941. Port.

Cassava. Bacterioses. Stems. Cuttings. Pests. Diseases and pathogens. *Xanthomonas manihotis.* **Disease control. Brazil.**

A government regulation forbids transport of cassava branches or cuttings outsido an area that was infected by *Bacillus manihotus* Arthaud-Berthet. The area under quarantine covers the following states: Espirito Santo, Rio de Janeiro, São Paulo, Paraná. Santa Catarina, Rio Grande do Sul, Minas Gerais. Mato Grosso, Goyaz and Districto Federal *(Summary by H.J.S.)* E02

0619-3003 LIMA, A. D. F. **Séria doença da mandioca.** *(A serious disease in cassava).* Revista Agronómica (Brazil) 14:167-168. 1958. Port.

Cassava. Diseases and pathogens. Pests. Bacterloses. Disease control. Leaves. Stems.

This paper presents general characteristics of a bacterial disease in cassava which causes plant defoliation and considerable loss of starch in young plants. Among other control measures, the following are recommended: use of healthy planting material, crop rotation, choice of resistant varieties, and use of clean agricultural tools. The disease is not identified by name. *(Summary by J.L.S.)* E02

0620-0961 WIEHE, P.O. and DOWSON, W.J. **A bacterial disease of cassava** *(Manihot utilissima)* **in Nyasaland.** Empire Journal of Experimental Agriculture 21(82):141-143. 1953. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Isolation. Biochemistry. Pests. Diseases and pathogens. Bacterioses. *Erwinia cassava. Xanthomonas manihotis.* **Etiology. Uganda.**

Severe leaf spotting leading to defoliation of cassava *(Manihot utilissima)* occurs in Nyasaland and has been shown to be due to a bacterium here described, for which the name *Xanthomonas cassava* sp. nov. is proposed. A similar disease already recorded from Uganda is probably due to the same pathogen, which was first named *Bacterium cassavae* Hansford in error. *B. cassavae* Hansford is synonymous with *B. lathyri* (Manns and Taubenhaus) Burgwitz, a common saprophyte of necrotic plant tissues. The wilt disease of cassava in South America, said to be caused by *Xanthomonas manihotis* (Arthaud-Berthet) Starr is quite distinct and may not be due to a species of **Xanthomonas.** *(Author's summary)* E02

0621-2475 ARAGAO, H. DE B. **Sur un flagellé du latex de** *Manihot palmata, Phytomonas francai* **n. sp.** *(About a flagellate on the latex of Manihot palmata, Phytomonas francai sp. nov.)* Compte Rendu de la Societé de Biologie 97:1077-1080. 1927. Fr., Illus.

Cassava. Taxonomy. *Xanthomonas manihotis.* **Diseases and pathogens. Pests. Bacterloses.** *Manihot esculenta.* **Brazil.**

A flagellate was found in cassava (*M. palmata,* "aipim" from Brazil) latex, affecting the whole plant. No external damage is shown by the host plant. The organism is large and very mobile, and its evolution is quite different from that of other well-known **Phytomonas.** A description is made of the flagellate and the name *Phytomonas francai* is proposed. *(Summary by H.J.S.)* E02

0622-4013 LOZANO, J.C. **Cassava bacterial blight (CBB).** Palmira, Colombia. Centro Internacional de Agricultura Tropical. Information Bulletin no. 2. 1973. 10p. Engl., 3 Refs., Illus.

Cassava. *Manihot esculenta.* **Pests. Bacterioses. Diseases and pathogens. Cassava bacterial blight. Disease control. Colombia.**

The most important bacterial disease of cassava is cassava bacterial blight (CBB). This disease was first recorded in Brazil but was later reported in Colombia and observed in several other countries in South America and Africa. Symptoms of this disease are leaf spotting, wilting, dieback and gum exudation on young shoots. Vascular strands of infected petioles and stem necrose appear as brown strings. The bacterium is spread by the use of infected planting material and infected tools. The disease spreads rapidly during the rainy season because of rain splash. The disease can be eradicated by removing and burning all plant debris, using healthy planting material, preventing the movement of people, tools and planting material from infected to clean areas, and using resistant cultivars. *(Summary by by J.L.S.)* E02

0623-2465 DRUMMOND, O. A. and HIPOLITO, O. **Notas sôbre a bacteriose de mandioca.** *(Cassava bacteriosis).* Ceres (Brazil) 2:281-307. 1941. Port., Sum. Port., Engl., 23 Refs., Illus.

Cassava. *Manihot esculenta.* **Pests. Diseases and pathogens. Bacterioses. Isolation. Etiology. Disease control. Cultivars. Leaves. Stems.** *Xanthomonas manihotis.* **Brazil.**

The authors describe the disease known as bacteriosis or (Leiteira) "milk disease" of cassava (*Manihot utilissima* Pohl, *M. aipi* Pohl). It is a quite serious and widely disseminated disease, caused by *Bacterium manihotus* n. sp. This organism grows well only in a special medium made with cassava shoots. Several isolations were made from diseased plants and 140 inoculations with pure cultures gave 77% positive results. The organism was studied in pure cultures obtained from isolations and reisolations. The following characteristics are described: size 1.0-4.6 x 0.4-1.2μm; bacilli lopho or monotrichia; gram negative; gelatin liquified, giving sacciform type, in 3 to 4 days; nitrates are reduced to nitrites; no hydrolization of starch; no production of indol; capsule absent; no acids from lactose, manite, salicine, amigdaline and inosite. Other sugars, like xilese, arabinose, levulose, maltose, glucose and dextrin are not generally attacked, but some tests gave positive results. Galactose gave 71% positive results. The bacteria is killed at 77.5ºC, when exposed 10 minutes. The oganism is named *Bacterium manihotus* n. sp. since it has a bacillar form and polar cilia. The nomenclature of Smith is used instead of Bergey's, with which the authors do not agree, for 2 reasons: (1) The name **Phytomonas** given by Bergey in 1923 to the bacteria of this type was used before by Donovan in 1909 to describe the forms of **Leptomonas** and **Leishmania,** which live in the latex of plants. The best authorities of these groups of flagellate accept this terminology. **Phytomonas** bacteria is homonymous to **Phytomonas** flagellate and this is an older name. According to the rules of nomenclature, accepted at the II International Congress of Microbiology, held in London in 1936, "generic homonyms are not permitted in the group Protista." (2) As shown by Burkholder, the group **Phytomonas,** created by Bergey, is an artificial one so the name **Bacterium,** given by Cohn in 1872 to the bacilli with polar cilia is as good as **Phytomonas** and has priority. Experiments were undertaken to study the transmissibility of the organism and two types of spreading the disease were found: by diseased stems which are commonly used to plant the cassava and by contaminated drops of water. The disease can be controlled by the following methods: avoiding the planting of contaminated stems which can be the only source of the disease in the regions where it does not exist yet; eradicating the diseased plants since the dew and rain drops are able to carry the disease from plant to plant; raising resistant varieties of cassava. Seventy varieties were studied and 5 showed some resistance. This work will be continued. *(Author's summary)* E02

0624-2486 BONDAR, G. **Molestia bacteriana da mandioca.** *(Bacterial disease in cassava).* **Boletim de** Agricultura (Brazil) 16:513-524. 1915. Port.

Cassava. Pests. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.* **Tubers. Identification. Laboratory experiments. Starch content. Disease control. Composition. Brazil.**

Information in this paper is concerned with the isolation, identification and etiology of *Bacillus manihot,* causal agent of a bacterial disease in cassava. Symptoms are characterized by decay of young shoots, latex exudation, defoliation and necrosis of aerial parts. The bacterium is also found in cuttings stored for long periods. A significant decrease of starch content in the tubers was observed; chemical analysis of sick tubers showed the following: moisture 84.98%; starch content 9.60%; starch content on dry matter basis 63%. Pathogenicity trials and control measures are included. *(Summary by J.L.S.)* E02

0625-0588 PACCA, D. W. **Contribuição ao estudo das doenças da mandioca.** *(Contribution to the study of cassava diseases).* Rodriguesia 3:171-178. 1937. Port., 6 Refs.

Cassava. Pests. Diseases and pathogens. Uromyces. Mycoses. ***Cercospora caribaea. Cercospora henningsii.*** **Disease control.** ***Xanthomonas manihotis.*** **Bacterioses. Etiology. Brazil.**

The author's observations are reported. Distribution, symptoms, etiology and control of 4 diseases are described: a bacteriosis (very similar to *Bacillus manihotis* Arthaud et Berthet), cassava rust (very similar to *Uromyces manihotis* Henn.) and 2 leaf spots *(Cercospora caribaea* Ciferri Ragnhildiana manihotis Stev. et Solh. and possibly *Helminthosporium manihotis* nov. sp.). *(Summary by H.J.S.)* E03 E02

0626-0845 CASTAÑO A., J. J. **Fuego foliar bacterial de la yuca,** ***Manihot utilissima*** **Pohl.** *(Cassava leaf bacterial blight).* Revista de la Facultad Nacional de Agronomia de Medellin 27(1):56-59. Span., 5 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Bacterioses. Laboratory experiments. Disease control. Etiology. Pseudomonas. Isolation. Leaves. Colombia.

From healthy and infected leaf tissues, a bacteria resembling *Pseudomonas solanacearum* was purified. The pathogenicity of the bacterium was proved hy inoculating healthy plants of cassava. New bacteria were isolated from the inoculated plants and showed to be similar to the first purified. Although Bouriquet mentioned the occurrence of *Pseudomonas solanacearum* in cassava as promoter of a drastic foliage wilt, he considered that *Bacteria robici* was the agent causing the blight in the leaves. This was confirmed by Dulong in Madagascar. Observations made by the author showed that the spread of this bacteriosis is favored by the rainy season and is restricted in the dry season. The author considered that both *B. robici* and *P. solanacearum* in cassava may correspond to special different forms within the *P. solanacearum* species; in such a case, reference must be made to *P. solanacearum F. robici* and *P. solanacearum F. manihotis*, respectively. Control measures are given. *(Summary by J.L.S.)* E02

0627-0806 LOZANO, J. C. **Bacterial blight of cassava,** ***Manihot esculenta*** **Crantz, in Colombia; etiology, epidemiology, and control.** Ph. D. Thesis. Madison, University of Wisconsin, 1972. 114p. Engl., Sum. Engl., 106 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Bacterioses. Cassava bacterial blight. Etiology. Disease control. Isolation. Laboratory experiments. Colombia.

A bacterial blight of cassava (*Manihot esculenta* Crantz) has become an increasingly important problem in Colombia because it causes extensive losses to an important source of food. Studies reported here were concerned with the isolation, identification, pathogenicity and dissemination of the causal organism and with the development of control measures. Symptoms of the disease are characterized by leaf spotting and blight of leaf tissues; wilting, dieback, and exudation of gum on young shoots; and vascular discoloration and necrosis in mature and old stem portions of susceptible cultivars. These symptoms are similar to those reportedly induced by *Xanthomonas manihotis* (Arthaud-Berthet) Starr: but studies on the morphology physiology, serology, and phage susceptibility of the bacterium isolated in Colombia and Brazil suggest that it is sufficiently different from *X. manihotis* to be considered a separate species. The cassava blight bacterium (CBB) differs from *X. manihotis* in cell size, motility and flagellation, production of H_2S, utilization of nitrate, starch hydrolysis, and in several serological relationships. A comparison of CBB with the type culture of *X. manihotis* revealed that the two bacteria also differed in pathogenicity, growth rate, serological characteristics and phage susceptibility. CBB is a gram-negative slender rod, motile by means of a single polar flagellum, not encapsulated and does not form spores. It is an aerobic, fast-growing bacterium, which forms no pigment on sugar-containing media. It hydrolyzes starch and gelatin and reduces litmus milk. It does not induce a hypersensitive reaction on tobacco leaves or cause soft rotting of potato tubers, or cassava roots. It produces levan, catalase, a[illegible]ine dihydrolase and lipase but does not produce H2S, indole, urease, tyrosinase, or phenylalanine deaminase. It is able to grow in ordinary media plus NaCl or tetrazolium chloride at maximum concentrations of 2.5 and 0.2%, respectively. The bacterium utilizes nitrate and ammonium as sources of N; most simple sugars can serve as sources of C, but acid is not produced; various amino acids and other organic acids are readily utilized. CBB can be separated by serological and phage-typing methods from species of **Erwinia** (3), **Pseudomonas** (2), and **Xanthomonas** (10), including *X. manihotis*. *A* **Bdellovibrio** sp. caused lysis specifically on CBB and could be used to separate CBB from other plant pathogenic bacteria. Isolates of CBB from distinct geographical areas could not be grouped on the basis of differences in virulence or biochemical characteristics. They belonged to two different serological groups; and two additional groups could be distinguished on the basis of differences in ability to hydrolyze starch and utilize sucrose, cellobiose and trehalose. However, these serological and biochemical groups were not correlated, nor were they related to geographical origin. Cassava leaves were inoculated by spraying aqueous suspensions of CBB cells and maintaining the plants under high moisture conditions for 6 h after inoculation. Addition of Tween 20 (0.01%) increased effectiveness of this procedure. Stem puncture was an effective method of inoculation as well. CBB normally penetrates the host via stomatal openings and wounds of epidermal tissues. The bacterium eventually invades the vascular tissues; and in leaves and young shoots, it causes extensive breakdown of parenchymatous tissues. In mature, highly lignified tissues of old stems or roots, the bacterium remains restricted to the vascular tissues. CBB moves systemically into vascular strands of roots of susceptible cultivars; in very susceptible cultivars it was found infecting roots 4 months after leaf spray-inoculation. Dispersal by splashing raindrops is probably the most important means of dissemination of CBB in localized areas. Dissemination from one area to another can also occur by means of infected vegetative "seed." Infested tools can also spread the bacterium. Controlled inoculation experiments in the field revealed that spread is correlated with total rainfall and occurs in the direction of prevailing winds. No dissemination occurred to plants growing 15 m away from an inoculum source. Satisfactory control of the disease was obtained by pruning most of the aboveground portion of infected plants, leaving only a 30-40 cm section at the base of the stem. However, this control method was dependent on (a) the susceptibility of the cultivars and (b) the length of time between initial infection and pruning. Rooting and indexing of excised buds provided a good control method since healthy plants were obtained from infected cultivars. This control method seems promising to clean up promising cultivars in breeding and selection programs or as a routine method for the production of certified cassava "seed." Disinfestation of tools used during routine cultivation procedures is also suggested to prevent dissemination of the pathogen. Twenty-one cassava cultivars were classified as resistant to CBB after greenhouse inoculation of more than 1200 cultivars obtained from the Centro Internacional de Agricultura Tropical CIAT, Cali (Colombia). The resistance of theses cultivars appeared related to restriction of penetration and systemic invasion by the parasite. Two cultivars, M. Col. 647 and M. Col. 667, were characterized by a hypersensitive reaction which limited the size of the lesions on leaves. The use of resistant cultivars remains the most promising method for control of the disease in the tropics. *(Author's summary)* E02

0628-0254 AMARAL, J. F. DO. **Estudo do organismo causador da bacteriose da mandioca.** *(A study of the cassava agent of the cassava bacteriosis).* Arquivos do Instituto Biológico 13:119-126. 1942. Port., Sum. Engl., 11 Refs. Illus.

Cassava. Pests. Diseases and pathogens. *Xanthomonas manihotis.* **Bacterioses. Etiology. Laboratory experiments. Isolation. Brazil.**

This bacteriosis is a vascular disease causing a wilt of cassava (*Manihot utilissima* Pohl). It attacks a great number of varieties and is of economic importance. The pathogenicity of the bacterium was tested with 6 isolates. The varieties Vassourinha, Manipeba, Cambaia and Gemedeira were all affected when inoculated. Morphologically, the microorganism is a motile rod with rounded ends. Dimensions are 0.6-0.9 μ x 1.6-2.0 μ. It is gram-negative and does not form spores; its monotrichous flagella are fairly easily stained. On agar plate (48 h at 30°C) it forms round colonies (2-3 mm in diameter) with raised glistening surfaces, the edge of which is entire. These colonies are milk white in color and viscid. Broth cultures (48 h at 30°C) are characterized by dense turbidity and abundant, viscid sediment. It grows well in sugars with no fermentation. The microorganism completely hydrolyzes starches, not only with cultures but also with filtrates from liquid media cultures. It does not reduce hydrogen sulfide, indole, ammonia or nitrates. Gelatin liquification begins on the 8th day. It digests milk without coagulation; litmus milk is peptonized with no discoloration. The organism is classified as a **Phytomonas.** *(Author's summary)* E02

0629-3145 A BACTERIOSE **da mandioca e do aipim.** *(Bacteriosis of cassava).* Porto Alegre. Brasil. Directoria de Agricultura, Industria e Commercio. Secção de Agricultura. Circular no. 29 1931. 6p. Port., Illus.

Cassava. Pests. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.* **Disease control. Brazil.**

Bacterial disease, caused by *Bacillus manihot* Bondar (reclassified as *Xanthomonas manihotis*) is characterized by leaf spotting, wilting, latex exudation, dieback and necrosis of the stems. Susceptibility of two varieties is compared. Control measures are included. *(Summary by J.L.S.)* E02.

0630-0250 BURKHOLDER, W. H. **Three bacterial plant pathogens:** *Phytomonas caryophyll* **sp. n.,** *Phytomonas alliicola* **sp. n., and** *Phytomonas manihotis* **(Arthaud-Berthet et Bondar) Viegas.** Phytopathology 32(2):141-149. 1942. Engl., Sum. Engl., 21 Refs.

Cassava. Pests. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.*

A description is given of 3 bacterial pathogens. Two are new species, *Phytomonas caryophylli* sp. n., which causes a wilt and root rot of carnations, and *Phytomonas alliicola* sp. n., which causes a bulb rot of onions. The third description is of *Phytomonas manihotis* (Arthaud-Berthet et Bondar) Viegas, a bacterium causing a wilt of cassava and of which no adequate description has been given hitherto. *(Author's summary)* E02

0631-0253 AMARAL, J. F. DO and VASCONCELLOS, L. G. DE. **Novos estudos do agente etiológico da bacteriose da mandioca.** *(Further studies of the etiological agent of bacteriosis of cassava).* Arquivos do Instituto Biológico 16:361-368. 1945. Port., Sum. Engl., 11 Refs. Illus.

Cassava. Pests. Diseases and pathogens. Etiology. *Xanthomonas manihotis.* **Bacterioses. Brazil.**

Continuing a study by the senior author of a culture of the causal agent of bacteriosis of cassava (*Manihot utilissima* Pohl & *M. aipi* Pohl), the writers compared it to a culture of *Phytomonas manihotis* isolated by H.W. Burkholder and one of *Bacterium manihotis*, Drummond & Hipólito, both received from Burkholder. The original culture isolated by Arthaud-Berthet and Bondar was not available. No significant differences were found in the morphological, cultural, physiological or serological characters of the 3 isolates, contrary to what was previously inferred from the descriptions by Burkholder and by Drummond and Hipólito. It is concluded that the agent of cassava bacteriosis is *Phytomonas manihotis* (Arthaud-Berthet) Viegas and that *Bacterium manihotis* is a synonym. *(Author's summary)* E02

0632-1678 LOZANO, J. C. and SEQUEIRA, L. **Bacterial blight of cassava in Colombia; etiology.** Phytopathology 64(1):74-82. 1974. Engl., Sum. Engl., 39 Refs., Illus.

Cassava. *Manihot esculenta.* **Cassava bacterial blight. Bacterioses. Diseases and pathogens. Pests. Etiology. Isolation. Laboratory experiments. Leaves. Stems.** *Xanthomonas manihotis.* **Colombia.**

The bacterial blight of cassava (*Manihot esculenta*) has increased in severity in Colombia during the past 5 years. Symptoms on susceptible cultivars include leaf spotting, wilting, dieback, gum exudation on young shoots, and vascular discoloration in mature stems. The bacterium (CBB) penetrates via the stomata or through wounds in epidermal tissues. It invades the vascular tissues of leaves and young shoots, resulting in extensive breakdown of parenchymatous tissues. In highly lignified tissues of old stems or roots, the bacterium remains restricted to the vascular strands. These symptoms are similar to those reportedly induced by *Xanthomonas manihotis*, but the isolates of CBB differ in cell size, motility, production of hydrogen sulfide, utilization of nitrate, starch hydrolysis, and in several serological characteristics. CBB is a gram-negative, motile, slender rod, with a single polar flagellum. It is aerobic, fast growing and forms no pigments on media containing carbohydrates. It hydrolyzes starch and gelatin and reduces litmus milk. It produces levan, catalase, arginine dihydrolase and lipase but not hydrogen sulfide, indole, urease, tyrosinase or phenylalanine deaminase. It grows in ordinary media plus NaCl or tetrazolium chloride at a maximum concentration of 2.5 and 0.2%, respectively. It utilizes nitrate and ammonium as sources of N, and most of the simple sugars as sources of carbon, but acid is not produced; various amino acids and other organic acids are readily utilized. Isolates of CBB from distinct geographical areas induced similar symptoms on cassava but belonged to 2 different serological groups, each separable into 2 additional groups on the basis of their ability to utilize sucrose, cellobiose and trehalose as carbon sources. However, these groupings were not correlated with geographical origin of the isolates. CBB was separated by serological- and phage-typing methods from 3 species of **Erwinia**, 2 of **Pseudomonas**, and 10 of **Xanthomonas**, including *X. manihotis*. A **Bdellovibrio** sp. caused lysis of CBB specifically and was used to separate CBB from other plant pathogenic bacteria. *(Author's summary)* E02

0633-1677 LOZANO, J. C. and SEQUEIRA, L. **Bacterial blight of cassava in Colombia: epidemiology and control.** Phytopathology 64(1):83-88. 1974. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Disease control. Cassava bacterial blight. *Xanthomonas manihotis. Manihot esculenta.* **Diseases and pathogens. Pests. Leaves. Stems. Pest control. Resistance. Bacterioses. Colombia.**

Dispersal by splashing raindrops is the most important means of disseminating the cassava blight bacterium (a possible strain of *Xanthomonas manihotis)* within localized areas in Colombia. Dissemination from one area to another occurs through propagation of infected plant parts and by means of infected tools. In controlled inoculation experiments in the field, plant-to-plant spread occurred in the direction of prevailing winds, and disease incidence was correlated with amount of rainfall. However, no dissemination occurred when host plants were located at least 15 m away from the inoculum source. Satisfactory disease control was obtained by excising upper portions of infected plants and allowing the stumps (20-30 cm) to resprout. Effectiveness of this control method was reduced when treating highly susceptible, severely infected cultivars. Rooting excised buds was an efficient method of obtaining healthy planting stock from infected cultivars. Eight out of 1293 cassava cultivars tested under greenhouse conditions were resistant to bacterial blight. Resistance was dependent upon restriction of penetration and systemic invasion by the pathogen; two cultivars (M. Col. 647 and M. Col. 667) exhibited a hypersensitive response, which limited the size of leaf lesions. The use of resistant cultivars remains the most promising method of control in the tropics. *(Author's summary)* E02

0634-2485 BITANCOURT, A. A. **O agente da bacteriose da mandioca.** *(The causal agent of cassava bacteriosis).* Biológico 7(2):37. 1941. Port., 6 Refs.

Cassava. Diseases and pathogens. Bacterioses. *Xanthomonas manihotis.* **Pests. Brazil.**

Cassava bacteriosis causes serious damage in the state of São Paulo (Brazil). Modifications in the taxonomic nomenclature of cassava are discussed. The first name was *Bacillus manihotus* Arthaud-Berthet. Other names have been used: *Bacillus manihot* sp. nov. (1915), *Bacillus manihotus* Arthaud-Berthet (1930), *Bacillus manihoti* Berthet et Bondar (1940), *Phytomonas manihotis* (Arthaud-Berthet et Bondar) Viegas. The author states that according to the system of nomenclature of the American Association of Bacteriologists the last name is the correct one. *(Summary by H.J.S.)* E02

0635-3150 SCHWARZ, M. B. **Slijmziekte in de cassave.** *(The soft rot of cassava).* Indische Culturen (Teysmannia) 11(17):498-499. 1926. Dutch., Illus.

Cassava. Diseases and pathogens. Pests. Tubers. Leaves. Stems. Roots. Bacterioses. Resistance.

Soft rot has the following symptoms: Leaves wilt, sometimes leaving only top leaves fresh. The roots appear to be rotten; first there is a brown discoloration of the xylem, which becomes visible in the stems. The disease can attack cassava at any age. The roots eventually rot. In the tissue, xylem tubes and many bacteria can be found. The bacteria are rod shaped and active. They are easily isolated and cultured and can infest healthy roots, causing the same symptoms. The bacterium is probably **Solanacearum**, because bacteria cultivated on potatoes could infest tomatoes with the same bacteria type, isolated from tomatoes and cassava. The variety Criolinha appeared to be resistant. *(Summary by A. van S.)* E02

0636-3040 COSTA, F. **Regiões infestadas pela bacteriose da mandioca.** *(Regions infected by cassava bacterioses).* Biológico 6:332. 1940. Port.

Cassava. Bacterioses. Diseases and pathogens. Pests. *Xanthomonas manihotis.* **Disease control. Brazil.**

This paper is a short communication from Brazilian Department of Agriculture declaring some zones infected with *Bacillus manihotus* Arthaud-Berthet, the casual agent of cassava bacteriosis. Control measures were taken to avoid the transportation of cuttings from the infected areas. *(Summary by J.L.S.)* E02

0637-0758 CASTAÑO, A., J. J. **Marchitez bacterial de la yuca (*Manihot utilissima* Pohl).** *(Bacterial wilt of cassava, Manihot utilissima Pohl).* Revista. Facultad Nacional de Agronomía, Medellín 27(1):43-55. 1972. Span., Sum. Span., Engl., 10 Refs.

Cassava. *Manihot esculenta. Xanthomonas manihotis.* **Etiology. Colombia.**

A bacterial disease affecting cassava (*Manihot utilissima* Pohl) was found in plant material submitted from several areas of the Atlantic Coast of Colombia. The disease appeared as a mucilaginous exudation on the stems, a wilting or yellowing of the leaves and a subsequent drying. The causal agent was found to be a gram-negative bacterium which showed some characteristics quite similar to those of the vascular **Xanthomonas** group. This bacterium coincides with the one reported by Duarte Silveira as *Xanthomonas manihotis* (Arthaud-Berthet) Breed *et al.*, that causes a wilting of cassava in Brazil; with *Bacillus manihotis* (Arthaud-Berthet et Bondar) Viegas; and with *Bacterium manihotis* n. sp., all of which seem to be synonymous. The name *Xanthomonas manihotis* (Arthaud-Berthet) Breed *et al. f. specialis*, is suggested for the causal agent of the bacterial wilt in Colombia. This disease is different from the one described as "fire" or blight of cassava leaves caused by *Phytomonas solanacearum* (E.F.S.) Bergey *et al. (Author's summary)* E02

0638-4784 BRADBURY, J. F. **Bacterial diseases of cassava.** PANS 21(1):44. 1975. Engl., Sum. Engl., 4 Refs.

Cassava. *Manihot esculenta. Xanthomonas manihotis.*

Recent development on the identities of the causal agents of bacterial diseases of cassava throughout the world are discussed: *Xanthomonas manihotis* (Arthaud-Berthet) Starr, *X. cassava* Wiehe and Dowson, and *Pseudomonas solanacearum* (E. F. Smith) E. F. Smith. *(Author's summary)* E02

T-1896

0639-4397 LOZANO, J. C. **El añublo bacterial de la yuca (*Manihot esculenta* Crantz) en América: etiología, epidemiología y control.** *(Bacterial wilt of Manihot esculenta Crantz in America; etiology, epidemiology and control).* Fitopatología 9(2):110-119. 1974. Span., Sum. Engl., Span., 25 Refs., Illus.

Cassava. Bacterial necroses. *Xanthomonas manihotis.* **Disease control. Resistance. Productivity. Etiology. Cassava bacterial blight.**

Bacterial wilt of cassava *(Manihot esculenta)* is the most serious disease in Central and South America , and it has recently been reported in Africa. The symptoms are foliage lesions, dieback, exudation of gum from the young sprouts, and vascular necrosis of stems and roots of susceptible cultivars. The disease spreads readily in the field through rain splashing. The dissemination from one area to another occurs through the planting of infected cuttings and by tools. Satisfactory control of the disease was obtained with the use of resistant varieties and with certified seed obtained from healthy young sprouts. *(Author's summary)* E02

0640-5210 LOZANO, J.C. **Bacterial blight of cassava.** PANS 21(1):38-43. 1975. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Cassava bacterial blight. *Xanthomonas manihotis.* **Disease control. Etiology.**

Bacterial blight of cassava is a serious problem in Central and South America and has been observed in parts of Africa. Symptoms include leaf spotting, wilting, dieback, gum exudation on young shoots, and vascular discoloration in mature stems and roots of susceptible cultivars. Dispersal by rain splashing is the most important means of dissemination within localized areas. Dissemination from one area to another occurs through infected planting material or by the use of contaminated tools. Delay in spread of the disease has been obtained by pruning infected plants. The use of resistant varieties and the production of certified bacteria-free planting material, obtained from plants propagated from shoot tip cuttings, has given satisfactory control. *(Author's summary)* E02

0641-4786 MARAITE, H. and MEYER, J. A. *Xanthomonas manihotis* **(Arthaud-Berthet) Starr, causal agent of bacterial wilt, blight and leaf spots of cassava in Zaire.** PANS 21(1):27-37. 1975. Engl., Sum. Engl., 30 Refs.

Cassava. *Xanthomonas manihotis.* **Isolation. Leaves. Zaire.**

Bacterial wilt of cassava has caused a severe reduction in tuber yield in the savanna of the southern part of Zaire in since 1970. Infection of young shoots often takes place through insect punctures made mainly by *Pseudotheraptus devastans* Distant. Systemic colonization of the stem leads to vascular browning, formation of bacterial pockets in the bark which extrude a yellowish white exudate, sudden drying of the leaves and necrosis of the stem tips. Angular leaf spots, accompanied by small droplets of exudate on the lower surface of the lesion and rapid blight of large areas of the lamina and defoliation are endemic in Zaire. Epidemics develop under conditions of heavy rainfall. The cultural appearance, the morphological and biochemical characters as well as cross-inoculation tests showed that the bacteria causing wilt, leaf spotting and blight are identical. They are identified as *Xanthomonas manihotis* (Arthaud-Berthet) Starr and can be distinguished from a Brazilian isolate of *X. manihotis* only by a lower amylolytic activity. A critical analysis of literature suggests a worldwide distribution of the disease. The recent epidemic development of bacterial wilt in Zaire and control by resistant cultivars are discussed. *(Author's summary)* E02

0642-0246 DRUMMOND-GONCALVES, R. **A bacteriose e a mandioca guaxupé.** *(Bacteriosis in guaxupé cassava).* Biológico 19:114-117. 1953. Port., Illus.

Cassava. *Xanthomonas manihotis.* **Pests. Diseases and pathogens. Bacteriosis. Brazil.**

Bacteriosis was first found in Brazil in 1911. It is caused by *Xanthomonas manihotis* (Arthaud Berthet) Burk. *(Summary by J.H.C.).* E02

See also 0242 0497 0577 0625 0658

0643-0211 SRIVASTAVA, K. C. and SAKSENA, R.P. **Studies on leaf spot disease of** ***Manihot utilissima*** **Pohl.** Labdev Journal of Science and Technology 4(2):146-148. 1966. Engl., 4 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Pests. Diseases and pathogens. Mycoses.** ***Glomerella cingulata.*** **Disease control. India.**

An account is given of the symptoms, pathogenicity, host range, morphology, effect of pH and control of *Colletotrichum glocosporoides (Glomerella cingulata)* on cassava. *(Summary by Review of Applied Mycology)* E03

0644-0245 OLIVEROS, B., LOZANO, J. C. and BOOTH, R. H. **A Phytophthora root rot of cassava in Colombia.** Plant Disease Reporter 58(8):703-705. 1974. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Roots. Pests. Diseases and pathogens. Mycoses.** *Phytophthora drechsleri.* **Colombia.**

A **Phytophthora** root rot is reported to result in severe losses of cassava grown in poorly drained soils in Colombia. Structures of the causal organism are consistent with those of *Phytophthora drechsleri.* Inoculation experiments have shown that this fungus is associated with severe rot of both damaged and undamaged swollen roots and death of rooted shoot-tip cuttings. *(Author's summary)* E03

0645-0721 VIEGAS, A. P. **Alguns fungos do Brasil. VI. Dacryomycetaceae-tremellaceae.** *(Some fungi of Brazil. VI. Dacryomycetaceae-tremellaceae).* Bragantia 5(4):239-251. 1945. Port., 6 Refs., Illus.

Cassava. Pests. Manihot. Diseases and pathogens. Mycoses. *Manihot esculenta.* **Brazil.**

A description is given of the following fungi: *Guepinia spathalaria* (Schw) Fries; *Eichleriella leveilliana* (B. e. C.) Burt found in **Petrea** sp.; *Exidiopsis manihoticola* Viegas found in peduncles of *Manihot utilissima* Pohl. var. **Oringy** and **Manihot** sp. (wild cassava); *Heterochaete nigerrima* n. sp. found in rotten wood; *Heterochaetella ochracea* n. sp. found in fallen bushes; *Heterochaetella chorisiae* n. sp. found in shoots of **Chorisia** sp.; *Hirneolina ubatubensis* n. sp. found in rotten wood; and *Seismosarca stratosa* n. sp. found in fallen vines. *(Summary by J.L.S.)* E03

0646-0342 CIFERRI, R. **Le malattie della manioca** (*Manihot esculenta* **Crantz) in San Domingo. III. Identita e nomenclatura della** "Cercospore," **viventi sulle** Manihot. [*Diseases of cassava* (**Manihot esculenta** *Crantz) in Santo Domingo. III. Identity and nomenclature of "Cercospora" occurring in Manihot*]. Bolletino della Stazione di Patologia Vegetale di Roma 20:90-114. 1940. Ital., 7 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Diseases and pathogens. Pests. Mycoses. Plant geography. Dominican Republic.** *Cercospora henningsii. Cercospora caribaea.*

The following nomenclatures are proposed for two **Cercospora** species: (1) *Cercospora henningsii* Allescher in P. Henn., Die Pflanzenw. Ostafrika, Teil C., p. 35 (1895)= [*Cercospora cassavae* Ell. et Ev.; *C. manihotis* P. Henn. (1902); *C. manihotis* P. Henn. (1907); *C. ceurae* Petch; *C. manihoticola* Stev. (1923, ined.; in etichetta); *Septogloeum manihotis* Zimm.; *Cercosporella pseudoidium* Speg.) non Cif. Myc. Doming. Exsicc. N. 12 (1931)] (2) *Cercospora caribaea* Chupp et Cif., Mycofl. Domingens. Exsicc., N. 12 (1931) (in etichetta); Chupp in Muller et Chupp (1935)=[*Cercospora henningsii* Auct. plurib. (incl. Cif., Ann Mycol., Vol XXIX, p.290, 1931 non Allescher; = *C. cearae* Chupp in Chardon et Toro (1930) non Petch; =*Ragnhildiana manihotis* Stev. et Solh.; = *Corynespora manihotis* Solh., ined. (in litt. (1932)]. Description of the symptoms, hosts and geographical distribution of the diseases caused by both **Cercospora** are given. *(Summary by H.J.S.)* E03

0647-0247 CLERK, G.C. and CAURIE, M. **Biochemical changes caused by some Aspergillus species in root tuber of cassava *(Manihot esculenta* Crantz).** Tropical Science 10(3):149-154. 1968. Engl., Sum. Engl., 6 Refs. Illus.

Cassava. Aspergillus. Biochemistry. Moulds. Pests. Diseases and pathogens. Mycoses. Soluble carbohydrates. Amino acids. N. Tubers. Plant physiology. Carbohydrate content.

Aspergillus flavipes, A. flavus, A. japonicus, A. niger and *A. ochraceus,* previously isolated from contaminated pieces of cassava root tuber during commercial preparation of cassava flour, have been shown to cause considerable biochemical changes in the cassava tuber. *Aspergillus japonicus* and *A. niger* caused dry weight losses of more than 70% in 20 days and shifted the initial pH of 6.3 to the acidic side. Moderate dry weight losses (below 44%) were induced by *A. flavipes, A. flavus* and *A. orchaceus;* the pH of tubers inoculated with these species became alkaline. Total N was lowered in all treatments except in *A. flavipes*-inoculated tubers. The amino acid and soluble carbohydrate contents of the tubers were altered quantitatively and qualitatively by the fungi. *(Author's summary).* E03 C03.

0648-1770 LAL, B and TANDON, R. N. **Utilization of monosaccharides by three isolates of *Colletotrichum capsici* (Syd.) Butler and Bisby.** Proceedings of the National Academy of Sciences. (Section B) 38(1):1-4. 1969. Engl., Sum. Engl., 11 Refs.

Cassava. *Manihot esculenta.* Pests. Diseases and pathogens. Mycoses. Sugars. Laboratory experiments.

The utilization of 8 monosaccharides (L (+) arabinose, D-xylose, L-rhamnose, D-glucose, D-fructose, D-galactose, L-sorbose and D-mannose) by three isolates of *Colletotrichum capsici* obtained from the leaf spot disease of *Codiaeum variegatum, Manihot esculenta* and *Solanum melongena,* respectively, was studied. Chromatographic analysis of the culture medium indicated that glucose was rapidly assimilated by all isolates whereas sorbose was utilized at a very slow rate. Different isolates showed marked variations in the time taken for the utilization of various monosaccharides. In all cases, the pH of the media became either neutral or alkaline. In all cases where the sugar was consumed from the medium by 10 days, the maximum dry weight was observed on the 11th day; but generally the dry weight continued to increase where the rate of its utilization was slow. In such cases, the maximum weight was observed on the 16th day. The results have been compared with other isolates. *(Author's summary)* E03

0649-1878 WILSON, K. I. and SATHIARAJAN, P. K. **Phyllosticta leaf spot of cassava *(Manihot utilissima* Pohl).** Science and Culture 31(1):4. 1965. Engl., Illus.

Cassava. *Manihot esculenta.* Pests. Diseases and pathogens. Mycoses. Phyllosticta. Leaves. Isolation. Laboratory experiments. India.

In June, 1964 a disease affecting the leaves of cassava *(Menihot utilissima* Pohl) was noticed at the Agricultural College Farm, Vellayani, Kerala State. The disease was found on the variety Kalikalan. Infection was mainly confined to the lower leaves. The causal organism was isolated in pure culture and identified as a species of **Phyllosticta.** Viegas first reported a leaf disease of cassa a from Brazil, caused by *Phyllosticta manihotae* Viegas. There is no previous record of this disease from India. Infection on the leaves generally originated as discolored areas at the tips, or at times on the margins, of individual lobes. As the disease progressed, the infected area enlarged and became yellowish-brown on the upper side and ashy-gray on the lower side. Often, the leaf curled backwards at the infected portion. In severe cases of infection, the leaves shriveled and dried. Numerous dark-colored pycnidia of the fungus were formed on the infected regions. They are globose and subcuticular, measuring 92.3 to 184.6μ in diameter. When the pycnidium is mounted in a drop of water, the spores emerged as tendril-like masses. The pycnidiospores are hyaline, unicellular and elliptical to ovoid in shape measuring 5.6 to 8.4μ X 2.4 to 3.2μ in size. The size and shape of the pycnidia and pycnidiospores of the fungus under study closely agree with that of *Phyllosticta manihotae* Viegas and is therefore identified as such. *(Full text)* E03

0650-3010 NORMANHA, E. S. A. and SILVA, J. R. DA. **Apodrecimiento de raízes de mandioca na região de Araras.** *(Cassava root rot in the Araras region).* Agronomico 16(7-8): 33-35. 1964. Port.

Cassava. Diseases and pathogens. Pests. *Cercospora henningsii. Cercospora caribaea. Sclerotium rolfsii.* **Mycoses. Brazil.**

News is presented of cassava root rot on commercial plantations. Descriptions are given of the symptoms. Fungi of **Cercospora** and **Sclerotium** are cited as causal agents. *(Summary by H.J.S.)* E03

0651-3859 SADASIVAM, K. V. **Cyanide-tolerant microorganisms in the rhizosphera of tapioca.** Soil Biology and Biochemistry 6(3):203. 1974. Engl., 9 Refs.

Cassava. Pests. Diseases and pathogens. Cyanides. Aspergillus. Soil analysis. Resistance. India.

Biochemical evidence suggests that cyanide could arise in soils during the decomposition of plant tissues containing organic nitriles. The largest single group of such compounds in plants is the cyanogenic glucosides. Strobel (1967) studying the metabolism of cyanide in soil reported that cyanide carbon and nitrogen were converted into carbonate and ammonia, respectively. Soil samples from areas supporting cyanogenic plants actively metabolized cyanide. Recently, Skowronski and Strobel (1969) isolated a strain of *Bacillus pumilus* showing extreme tolerance to cyanide from fields in which flax crops had been grown for 73 consecutive years. The present report concerns the occurrence of cyanide tolerant organisms in the rhizosphere of tapioca (*Manihot utilissima* Pohl.) a cyanogenic plant. To isolate microorganisms tolerant to cyanide, rhizosphere samples from field-grown tapioca plants and samples of soil away from the influence of plant roots in the same field were collected and plated, using a dilution plate technique. Appropriate quantities of KCN solution were added to the molten media (45°C) to give final concentrations of 100, 500 and 1,000 parts| 10^6. The media were then poured into petri dishes containing 1 mililiter of a suspension of rhizosphere soil or control soil. The plates were incubated at room temperature for 7-10 days. The microorganisms developing on the plates were subcultured on agar slants (pH 7.6) containing the same concentration of KCN as in the plates from which they were transferred. Soil extract agar (glucose 1.0 g, K_2 HPO_4 0.5 g, soil extract 100 mililiters, distilled water 9,000 mililiters and potato dextrose agar (peeled potato 200 g, dextrose 20 g, agar 17 g, water 1,000 mililiters) were used for isolating bacteria and fungi, respectively. No colonies developed in plates containing 500 and 1,000 parts| 10^6. A similar inhibitory effect of HCN towards bacteria, fungi and actinomycetes has been reported by earlier workers (McCallan and Weedon, 1940; Polunin, 1942, Trione, 1960). At a concentration of 100 parts| 10^6, two bacteria, (a **Streptomyces** sp), and two fungi (an **Aspergillus** sp. and *Rhizopus nigricans)* were isolated from rhizosphere soil. The bacterial isolates were Gram-negative, rod-shaped organisms; one was pale pink and the other was light cream when grown on nutrient-agar. The isolate of *R. nigricans* could use KCN as a source of N in synthetic Czapek-Dox medium, where $NaNO_3$ was replaced by KCN at the rate of 200 parts| 10^6 and thus tolerated larger concentrations of KCN than the other organisms. The two bacterial isolates showed tolerance of KCN up to 50 parts| 10^6 in the nutrient medium (beef extract 3 g, peptone 5 g, agar 15 g| 1 medium). The utilization of cyanide by bacteria (Skowronski and Strobel, 1969), fungi (Ivanov et al., 1936) and actinomycetes (Cochrane, 1961) has been reported before. Allen and Strobel (1966) reported the assimilation of HCN by a variety of fungi, incorporating the carbon atom of KCN into amino acids and also suggested the existence of a cyanide microcycle in nature wherein a molecule of cyanide given off by the roots of a higher plant could be assimilated by microorganisms and vice versa. In view of the abundance of **Aspergillus** spp. and **Rhizopus**, spp. in the rhizosphere of tapioca (Sadasivam, 1970) and even if a small proportion of these had the ability to assimilate cyanide, it would appear reasonable to assume that they may utilize the cyanide present in the root region and may even nullify any toxicity due to the presence of cyanide. *(Full text)* F03

0652-3006 MULLER, A. S. and ROBERTS, D. A. **Plant disease records at Zamorano, Honduras. II. August, 1960.** Ceiba 9(1):49-54. 1951. Engl., 6 Refs.

Cassava. *Cercospora henningsii.* **Starch crops. Diseases and pathogens. Pests. Mycoses. Honduras.**

Diseases observed in 52 plants are listed. Data given includes vegetables, starch crops, grasses, fruits and ornamentals. Cassava leaf spotting, caused by *Cercospora henningsii* was observed, but it was of minor importance. *(Summary by H.J.S.)* E03

0653-2463 BAKER, C. F. **Second supplement to the list of the lower fungi of the Philippine Islands.** Philippine Journal of Science 46 (3):479-536. 1931. Engl.

Cassava. *Manihot esculenta. Manihot dichotoma.* **Pests. Diseases and pathogens. Mycoses. Philippines.**

A list is given of 664 fungi, of which the following were found on cassava *(Manihot utilissima): Guignardia manihoti* Sacc., *Diplodia manihoti* Sacc., *Phoma herbarum* Westd., *Colletotrichum lussoniense* Sacc., *Cercospora henningsii* Allesch., *Cercospora manihotis* P. Henn., and *Phyllosticta manihoticola* Syd. on *Manihot dichotoma. (Summary by J.L.S.)* E03

0654-3052 SRIVASTAVA, K.C. **Antimicrobial activity of** *Colletotrichum gloesporioides.* Labdev Journal of Science and Technology 7B(3):235. 1969. Engl.

Cassava. *Manihot esculenta.* **Pests. Diseases and pathogens.** *Glomerella cingulata.* **Mycoses. Laboratory experiments.**

Colletotrichum gloeosporioides Penz, an isolate from diseased leaves of *Manihot utilissima* Pohl. (Srivastava and Saksena, 1966) was cultured for 15 days at 25°C in Richard's broth at pH 5, 7 and 8 in 150-ml Erlenmeyer flasks, each containing 25 ml nutrient solution. On the 16th day, the filtrates of broth cultures of pH 5, 7 and 8 were tested separately against *Bacillus subtilis, Escherichia coli* and *Curvularia lunata.* Both the bacteria, mixed with nutrient-agar medium, were seeded separately in 4"-diameter petri dishes and sterile filter paper discs one cm in diameter, dipped in the culture filtrates of *C. gloeosporioides,* were placed over the seeded medium. The plates were incubated at 37°C for 24 hours. *C. lunata* was similarly seeded with 2% potato-dextrose-agar medium and similar paper discs, dipped in culture filtrate of *C. gloeosporioides,* were placed on the seeded medium. The plates were incubated at 35°C for 72 hours. On observation, *C. gloeosporioides* failed to show any antibacterial or antifungal activity at pH 5, 7 and 8 against the organisms used in the present investigation. *(Full text)* E03

0655-3000 LEATHER, R. I. **A catalogue of some plant diseases and fungi in Jamaica.** Jamaica. Ministry of Agriculture and Lands. Bulletin no. 61. 1967. 92p. Engl., 18 Refs.

Cassava. Diseases and pathogens. Pests. *Cercospora henningsii. Cercospora caribaea. Glomerella cingulata.* **Rosellinia.** *Uromyces manihotis.* **Mycoses. Jamaica.**

This bulletin, which includes the data listed by Larter and Martyn (1943) and Dale (1955), is an attempt to catalogue the substantiated records of plant diseases and fungi accumulated by the plant pathologists of the Plant Protection Division since 1943, but additional information concerning economic plants has been extracted from other sources. Data presentation follows closely that adopted by Larter and Martyn (1943) except that a pathogen-host list is included. In some instances it has not been practicable to differentiate between the possible causative and associated organisms since this has not been established; wherever possible the former is given precedence. About 600 hosts and 1,700 pathogens are listed. Part one of the catalogue is arranged alphabetically by hosts, as follows: plants, fungi and lichens, insects, and miscellaneous. Part two is arranged by pathogens as follows: fungi, algae, actinomycetes and bacteria, virus diseases, and unidentified and nonparasitic diseases. The following pathogens are reported for cassava: *Cercospora caribaea* (leaf spot), *Cercospora henningsii* (Leaf spot), *Glomerella cingulata* (anthracnose), **Rosellinia** sp. (Black rot) and *Uromyces jatrophae* (Rust). *(Author's summary)* E03

0656-3849 MULLER, A. S. and CHUPP, C. **Cercosporae de Minas Gerais.** *(Cercosporae in Minas Gerais, Brazil)* Arquivos do Instituto de Biologia Vegetal 1(3):213-220. 1934. Port., Sum. Engl.

Cassava. Pests. Diseases and pathogens. Mycoses. *Cercospora caribaea.* **Brazil.**

This paper presents a preliminary list of the Cercosporae collected in Minas Gerais (Brazil) and placed in the herbarium of the State Agricultural College in Vicosa. A duplicate set was sent to Cornell University, where the comparative studies were made, following keys to species, according to orders of the host plants. Seventy-one species are given, ten of which are new. *(Author's summary)* E03

0657-0467 DRUMMOND-GONCALVES, R. **Saporema.** *(Saporema).* Biológico 3:302-305. 1937. Port., Illus.

Cassava. Diseases and pathogens. Pests. Etiology. Brazil.

Saporema is a root rot that produces stonelike formations weighing 3.5-28 kg; these are frequently found in banana and cassava plantations. Research indicates that in some cases, these formations consisted of mycelia of *Polyporus saporema* or allied species; in other cases and especially in banana plantations, this is a disease possibly caused by bacteria, nematodes and fungi of **Rosellini** and **Fusarium.** *(Summary by H.J.S.)* E03

0658-1963 SADASIVAM, K. V. and PRASAD, N. N. **Phyllosphere and rhizosphere microflora of healthy and diseased tapioca plants.** Science and Culture 39(1):46-49. 1973. Engl., 16 Refs.

Cassava. Diseases and pathogens. Bacterioses. Mycoses. Roots. Leaves. HCN content. Plant physiology. Metabolism. Pests.

Healthy and diseased (with leafspot, *Cercospora henningsii*) plants of the same age were compared. On the leaves of the diseased plants, bacteria had increased about 4-fold and fungi, 7-fold, whereas actinomycetes had decreased by half. On the roots of the diseased plants the bacteria had increased about 2-fold, but the fungi and actinomycetes on both roots and tubers had remained about the same. The HCN content was somewhat lower in the diseased leaves and roots and somewhat higher in the tubers. *(Summary by Chemical Abstracts)* E03 E02

0659-2185 BOURIQUET, G. **Pathologie du manioc dans les térritoires français d'Outre-mer.** *(Cassava plant pathology in the Overseas French Territories).* *In* Congrès du Manioc et des Plantes Féculentes Tropicales, Marseille, 1949. Compte-rendu. Marseille, Institut Colonial, 1949. pp. 73-75. Fr., 6 Refs.

Cassava. Diseases and pathogens. Pests. Viroses. Mycoses. Bacterioses. Disease control. Malagasy Republic. Java.

Brief notes are given about mosaic diseases, fire disease (*Bacterium robici* Bour), cercosporioses, antracnoses, rotting (*Phaseolus manihotis* Heim), cutting alterations *(Lasiodiplodia theobromae)* and damage caused by *Raghnildiana manihotis.* Information given concerns historical notes on disease development, symptoms, signals, damage and control. *(Summary by H.J.S.)* E03 E04

0660-0263 DRUMMOND-GONCALVES, R. **Apodrecimento das hastes e raizes da mandioca.** *(Rotting of cassava tubers and stems).* Biológico 23:244-245. 1957. Port.

Cassava. Diseases and pathogens. Pests. Disease control. Tubers. Mycoses. Stems. Java. Brazil.

Comments are given on the symptoms and control of a cassava root disease found in Brazil and on the identity of its causal agent. A ring was observed on the stem near the ground; the tubers and their peduncles were decayed. The fungus *Helicobasidium compactum,* which also affects other plants in Brazil and Java, was found to be the causal agent. Burning affected plants is recommended. *(Summary by H.J.S.)* E03

0661-0269 **PLEOPHRAGMIA MANIHOTICOLA n. sp.** Bragantia 3(4):45-48. 1943. Port., 1 Ref., Illus.

Cassava. Diseases and pathogens. Mycoses. Leaves. Pests. Brazil.

A description is given of the developmental stages of the fungus *Pleophragmia manihoticola* which was isolated from cassava leaves in Campinas, Sao Paulo (Brazil). Drawings of the fungus, as well as a Latin description for taxonomical purposes, are presented. *(Summary by H.J.S.)* E03

0662-2283 FERNIER, H. **Un Bombardia nouveau sur manioc. Remarques sur l'anatomie de la paroi périthéciale de quelques Bombardia et la différenciation des ascospores chez les Sordariacées.** *(A new Bombardia on cassava; notes about the perithecial wall anatomy of some Bombardia and the differentiation of ascospores in Sordariaceae).* Revue de Mycologie 19 (suppl.):1-19. 1954. Fr., Sum. Fr., 7 Refs., Illus.

Cassava. Mycoses. Diseases and pathogens. Pests.

Bombardia manihotis nov. spp. provided a basis for the study of a significant structure in the perithecial walls. These walls are comprised of two zones: the inner zone which consists of enlongated hyaline cells and the outer zone formed by discontinuous masses of cells with very thick walls, linked to each other by elongated cells with a fine wall. Externally, the perithecium seems to consist of hexagonal carbonated plates. This structure was found in *Lasiosphaeria dichoospora* Ell. et Ev., erroneously classified as *Eosphaeria uliginosa* (Fr.) v. Hohn. The perithecial wall of *Bombardia fasciculata* (Fr.) consists of a large, slightly pigmented medium zone limited by two brown zones which are not very thick. This perithecial wall has been recognized as identical to that of *Bombardioidea bombardiodes* (Auers W.) Moreau. The structure of the perithecium of *Bombardia coprophila* (Fr.) Kirsch. is in between that of the structures of *Bombardia manihotis* and that of **Sordaria** and **Pleurage.** These different types of perithecial walls within the same genus **Bombardia** has led to the reclassification of the **Bombardia** genus in a wider sense that is defined as follows: **Bombardia** (sensu nobis) = **Bombardia** (sensu Moreau) = **Lasiosordiaria** (sensu Chementais) = **Lasiosordiaria** (sensu Munk) = **Bombardia** (sensu Munk). Under the name of *Bombardia brassicae* (Kl.) Kirsch, 2 different mushrooms were erroneously put together: *Bombardia culmigena* (Sacc.) nov. comb. and *Pleurosordaria brassicae* nov. gen. et nov. comb. The genus **Pleurosordaria** is characterized by the elliptic differentiation of the ascospores which possess two other germinative spores and two appendices. This genus establishes a stage of transition between **Sordaria** and **Pleurage.** *(Author's summary)* E03

0663-1588 SATHYRAJAN, P. K., CHADRASEKHARAN NAIR, M. and RAMANTHA MENON, M. **An Alternaria leaf spot of tapioca.** Current Science 44(1):32. 1975. Engl., 1 Ref.

Cassava. *Manihot esculenta.* **Pests. Diseases and pathogens. Mycoses. Alternaria. Leaves. India.**

At the instructional farm of the College of Agriculture at Vellayani, cassava plants *(Manihot esculenta Crantz)* about 7 months of age were affected by a leaf spot disease during April, 1974. The spots were observed mainly near the tips of the leaf lobes. The minute spots had grayish white centers and brown margins. The leaf tips often dried because of the formation of a number of spots. Only rarely were spots observed on the basal part of the leaf blade. Repeated isolations from the infected regions yielded an **Alternaria** species. The pathogenicity of the same was established by spray inoculating plants artificially with 6-day-old cultures of the organism. Typical leaf spot symptoms were formed in 7-10 days after inoculation. The fungus was reisolated into pure culture from inoculated plants. A detailed study of the morphological characters of the fungus on potato-dextrose agar revealed the following: The mycelium was slightly dark and 2.25-10.5 μ wide. Conidia were mostly single, sometimes in chains of 1-3, provided with 1-9 transverse septa and a maximum of 3 longitudinal septa. Conidia were dark brown, obclavate, rarely elliptical, attenuate, beak short, rarely long. Including the beak, the conidia measured 14.04-76.38 μ (40.07 μ); the beak alone was 8.13-61.75 μ in length (15.37 μ). The breadth at the basal region ranged between 5.68 13.0 μ (10.75 μ) and at the base of the beak, 3.25-8.12 μ. The conidiophore measured on the average 78.5 μ x 3.25 μ, with 6-9 septations and 1 or 2 lateral scars. The morphological details closely resembled these of *Alternaria palandui* Ayyangar reported from **Allium** species by Ayyangar (1928). Artificial cross inoculation of *Allium cepa* L.

by the isolate from cassava gave positive results. From the close resemblance of the morphological characters and by the cross inoculation tests carried out, the isolate from cassava was identified as *A. palandui* Ayyangar. For the first time, cassava is recorded as a host of this organism causing leaf blight disease. *(Full text)* E03

0664-2434 RAMAKRISHNAN, C. K., MENON, M. R. and SAJOO, B. V. *Cercospora henningsii* **Allesch. on ceara rubber.** Agricultural Research Journal of Kerala 8(2):129-30. 1970. Engl., 2 Refs., Illus.

Manihot glaziovii. **Pests.** ***Cercospora henningsii.*** **Diseases and pathogens. Mycoses. India.**

Cercospora henningsii Allesch. is recorded for the first time on ceara rubber (*Manihot glaziovii* Muell. Arg.) in India. The disease appeared on the older leaves as minute, dark green spots which soon turned brown. The fruiting bodies were found in the center of the spots. The conidiophores (in clusters of 5 to 10) arising from the stroma were septate, light brown in color, with bulged bases and echinulate tips. The conidia were 1-8 septate, hyaline, straight or irregularly curved, measuring 5.71µ x 47.72µ on an average. *(Summary by Biological Abstracts)* E03

0665-2293 HEIM, R. **Le** ***Phaseolus manihotis*** **sp. nov., parasite du manioc a Madagascar et considerations sur le genre Phaseolus Pat.** *(Phaseolus manihotis, a cassava parasite in Madagascar, and considerations of the genus Phaseolus Pat).* Annales de Cryptogamie Exotique 4:175-189. 1931. Fr., 19 Refs., Illus.

Cassava. Mycoses. Diseases and pathogens. Pests. Disease control.

An extensive study of the fungus is presented. Data given concern macro- and microscopic characteristics; differences between *Phaseolus manihotis* and other species of the same genus; extraction, nature and location of coloring substances contained in *P. nidulans* and *P. manihotis;* polyporic acid ("acide polyporyque") of *P. nidulans;* the extraction of a substance giving acid reaction from *P. manihotis;* and symptoms, development and control of the root rotting caused by *P. manihotis. (Summary by H.J.S.)* E03

0666-2051 VIENNOT-BOURGIN, G. and GRIMALDI, J. **Les Cercospora, parasites des feuilles de manioc.** *(The parasitic* **Cercospora** *of cassava leaves).* Revue International de Botanique Appliquée 30:138-146. 1950. Fr., 10 Refs., Illus.

Cassava. Mycoses. *Cercospora henningsii.* **Leaves. Diseases and pathogens. Pests.** *Cercospora caribaea.*

Discussions about the taxonomy of the **Cercospora** species affecting cassava leaves are presented. The following species were finally distinguished: (a) *Cercospora henningsii* Allesch=*C. cassavae* Ell. et =*C. manihotis* Henn. 1902= *C. cearae* Petch=*Septogloeum manihotis* Zimm.= *C. manihoticola* Stev. *Cercosporella pseudoidium* Steg.= *Helminthosporium hispaniolae* Cif.=*Helminthosporium manihotis* Rang. The ascosporic stage of this species is *Mycosphaerella manihotis* Syd.=*M. manihotis* Ghesq. et Henr. (b) *Cercospora caribaea* Chupp et Cif.= *C. henningsii* auct. pluribus incl. Cif. non All= *C. cearae* Chupp 1930 non Petch =*Ragnhildiana manihotis* Solh. et Stev.= *Corynespora manihotis* (Solh. et Stev.) Solh. The ascosporic stage of this species is probably a **Mycospharella.** In addition, in 1935 Muller and Chupp separated *Cercospora vicosae* sp. nov. from *C. henningsii* and from *C. cariabaea,* of which no mention has been found in the literature. It was impossible to define the systematic position of these species. *(Summary by H.J.S.)* E03

0667-3118 DE URRIES, M. J. **Notas micológicas.** *(Mycological notes)* Anales del Instituto Botánico A. J. Cavanillo 10(2):193-228. 1952. Span., 16 Refs., Illus.

Cassava. Diseases and pathogens. Mycoses. Pests. Stems.

A description is given of 32 fungi. *Gloesporium caballeroi* sp. nov. was found in cassava stems at the Valencia (Spain) Botanical Garden. *(Summary by H.J.S.)* E03

0668-0566 GOLATO, C. *Cercospora henningsii* **sulla manioca in Nigeria.** *(Cercospora henningsii on cassava in Nigeria).* Rivista di Agricoltura Subtropicale e Tropicale 57(1-3):60-66. 1963. Ital., Sum. Ital., Fr., Engl., 11 Refs., Illus.

Cassava. *Cercospora henningsii. Manihot esculenta.* **Pests. Diseases and pathogens. Mycoses. Identification. Etiology. Nigeria.**

The author describes a disease of *Manihot utilissima* Pohl caused by *Cercospora henningsii.* Allescher, which he studied while he was in Nigeria. *(Author's summary)* E03

0669-3148 **ROOT DISEASE in replanted areas.** Ceylon. Rubber Research Scheme. Advisory Circular no. 10 (Suppl.). 1943. 2p. Engl.

Cassava. Diseases and pathogens. Inter-cropping. Cultivation systems. Pests. Disease control. Rubber. Mycoses. Sri Lanka.

A severe outbreak of *Fomes lignosus* occurred in an area replanted to rubber and interplanted with cassava. Inspection showed that the infection has originated from old rubber roots and that cassava has helped spread the disease. Cassava could be used as an indicator plant, but the foliage does not necessarily wilt when the roots are attacked. The disease is not normally revealed until the crop is harvested. Recommendations are given for eradication of the disease. *(Summary by H.J.S.)* E03 K01

0670-3371 SECHET, M. **Maladie du manioc.** *(A cassava disease).* Bulletin Agricole de Madagascar 2(15):19-20. 1949. Fr.

Cassava. Diseases and pathogens. Pests. Disease control. Tubers. Mycoses. K. Fertilizers. Rosellinia.

Cassava root rotting was found at Moramanga, Madagascar. The symptoms were a paler coloration of leaves, an aqueous aspect of stem pith, and a withering appearance. Symptoms of the tubers were grayish white filaments; and disease at an advanced stage causes rotting. Basal portions of different-aged plants are also attacked. The causal agent is a fungus of the genus **Rosellinia.** Due to the lack of advanced development, it has not been possible to identify it with *R. necatrix*, which causes rotting in fruit trees. Damage of this disease is significant due to its fast propagation. Sick plants and their neighbords should be pulled out; 1 kg lime| m² should be spread in infected sites; the soil should be opened to sunlight. Care must be taken to avoid excessive planting unless healthy plants are to be used. Use of K may be of great advantage. *(Full text)* E03

0671-0568 FASSI, B. **Premières observations sur une pourrite des racines du manioc causée par un Phytophthora.** *(Observations of cassava root rot caused by a Phytophthora).* Bulletin d'Information de l'INEAC 6(5):313-317. 1957. Fr., Illus.

Cassava. Tubers. Diseases and pathogens. Mycoses. *Phytophthora drechsleri.* **Pests. Zaire.**

A general overview of cassava root rot (**Phytophthora** sp.) is given including disease symptoms, soil and climate conditions, pathogenicity trials, cultural practices and control methods. The first symptoms are observed in the vascular zone, which becomes yellow or light brown in color. In laboratory trials the organism was isolated and identified as **Phytophthora** sp., a phycomycete of the **Pythiaceae** family. Germination of reproduction and propagation organs of the fungus requires a water-saturated milieu; therefore it appears at the beginning of the rainy season. The fungus attacks both sweet and bitter varieties. Planting should not be done in infected soils, and drainage should be provided. Planting distances should not exceed 1 x 1 m. Leaving the roots unharvested for extended periods of time may increase **Phytophthora** attacks. *(Summary by J.L.S.)* E03

0672-2396 FIGUEIREDO, M. B. **Mandioca com "ferrugem".** *(Cassava rust).* Chacaras e Quintais 116(1):30-31. 1967. Port.

Cassava. Pests. Mycoses. Diseases and pathogens. Brazil.

The author answers a letter dealing with cassava rust in Sao Paulo, Brazil. It is believed that a **Uromices sp.** caused the disease. *Sclerotium rolfsii* was found inducing root rot. *(Summary by H.J.S.)* E03

0673-0590 DRUMMOND-GONCALVES, R. **Podridão das raizes.** *(Root rot).* **Biológico 16:17-18.** 1946. Port., Illus.

Cassava. Pests. Diseases and pathogens. Mycoses. Rosellinia. Disease control. Brazil.

Root rot is caused by fungi of **Rosellinia** genus and of **Agaricaceae.** A description is given of the microenvironment, of the **Rosellinia** fungus, the way it attacks the plant and the methods of control. *(Summary by H.J.S.)* E03

0674-0284 CASTAÑO A., J. J. **Mancha foliar de** *Cercospora caribaea* **en yuca (***Manihot utilissima* **Pohl), en la región de Barbosa (Antioquia).** *(Leaf spots of Cercospora caribaea in cassava, Manihot utilissima Pohl, in the region of Barbosa, Antioquia).* Agricultura Tropical (Colombia) 25(6):327-329. 1969. Span., Illus.

Cassava. Pests. Diseases and pathogens. Mycoses. *Cercospora caribaea. Cercospora henningsii.* **Colombia.**

This article studies the principal pathological problems of leaf spots caused by **Cercospora** spp. in cassava leaves. It describes the damage caused by *Cercospora caribaea* and *C. henningsii. (Summary by P.A.C.)* E03

0675-2471 BITANCOURT, A. A. and JENKINS, A. E. *Sphaceloma manihoticola* **sp. nov.** Arquivos do Instituto Biológico 20:15-16. 1950. Port.

Cassava. Mycoses. Leaves. Petioles. Diseases and pathogens. Pests. Brazil. Dominican Republic.

This fungus, found in Brazil and in the Dominican Republic, causes a leaf spotting in cassava plantings. A description is given of symptoms of the so-called canker disease ("verrugose"), which causes damage mainly in the nerves, leaf edges and petioles. *(Summary by H.J.S.)* E03

0676-0327 FIGUEIREDO, M. M. and ALBURQUERQUE, F. C. DE. **Podridão mole das raizes da mandioca,** *Manihot esculenta. (Soft rot of cassava, Manihot esculenta, roots).* Pesquisa Agropecuaria Brasileira 5:389-393. 1970. Port., Sum. Engl., 5 Refs., Illus.

Cassava. Roots. *Phytophthora drechsleri.* **Pests. Diseases and pathogens. Mycoses. Disease control.**

A **Phytophthora** sp. was isolated from the transition layer tissues of rotten cassava roots. Its sporangia were irregular in size and shape. They were able to germinate or liberate zoospores at certain temperature and moisture conditions. Its oogonium was globose; the amphigynous antheridium adhered to its base. The fungus also formed some oospores in tap water. On the basis of the characteristics of the sporangia and oospores, the species was identified as *Phytophthora drechsleri.* Inoculation tests into small vertical incisions made on the stem proved the pathogenicity of the fungus. The inoculated plants died from the rotted areas around the inoculated wounds; plants that were wounded but not inoculated remained healthy. When the fungus was introduced into the root incision, it caused tissue deterioration and sometimes death of the plants. Drawings of the main structures of the **Phycomycete** are presented. Some control measures are suggested, taking into account physical conditions of the soil. Resistant varieties would certainly be the most appropriate method of control in areas where soils are highly infested with the spores of the pathogen. *(Author's summary)* E03

0677-0603 POWELL, P. E. **The Cercospora leaf spots of cassava.** Ithaca, N.Y., Cornell University, 1968. 15p. Engl., 15 Refs.

Cassava. ***Cercospora henningsii. Cercospora caribaea.*** **Mycoses. Pests. Diseases and pathogens. Dis[illegible] control. Brazil.**

This paper is a review of literature on *Cercospora henningsii* and *C. caribaea*, which respectively cause brown and white leaf spot in cassava. These two diseases are described, compared and contrasted. Drawings of the fungi are included. *(Summary by H.J.S.)* E03

0678-0241 VIEGAS, A. P. **Manchas das folhas da mandioca, produzidas por Cercosporas.** *(Cassava leaf spots produced by* **Cercospora** *spp.).* Bragantia 1(3):233-248. 1941. Port., 57 Refs., Illus.

Cassava. Mycoses. Etiology. Pests. Diseases and pathogens. ***Cercospora henningsii. Cercospora caribaea.*** **Disease control. Leaves. Economics. Brazil.**

This paper is divided into two parts: one concerning brown leaf spot *(C. henningsii)* and another concerning white leaf spot *(C. caribaea)*. Data given on both fungi deal with variety susceptibility, geographical distribution, economic importance, damage, etiology, life cycle and control. It seems that brown spot does not have any economic importance; but white spot does, mainly in hot weather. *(Summary by H.J.S.)* E03

0679-0240 VIEGAS, A. P. **Alguns fungos da mandioca, II.** *(Some fungi of cassava, II.).* Bragantia 3(2):21-29. 1943. Port., 6 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Mycoses. Fusarium. Brazil.

The following fungi attacking cassava are described: (1) *Exidiopsis manihoticola* Nov. sp. is found on the cuttings and stems of *Manihot utilissima* Pohl and Manihot spp. (wild species). (2) *Fusarium aquaeductuum* var. medium Wr., a saprophyte fungus found on cassava cuttings when piled outdoors in the rainy season. Rotting of this fungus was verified at Nova - Obessa, Campinas (Brazil); it also occurs in rotten wood in America, Europe and Asia. *(Summary by J.L.S.)* E03

0680-0325 GOLATO, C. and MEOSSI, E. **Una grave infezione fogliare della manioca in Ghana.** *(A serious cassava leaf spot disease in Ghana).* Rivista di Agricoltura Subtropicale e Tropicale 65(1-3):21-26. 1971. Ital., 12 Refs., Illus.

Cassava. Leaves. ***Cercospora henningsii.*** **Pests. Diseases and pathogens. Mycoses. Ghana.**

Symptoms are described of a leaf spot disease in cassava frequently observed in the Ashanti and eastern regions of Ghana. Morphological information is given on the causal fungus *(Cercospora henningsii)*. The dark leaf spots are 2-3, to 11 mm in diameter, depending on the conditions, and are surrounded by a dark grayish zone; later the central part of the spots turns light grayis in color. The disease may result in partial or complete leaf fall. Damage is difficult to assess since the disease often occurs in combination with the mosaic virus disease. Treatment with Colper-based fungicides might be effective but is probably uneconomical. *(Summary by Tropical Abstracts)* E03

0681-1702 EKUNDAYO, J. A. and DANIEL, T. M. **Cassava rot and its control.** Transactions of the British Mycological Society 61(1):27-32. 1973. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Diseases and pathogens. Mycoses. Moulds. Tubers. Aspergillus.** ***Lasiodiplodia theobromae.*** **Disease control. Pests.**

Soft rot of cassava *(Manihot utilissima* Pohl) was found to be caused by *Lasiodiplodia theobromae* (Pat.) Grill. & Mobl., *Trichoderma harzianum* Rifai, *Cylindrocarpon candidum* (Link) Wollenw., *Aspergillus* *niger* van Tieghem and *Aspergillus flavus* Link. The organisms enter tubers through wounds, bruises and natural openings. High relative humidities (50-100%) favor rot development by *L. theobromae;* and in the presence of light, pycnidia are formed. Benomyl (a systemic fungicide) controls soft rot of cassava tubers. *(Author's summary)* E03

0682-0239 VIEGAS, A. P. **Alguns fungos da mandioca. I.** *(Some cassava fungi. I.).* Bragantia 3(1):1-17. 1943. Port., 29 Refs., Illus.

Cassava. Manihot. Pests. Diseases and pathogens. Mycoses. Taxonomy. Oidium. ***Sclerotium rolfsii.*** **Phyllosticta.** ***Manihot esculenta.*** **Leaves. Brazil.**

Descriptions are given of three fungi: (1) *Oidium manihotis* P. Henn; a disease known as mildew, attacking the leaves of cassava. This disease is found exclusively on the leaves of **Manihot** wild species. Mueller referred to the species occurring at Minas as *Oidium manihotis* Av. Saccá; (2) *Sclerotium rolfsii* Sacc. This was the first time that the occurrence of this fungus was verified in Brazil. A list is given of crops susceptible to this fungus; (3) *Phyllosticta manihotae* n. sp. is found on the leaves of *Manihot utilissima* Pohl. *(Summary by J.L.S.)* E03

0683-0341 CIFERRI, R. **Le malattie della manioca** *(Manihot esculenta* **Crantz) in San Domingo. II. La malattia delle macchie fogliari circolari** (*Helminthosporium hispaniolae* **Cif**). *(A disease of cassava, Manihot esculenta Crantz, in Santo Domingo. II. The circular leaf spot disease, Helminthosporium hispaniolae Cif).* Bolletino della Stazione di Patologia Vegetale di Roma 13:261-307. 1933. Ital., Sum. Engl., 19 Refs., Illus.

Cassava. ***Cercospora henningsii.*** **Leaves. Etiology.** ***Manihot esculenta.*** **Dominican Republic.**

The circular leaf spot disease of cassava is fully described. The causal agent is *Helminthosporium hispaniolae* Cif., a fungus closely related to the Brazilian *H. manihotis* Rang. Characteristics of the fungus in nature and in culture are given, as well as data on the geographical range, seasonal distribution, etc. The disease has been reproduced by artificial inoculations on germinated cuttings enclosed in moist chambers or under normal environmental conditions. The varietal susceptibility of cultivated varieties has been studied: varieties with violet, bluish or brownish young leaves are more resistant than varieties with green or yellowish green leaves. Under natural conditions, young (not fully developed) leaves are very resistant or immune to the disease. Solutions of untreated anthocyan from young leaves inhibited germination of conidia. The relation between total surface area of leaf spots and meteorological conditions were studied using Pearson's partial and total correlation indices. A significant, moderately high positive correlation was found. The disease is not of primary importance; hence no methods for artificial control are proposed. *(Author's summary)* E03

0684-0595 CHEVAUGEON, J. **Maladies cryptogamiques du manioc en Cote d'Ivore. I. Observations préliminaires sur la nécrose des sommités.** *(Cryptogamic diseases of cassava in the Ivory Coast. I. Preliminary notes on the necroses of aerial parts).* Revue de Pathologie Végétable et d'Entomologie Africole de France 29(1-2):3-9. 1950. Fr., 12 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Isolation. Identification. Stems. Petioles. Laboratory experiments. Mycoses. Ivory Coast.

The most frequent and damaging disease in the Ivory Coast after the mosaic, is the necrose of the aerial part. Generally, the causal agent of the necrose of aerial parts is *Gloeosporium manihotis* Hennings, but in the Ivory Coast it was identified as *Colletotrichum manihotis* Hennings. The first symptoms appear near the top of young branches. Branches lose their chlorophyll, their diameter decreases, and they wither. Early shedding of leaves occurs and the apex dies. Lower parts of the attacked plant are marked by a thin black or brownish red line, according to variety. Isolation, identification and pathogenicity trials were carried out. After laboratory experiments, the name of *Glomerella manihotis* was proposed for the causal agent. *(Summary by J.L.S.)* E03

0685-3046 AMARAL, J. F. DO. **Ferrugem (Uromyces) da mandioca.** *(Cassava rust, Uromyces).* Biologico 8:148. 1942. Port.

Cassava. Mycoses. *Uromyces manihotis.* **Diseases and pathogens. Pests. Brazil.**

A brief description is given of damage caused by the fungus *Uromyces manihotis.* The disease is called rust. **Uromyces** was found in association with **Cloesporium.** *(Summary by H.J.S.)* E03

0686-3012 NORMANHA, E. S. and SILVA, J. R. DA. **Novo mal ataca a mandioca.** *(A new disease attacks cassava).* Coopercotia 21(181):47-48. 1964. Port., Illus.

Cassava. Mycoses. Roots. Leaves. Tubers. Identification. Diseases and pathogens. Pests. *Sclerotium rolfsii. Cercospora henningsii. Cercospora caribaea.* **Rosellinia. Brazil.**

A disease causing collar and root rot was reported in commercial cassava plantations in Araras (São Paulo). Disease symptoms are described; the causal agent is possibly *Sclerotium rolfsii. (Summary by H.J.S.)* E03

0687-3015 PACCA, D. W. **Sôbre o "diplodia" da mandioca. (Diplodia in cassava).** Rodriguesia 1(2):77-81. 1935. Port., 5 Refs.

Cassava. Mycoses. Storage. Diseases and pathogens. Pests. Tubers.

Diplodia theobromae does not attack vigorous tissues of cassava plants. It is the main causal agent of frequent alterations in tubers soon after harvesting. A description is given of field trials carried out on **Diplodia** infestation. *(Summary by H.J.S.)* E03

0688-3029 VIEGAS, A. P. **A podridão das raizes de mandioca.** *(Cassava root rot).* Revista Agronómica (Brazil) 17:202-208. 1955. Port., Sum. Port., Engl., 8 Refs., Illus.

Cassava. Roots. Diseases and pathogens. Pests. Mycoses. Rosellinia. *Manihot esculenta.* **Brazil.**

Healthy cassava plants raised in large cement pots were inoculated with pure cultures of *Rosellinia bunodes.* The fungus caused root rot identical to that of samples collected in the field at Santa Catarina. *(Author's summary)* E03

0689-3086 THOMPSON, A. **Notes on plant diseases in 1937-1938; tapioca.** Malayan Agricultural Journal 27(3):97. 1939. Engl., Illus.

Cassava. Mycoses. Diseases and pathogens. Pests. Malaysia.

A heavy mortality from root disease was reported from an area in Lower Perak, where cassava had been planted in heavy clay subject to waterlogging. The fungus responsible for the death of the plants was *Sphaerostile repens. (Full text)* E03

0690-3032 VIEGAS, A. P. **Alguns fungos do Brasil, Cercosporae.** *(Some fungi from Brazil, Cercosporae).* Boletim da Sociedade Brasileira de Agronomia 8(1):1-160. 1945. Port., 111 Refs., Illus.

Cassava. Manihot. *Manihot glaziovii. Cercospora caribaea. Cercospora henningsii.* **Diseases and pathogens. Mycoses. Pests. Laboratory experiments. Identification. Brazil.**

About 380 species of the genus **Cercospora** are described with excellent drawings of the fungi and host signals. Fungi described relating to **Manihot** spp. are *C. caribaea,* and *C. manihobae* Viegas sp. nov., found in cassava; *C. henningsii* found in cassava and in *Manihot glaziovii;* and *C. vicosae* Mueller e Chupp found in **Manihot** spp. A general description of the genus is given. *(Summary by H.J.S.)* E03

0691-3113 GRILLO, H. V. S. **Lista preliminar dos fungos assignalados em plantas do Brasil.** *(Preliminary list of fungi cited for Brazilian plants).* Rodriguesia 2:39-96. 1938. Port., 6 Refs.

Cassava. Manihot. Diseases and pathogens. Pests. Mycoses. Brazil.

Fungi existing in the herbarium of the Instituto de Biologia Vegetal (Rio de Janeiro) are listed. The herbarium has about 2,000 samples of fungi related to about 1,000 species of hosts conserved in formaldehyde or in Pollaci-Drummond liquid. Twenty-one fungi found on **Manihot** spp. are included. *(Summary by H.J.S.)* E03

0692-3146 RORER, J. B. **Fungus diseases of cassava.** Bulletin of Department of Agriculture, Trinidad and Tobago 14(2):36-38. 1915. Engl.

Cassava. Mycoses. Leaves. Tubers. Stems. Diseases and pathogens. Pests. Trinidad and Tobago.

Brief notes are given on fungus diseases in Trinidad. The island was free of mycoses until a few years ago; but with the increased areas planted to cassava, some fungi attack leaves, stems and roots. Fungi remain unidentified. *(Summary by H.J.S.)* E03

0693-4443 NAGARAJA, V., BHAT, R. V. and TULPULE, P. G. *Aflatoxin-like factor in tapioca (Manihot utilissima).* Environmental Physiology and Biochemistry 3(1):13-18. 1974. Engl., Sum. Engl., 16 Refs.

Cassava. Cassava chips. Diseases and pathogens. Mycoses. Pests. Dried tubers. Analysis. Toxicity. India. Moulds.

About 20 samples of fungal infected cassava chips were screened for aflatoxin contamination. An aflatoxin-like compound was found to be present in most of the samples but several confirmatory tests ruled out aflatoxin. The importance of confirmatory tests in screening protocols is discussed. *(Author's summary)* E03.

0694-3093 OVEREEM, C. VAN. **Cercosporaceae.** Icones Fungorum Malayensium no. 10:1-4. 1925. Germ., 19 Refs.

Cassava. Leaves. *Cercospora henningsii.* **Diseases and pathogens. Mycoses. Pests.**

Cercospora cassavae (Syn. *C. manihotis* H. and *C. henningsii* A.) is characterized by small, often roundish leaf spots. The spots can also be large, leaf drop occurs, and there are conidia on leaves and upper leaf surfaces. The mycelium is conically septated. The disease seems to be spread all over the world in cassava-growing areas; it is not described in depth due to the relatively low yield reductions it causes. The disease can, however, be serious in plants weakened by spider mite attack. A short review is given of the history of the description of the fungus, as well as of its taxonomy related to other groups of fungi, especially the **Cercosporaceae.** *(Summary by A. van S.)* E03

0695-3062 SACCA, R. A. **Una molestia de mandioca;** *Sclerospora manihot. (A disease of cassava; Sclerospora manihot).* Fazendeiro 5:368-369. 1972. Port., Illus.

Cassava. Pests. Diseases and pathogens. Mycoses. Disease control. *Manihot esculenta.* **Brazil.**

Damage caused by *Sclerospora manihot* may be considered of economic importance. The fungus propagates easily in low humid regions. Crop density plays an important role in its propagation. Damaged plants present decoloration of the parenchyma,leaf wilting, curling and defoliation. Since leaves are affected, starch content may decrease. The use of resistant varieties is recommended. Planting should not be done in humid and shaded regions; drainage should also be provided. *(Summary by J.L.S.)* E03

0696-3020 THOMPSON, A. **Notes on *Sclerotium rolfsii* Sacc. in Malaya.** Malayan Agricultural Journal 16:48-58. 1928. Engl., 6 Refs., Illus.

Cassava. Starch crops. Rice Mycoses. Deterioration. Laboratory experiments. Diseases and pathogens. Pests.

Sclerotium rolfsii Sacc. is a fungus which possesses no known conidial stage and which survives by means of hard, small, round brownish bodies known as sclerotia. It attacks groundnut, coffee, sweet potatoes, tomatoes, potatoes, *Capsicum annuum*, sugar cane and rice. In Malaya it has been observed in *Helianthus tuberosus, Piper betle, Crotalaria usaramoensis, Tephrosia candida, Spathoglottis plicata, Glycine hispida,* rice, **Caladium** spp. and cassava. It attacks the parts of the plants in contact with the ground. Data given deal with symptoms, cultural studies, inoculation experiments and control measures. *(Summary by H.J.S.)* E03

0697-0306 CASTAÑO A., J. J. **La "llaga negra" o "podredumbre negra" radicular de la yuca.** *(Black root rot of cassava).* Agricultura Tropical (Colombia) 9(11):21-29. 1953. Span., 3 Refs., Illus.

Cassava. Diseases and pathogens. Etiology. Pests. Disease control. Mycoses. Colombia.

A description is given of the symptoms and the etiology of the black root rot of cassava, which is caused by *Rosellinia necatrix* or by *Dematophora necatrix*. Control methods are discussed. A number of cultivation measures are recommended, including treating the soil with lime. *(Summary by Tropical Abstracts)* E03

See also 0072 0554 0577 0812 1732 1923

E04 Viroses

0698-2353 LE MANIOC dans la Grande Ile. *(Cassava in the Great Island).* Chronique d'Outre Mer 10:35-36. 1952. Fr.

Cassava. Cultivation. Production. Diseases and pathogens. Cassava mosaic virus. Pests. Resista. Viroses. Malagasy Republic.

The cultivation of cassava in Madagascar decreased 90% between 1935 and 1937 because of mosaic disease. Extensive selection experiments with many varieties have produced clones resistant to mosaic disease and rotting, that mature rapidly, and have a high starch content. In 1950, 191,630 ha produced 817,000 tons of roos; and in 1951, 210,864 ha produced 952,742 tons. *(Summary by Tropical Abstracts)* E04

0699-0428 ABRAMIDES, E., NORMANHA, E.S. and ESPINO, A. **Queda de produção de raizes de mandioca devida a um tipo de superbrotamento no sul do México.** *(Decrease of cassava tuber production due to a witches'-broom disease in southern Mexico).* Ciencia e Cultura 16(2):143. 1964. Port.

Cassava. Cassava common mosaic virus. Diseases and pathogens. Productivity. Statistical analysis. Viroses. Pests. Tuber productivity. Mexico.

Data are given on statistical analyses made to test the influence of a broomlike disease on cassava tuber yields. *(Summary by H.J.S.)* E04

0700-0849 KENYA. DEPARTMENT OF AGRICULTURE. **Cassava.** *In*_____. Annual Report of the Agricultural Officer (Experiments), Coast Province, 1952. pp.148-151. Engl.

Cassava. Pests. Viroses. Cassava mosaic virus. Cassava brown streak virus. Productivity. Timing. Cultivars. Diseases and pathogens. Field experiments. Resistance. Kenya.

This paper gives qualitative data about a trial for testing the resistance of 43 cassava clones to mosaic and brown steak virus. It also describes some preliminary observations of yield increments at different periods of maturity and examines the ratio of the tops of roots of some cassava clones. *(Summary by H.J.S.)* E04

0701-0345 CHILDS, A.H.B. **Trials with virus resistant cassavas in Tanga Province, Tanganyika.** East African Agricultural Journal 23(2):135-137. 1957. Engl.

Cassava. Cultivars. Field experiments. Cuttings. Propagation materials. Diseases and pathogens. Viroses. Cassava mosaic virus. Cassava brown streak virus. Resistance. Selection. Hybrids. Pests. *Manihot esculenta.* Tanzania.

Material of cassava hybrids was received from the East African Agriculture and Forestry Research Organization, Amani, for multiplication and further testing in 1952 and 1953. By the long rains of 1955, 8 varieties had been selected on the basis of resistance to virus disease and yielding qualities, and further tests were carried out at 32 centers in Tanga and Pangani Districts. The varieties chosen were all third backcross hybrids from a cross between cassava (*Manihot esculenta* Crantz) and ceara rubber. (*M. glaziovii*). The object of the trials was to demonstrate to the local cultivators the higher yielding qualities of virus-resistant varieties and the superiority of ridge planting over planting on the flat. The hybrids were compared with the local varieties Fungamkia, which shows some resistance to mosaic, and Gide, which is highly susceptible but popular with cultivators since its bitterness deters pigs. Details are given of the different treatments. The two varieties chosen for multiplication and distribution were 46106| 27 for the sandy soils and 4763| 16 for the red soils. Variety 46106 | 27 was easy to establish on both types of soil, produced abundant planting material, showed a high degree of virus resistance and yielded well. It showed up particularly well on the poorest soils. *(Summary by P.A.C.)* E04

0702-0851 KENYA. DEPARTMENT OF AGRICULTURE. **Cassava.** *In*________.Annual Report 1952. Nairobi, 1953? v.2. pp. 191-193. Engl.

Cassava. Clones. Pests. Diseases and pathogens. Cassava mosaic virus. Cassava brown streak virus. Viroses. Cultivars. Resistance. Kenya.

Brief notes are given on the research carried out on the mosaic and brown streak resistance of some clones and varieties of cassava. A table is given dealing with the percentage of plants showing mosaic and brown streak attack. *(Summary by H.J.S.)* E04

0703-0244 SILBERSCHMID, K. O. **mosaico da mandioca.** *(Cassava mosaic).* Biológico 4(6):177-131. 1938. Port., 3 Refs., Illus.

Cassava. Cassava mosaic virus. Viroses. Diseases and pathogens. Pests. Leaves. Brazil.

Based on distribution of the mosaic disease on cassava leaves, the author has classified it into four groups. On the variety Vassourinha, the disease was located on the lamina and bore no relationship to the leaf veins, while on other varieties (one unidentified) there was a close relationship with leaf veins. The symptoms of the mosaic virus were the same as those of tobacco mosaic virus. Description of damage in included. This disease has also been recorded in Africa. *(Summary by J.L.S.)* E04

0704-2474 THURSTON, H. D. **Threatening plant diseases.** Annual Review of Phytopathology 11:27-52. 1973. Engl., 231 Refs.

Cassava. *Mgnihot esculenta.* **Diseases and pathogens. Viroses. Cassava mosaic virus. Etiology.** *Manihot glaziovii.* **Resistance. Pests.**

Resistance to *Sclerospora philippinensis* has been found in several maize lines native to the Philippines. The same lines are resistant to *S. sacchari* in Taiwan and *S. sorghi* in Thailand. Maize lines resistant to *S. philippinensis* and *S. sacchari* in Asia are also resistant in the USA. Many sources of resistance to *Xanthomonas oryzae* have been found in rice, but the occurrence of numerous strains of the pathogen complicates breeding. Good resistance to African cassava mosaic has been found in three clones, all derivatives of *Manihot glazovii.* Various lower levels of resistance have been reported but no immunity. Resistance to *Dothidella ulei,* attacking rubber, has been found but the existence of many physiological races complicates breeding. A plantain resistant to *Pseudomonas solanacearum* has been reported. Similar information is provided for 14 other crop diseases of intermediate or limited threat. *(Summary by Plant Breeding Abstracts)* E04

0705-0110 **SUPERBROTAMENTO OU envassouramento da mandioca.** *(Witches'-broom disease in cassava).* Biológico 8:164-165. 1942. Port., Illus.

Cassava. Diseases and pathogens. Pests. Cassava common mosaic virus. Viroses. Disease control. Brazil.

This paper is a short communication from the Department of Agriculture (Brazil) as part of a preventive campaign against the spread of witches'-broom disease in cassava in the state of São Paulo. *(Summary by J.L.S.)* E04

0706-3064 DEIGHTON, F.C. **Cassava.** Sierra Leone, Agricultural Department, 1929. p.15. Engl.

Cassava. Diseases and pathogens. Cassava mosaic virus. Viroses. Disease control. Ceara rubber. Sierra Leone.

Suggestions are made for cassava mosaic control in Sierra Leone plantations. Affected plants should be burned. Only cuttings from healthy plants should be used for planting. *(Summary by H.J.S.)* E04

0707-1784 COMMONWEALTH MYCOLOGICAL INSTITUTE. **Pathogen: Cassava mosaic viru (Dammer) Lefrevre. Hosts:** *Manihot esculenta. In* ———. Distribution maps of plant diseases. : no. 148. 1967. 2p. Engl.

Cassava. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Maps. *Manihot esculenta.* **Africa.**

Cassava mosaic virus (Dammer) Lefevre has been recorded in Angola, Cameroon, the Congo, Ghana, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Nigeria, Rhodesia, Tanzania, Uganda and Zambia. Reports of this disease in Java, Thailand, South and Central America are probably attributable to forms of insect damage that are the same in appearance as the leaf symptoms of this virus. *(Summary by J.L.S.)* E04

0708-3001 DRUMMOND-GONCALVES, R. **Superbrotamento da mandioca.** *(Cassava witches'-broom disease).* Biológico 7:329-330. 1941. Port.

Cassava. Diseases and pathogens. Pests. Cassava common mosaic virus. Viroses. Disease control. Brazil.

Answer is given to a question on the control of cassava witches'-broom disease. The causal agent of the disease is not known. Burning the infected plants and using the cassava variety called Vassourinha was recommended. Brief notes of the disease symptoms are given, as well as some remarks about research in progress on this disease. *(Summary by H.J.S.)* E04

0709-2466 DRUMMOND, O. DE A. **Mandioca; estudos de variedades resistentes ao envassouramento (virus).** *(Cassava; varieties resistant to witches'-broom disease virus).* Boletim Agricola, (Brazil) 4(11-12):152-153. 1955. Port.

Cassava. Resistance. Diseases and pathogens. Cultivars. Field experiments. Pests. Cassava common mosaic virus. Viroses. Brazil.

Twenty-five varieties were tested to find their resistance to witches'-broom disease. Clones tested were collected in Pará.Amazonas, Territorio do Amapá and Ceará. After 5 months, 10 varieties were free of the disease. *(Summary by H.J.S.)* E04

0710-0268 LISTER, R. M. **Mechanical transmission of cassava brown streak virus.** Nature 183 (4675):1588-1589. 1959. Engl., 4 Refs., Illus.

Cassava. Diseases and pathogens. Pests. Viroses. Cassava brown streak virus. Virus transmission. *Manihot esculenta.* **Laboratory experiments.**

This article discusses laboratory methods used for a mechanical transmission of the brown streak virus of cassava (*Manihot utilissima* Pohl) from the cassava plant to several solanaceous plants. Results of the experiments are given. *(Summary by P.A.C.)* E04

0711-4778 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. **Improvement of food crops; Cassava.** *In* ______. Annual report 1958-59. pp.10-12. Engl.

Cassava. *Manihot esculenta. Manihot glaziovii.* **Cassava mosaic virus. Hybridization. Field experiments.** *Manihot melanobasis.* **Nigeria.**

Cassava cultivars and lines were screened for yield and disease resistance. Hybrids from *M. glaziovii* and *M. utilissima* showed high resistance to cassava mosaic virus. *(Summary by C.B.)* E04 F01

0712-2218 DUFRENOY, J. and HEDIN, L. **La mosaique des feuilles du manioc au Cameroun.** *(The cassava leaf mosaic in Cameroon).* Revue de Botanique Appliquée et d'Agriculture Tropicale 9(94):361-365. 1929. Fr., Illus.

Cassava. *Manihot glaziovii.* **Etiology. Diseases and pathogens. Cassava mosaic virus. Pests. Cameroon.**

A brief description is made of the symptoms of cassava leaf mosaic. The geographical distribution of cassava cultivation in West Africa and Cameroon is also given. *(Summary by H.J.S.)* E04

0713-2202 **CASSAVA MOSAIC.** *In* Nigeria. Department of Agricultural Research Annual report 1959-1960. pp. 15-16. Engl.

Cassava. Diseases and pathogens. Cassava mosaic virus. Productivity. Viroses. Pests. Cultivars. Resistance. Nigeria.

It is suggested that tolerance to the mosaic virus complex can be estimated by reduction in the yield of the host plant. Resistance of some varieties to mosaic virus infection and tolerance to the pathogen are briefly described. *(Summary by H.J.S.)* E04

0714-2007 STOREY, H. H. **Virus diseases of East African plants. VI. A progress report on studies of the diseases of cassava.** East African Agricultural Journal 2:34-39. 1936. Engl., Illus.

Cassava. Diseases and pathogens. Viroses. Pests. Cassava mosaic virus. Cassava brown streak virus. Disease control. Kenya.

In the past, mosaic in cassava has been regarded as a single entity. Field trials were conducted to test a collection of mosaic types selected in the field near Amani. The result has been the separation of local strains of virus into two groups according to the severity of the symptoms. In addition, a virus producing a different type of symptom, to which the name "brown streak" has been given tentatively, has recently been recognized. Descriptions are given of the symptoms of these diseases, as well as suggestions for their control. *(Summary by H.J.S.)* E04

0715-2173 BOLHUIS, G.G. **Waarnemingen over de zg. mozaiek-ziekte bij cassava op Java.** *(Observations on the so-called mosaic disease in cassava in Java).* Buitenzorg, Java. General Agricultural Research Station. Communication no. 92. 1949. 9p. Dutch., Sum. Engl., 6 Refs.

Cassava. Diseases and pathogens. Pests. Mosaic diseases. Cassava mosaic virus. Viroses. Clones. Plant breeding. Java.

Observations dating from 1930 regarding the occurrence of a mosaic-like disease at Buitenzorg Research Station are described. Despite the contradictory facts concerning the agents causing the disease, it is apparent that so far no cassava mosaic caused by a virus has ever occurred in Java and that the symptoms observed were caused by a drop in temperature. It is not considered necessary to destroy the diseased plants on account of their low production, as they will disappear in the course of further stages of selection. *(Summary by H.J.S.)* E04

0716-2114 MOUTON, J. and SILLANS, R. **Les plantes á tubercules comestibles. Le manioc.** *(Tuber edible plants. Cassava).* Annales du Musée Colonial de Marseille 2:55-61. 1954. Fr., Illus.

Cassava. Viroses. Disease control. Productivity. Cassava mosaic virus. Diseases and pathogens. Pests. Central African Republic.

Brief notes are given about cassava in the Central African Republic. Information presented deals with plant pathology (mosaic virus), control, yields and local varieties. *(Summary by H.J.S.)* E04

0717-0261 DRUMMOND-GONCALVES, R. **Superbrotamento ou envassouramento da mandioca.** *(Witches'-broom disease in cassava).* Biológico 8:87-88. 1942. Port., Illus.

Cassava. Cuttings. Branching. Plant physiology. Pests. Diseases and pathogens. Cassava common mosaic virus. Viroses. Germination. Plant development. Developmental stages. Brazil.

Witches'-broom disease was recorded in northeastern Brazil. Cuttings attacked by this disease sprout abnormally; up to 12 buds have been registered at one single point. These buds are usually deformed and weak. This abnormal brushlike growth of small thin branches gives the plant a totally different appearance from a healthy cassava plant. Rooting of diseased cuttings is abnormal. The production of roots in diseased plants is very low. The disease is transmitted by diseased material; methods to avoid its spreading are given. *(Summary by J.L.S.)* E04

0718-2113 NICHOLS, R. F. W. **Virus diseases of cassava.** *In* East African Agricultural and Forestry Research Organization. Annual report 1950. pp. 18-21. Engl.

Cassava. ***Manihot dichotoma.*** **Genetics. Cassava mosaic virus. Cassava brown streak virus. Backcrossing. Hybridizing. Plant breeding. Diseases and pathogens. Viroses.** ***Manihot glaziovii.*** **Seed. Resistance. Field experiments. Pests. Kenya.**

Data are given on the plant pathology investigations carried out at Amani (Kenya). Information deals with interspecific hybridization of *Manihot dichotoma* to obtain resistant clones for mosaic and brown streak diseases. The first generation of hybrids possessed roots which were partly woody and therefore of no commercial value as a source of starch. Methodology and policies to be followed are briefly discussed. Field trials to eliminate the least resistant clones are briefly described. Clones of several varieties have been distributed for testing under widely divergent conditions. *(Summary by H.J.S.)* E04 G01

0719-0267 JENNINGS, D. L. **Observations on virus diseases of cassava in resistant and susceptible varieties. II. Brown streak disease.** Empire Journal of Experimental Agriculture 28 (111):261-270. 1960. Engl., Sum. Engl., 7 Refs. Illus.

Cassava. Pests. Diseases and pathogens. Viroses. ***Manihot melanobasis.*** **Hybrids. Cassava brown streak virus. Cultivars. Plant breeding. Resistance. Field experiments. Tanzania.** ***Manihot esculenta.***

It was previously thought that low temperatures were inimical to the survival of plants infected with brown streak virus; but when diseased material was grown at high altitudes in Tanganyika, it was found that the low temperatures encountered did not induce lethal symptoms. Similarly, in trials carried out in coastal regions it was found that temperature, although important, was not necessarily the main factor controlling the intensity of the brown streak symptoms recorded. An account is given of some variations in the form of brown streak disease which occurred in resistant and susceptible varieties of cassava under test in field-resistance trials. Resistant varieties exposed to infection tended to remain free of symptoms; and when symptoms did occur, they were usually mild and frequently restricted to the roots. In these varieties symptoms were often transient, recovery occurring in the second season's growth; but hybrids derived from *Manihot melanobasis* were anomalous in this respect. In an experiment with two susceptible varieties, plants derived from a stock which had been infected for some time appeared to possess a greater capacity to recover than plants derived from a clean stock. Seasonal variations in the severity of brown streak disease in two control varieties were positively correlated with variations in the degree of resistance shown to mosaic disease. *(Author's summary)* E04

0720-3098 MULLER, H. R. A. **Mozaiekiekte bij cassave.** *(Cassava mosaic* . Batavia, Java. Institut voor Plantenziekten. Bulletin no. 24. 1931. 17p. Dutch., Sum. Fr., 14 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Disease control. Java.

Cassava mosaic disease was recorded in Buitenzorg. Symptoms of this disease are described and compared to those caused by *Tetranychus bimaculatus.* Two control measures are recommended burning of infected plants and use of healthy propagation material. *(Summary by J.L.S.)* E04

0721-3152 TIDBURY, G. E. **A note on the yield of mosaic-diseased cassava.** East African Agricultural Journal 3:119. 1937. Engl.

Cassava. Diseases and pathogens. Pests. Viroses. Productivity. Cassava mosaic virus. Kenya.

Three local varieties of cassava in Zanzibar were tested to show the effect on tuber yields caused by partly and wholly-diseased stools. The wholly-diseased plants yielded significantly less than other types. There was no significant difference between the yield of a partly-diseased plant and that of a healthy plant. *(Summary by H.J.S.)* E04

0722-0251 McKINNEY, H. H. **Mosaic diseases in the Canary Islands, West Africa and Gibraltar.** Journal of Agricultural Research 39(8):557-558. 1929. Engl., Sum. Engl., 13 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Mosaic diseases. Viroses. Canary Islands. Africa. Gibraltar.

A study is made of green and yellow mosaics in the Canary Islands, West Africa and Gibraltar. As regards cassava, green mosaic was found on **Manihot** spp. in West Africa. *(Summary by T.M.)* E04

0723-2299 GUILLOTEAU, S. and DULONG, R. **Synthèse et conclusion de la collection des maniocs non mosaïqués campagnes: 1963-1965-1967.** *(Synthesis and conclusion of the cassava collection resistant to mosaic disease: 1963-1965-1967).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1968. 10p. Fr.

Cassava. Cultivars. Productivity. Field experiments. Cassava mosaic virus. Resistance. Diseases and pathogens. Pests. Viroses. Selection. Malagasy Republic.

This report summarizes the work carried out by the Experimental Station of Lac Alaotra to classify varieties resistant to mosaic virus. The collection was started in 1929, and 189 clones are classified as resistant. Hybrid H.54 was used as the control. Varieties were classified according to theoretical yield or yield per plant. Percentage is expressed according to the corresponding control. *(Summary by H.J.S.)* E04

0724-2295 HEDIN, L. **Culture du manioc en Côte d'Ivoire; observations complementaires sur la mosaique.** *(Cassava cultivation in Ivory Coast; complementary observations on the mosaic disease).* Revue de Botanique Appliquée et d'Agriculture Tropicale 11(119):558-563. 1931. Fr.

Cassava. Cultivation. Diseases and pathogens. Pests. Field experiments. Vectors. Mosaic diseases. Viroses. Cuttings. Ivory Coast.

Cassava is mainly cultivated in the regions of Grand Bassam and Abidjan. As with other food crops, it is always cultivated in clearings. Field observations led to the categorization of the mosaic symptoms into 3 groups: curly leaf, pale green or yellowish leaf discoloration without vein deformation, and leaf chlorosis without vein deformation. Stunting caused by the mosaic was not observed. Trials on the transmission of the mosaic by means of soil and seeds were unsuccessful. Transmission was accomplished by using infected cuttings and by vectors (coccids). The disease was also transmitted in experimental inoculation, of which a short description is given. *(Summary by J.L.S.)* E04

0725-0368 EKANDEM, M. J. **Cassava investigations carried out in northern Nigeria 1958-1962.** Nigeria. Federal Department of Agricultural Research. Memorandum no. 55. 1964. 11p. Engl., Sum. Engl.

Cassava. Gari. Foofoo. Cultivars. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Field experiments. Resistance. Human nutrition. Nigeria.

Cassava mosaic leaf virus can reduce yields to 30%; some varieties show field resistance to the disease. Yield is related to the degree of symptom expression: plants with severe symptoms have lower yields than plants with slight symptoms. Increase in yield can be obtained by extending the growing season, from 12 to 18 and 24 months. In trials carried out for 2 seasons in the Riveraine areas, introduced varieties generally proved superior in yield to the most popular local varieties. North of Minna, variety 43083 is considered as good as CH50 and Dan Warri. In general, the classification of the taste of the varieties into bitter and sweet is not affected by different ecological conditions. Some of the introduced varieties have proved acceptable to the local people at Yandev in the form of gari and foofoo. *(Author's summary)* E04 H01

0726-0366 BRIANT, A. K. and JOHNS, R. **Cassava investigations in Zanzibar.** East African Agricultural Journal 5:404-412. 1940. Engl., Sum. Engl., 3 Refs.

Cassava. Cultivars. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Resistance. Productivity. Kenya.

Over 100 cassava varieties have been grown at Kizimbani. The best-yielding of the sweet varieties tested so far are Msitu (local variety), Mpezaze (from Amani), and Kru (from the Gold Coast via Amani). The variety Msitu is being propagated on a large scale for public distribution. Information has been obtained on the effect of primary and secondary infection with mosaic disease on the yield of individual plants of 18 varieties. Primary infection seriously reduced yield; secondary infection was of less importance. Infected cuttings should therefore not be planted. There appears to be a correlation between the occurrence of new cases of secondary infection and past climatic conditions. Experimental work is being continued. *(Author's summary)* E04 D03

0727-3492 SCAIFE, A. **Cassava mosaic and resistant varieties.** Ukiriguru, Tanzania. Western Research Center. Research Notes no. 2. 1967. pl. Engl., 3 Refs.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Cultivars. Resistance. Sweet cassava. Bitter cassava. Tanzania.

Results are given of trials conducted at Ukiriguru (Tanzania) with cassava varieties that were either resistant or tolerant to mosaic virus. *(Summary by Tropical Abstracts)* E04

0728-3131 KENYA. DEPARTMENT OF AGRICULTURE. Cassava. *In* ______. Annual report 1955. Nairobi, 1956. pp. 225-226. Engl.

Cassava. Resistance. Diseases and pathogens. Pests. Cassava mosaic virus. Viroses. Field experiments. Research. Kenya.

This is a continuation of cassava resistance trials reported in the 1953 Annual Report. Seventeen new clones were under observation. The incidence of mosaic was slight at the beginning of the trial; but as the dry season progressed, the incidence of mosaic rose sharply. During the trial certain plants appeared to recover from a mild attack of mosaic, being first recorded as infected and later as free from the disease. However, in the majority of cases, mosaic was recorded again before the trial was completed. *(Summary by H.J.S.)* E04

0729-3129 COMMONWEALTH MYCOLOGICAL INSTITUTE. **Pathogen: cassava brown streak virus Storey. Hosts:** *Manihot esculenta. In* ———— •Distribution maps of plant diseases. Map no. 300. 1968. 2p. Engl., Illus.

Cassava. Pests. Diseases and pathogens. Viroses. Cassava brown streak virus. Maps. *Manihot esculenta.* Africa.

Cassava brown streak virus has been recorded in East Africa, Malawi, Mozambique, Rhodesia, Tanzania, and Uganda. *(Summary by J.L.S.)* E04

0730-0584 MORALES, F. J. **Superbrotamento.** *(Witches'-broom disease).* Ithaca, N. Y., Cornell University, 1957? 16p. Engl., 14 Refs.

Cassava. Pests. Diseases and pathogens. Viroses. Cassava common mosaic virus. Disease control. Leaves. Brazil.

Notes are given on witches'-broom disease, which is also called super (superbrotamento) or excess budding (envasouramento). This disease of cassava was first observed in Minas Gerais (Brazil) in 1939. It was later reported in Venezuela in 1952. A brief account is given of the basic symptoms, importance and control of the disease. No studies have been done on dispersal pattern, and little is known about its etiology. It seems that it is the same as the "cassava mosaic virus" disease reported in Java in 1931. *(Summary by H.J.S.)* E04

0731-0780 FRANCOIS, E. **La mosáique du manioc; un grave péril.** *(Cassava mosaic; a great danger).* Agronomie Coloniale 26:333-338. 1937. Fr.

Cassava. Diseases and pathogens. Pests. Cassava mosaic virus. Viiroses. Malagasy Republic.

Historical notes on cassava mosaic are given, as well as the methodology followed in Madagascar to control the disease, which still causes serious damage to cassava plantations. *(Summary by H. J..S.)* E04

0732-0230 BONDAR, G. **Dois males nas folhas da mandioca. I. A. "verruga" provocada pelo díptero** *Eudiplosis brasiliensis* **RBS. II. O "mosaico" provocado pelo thysanoptero** *Euthrips manihoti* **sp. n.** *(Two leaf diseases of cassava. I. Warts produced by a dipterous Eudiplosis brasiliensis RBS. II. Mosaic produced by a thysanopterous Euthrips manihoti sp. n.).* Chacaras e Quintaes 30:215-218. 1924. Port., 5 Refs., Illus.

Cassava. Leaves. *Eudiplosis brasiliensis.* **Entomology. Galls. Cassava mosaic virus. Diseases and pathogens. Pests. Injurious insects. Noxious animals. Pest control. Insect control.** *Euthrips manihoti.* **Cecidomyiidae. Viroses. Brazil.**

This article describes 2 leaf diseases of cassava: Blisters, scientifically known as Cecidias and produced by the excretion of a dipterous (*Eudiplosis brasiliensis* RBS),are controlled by burning or burying the leaves 20-30 cm deep; Mosaic,according to field observations the vector of this disease is a thysanopterous (*Euthrips manihoti* sp. n.). The disease originates when the insect bores into the leaf in order to suck sap. Diluted tobacco extract is used to control it. Cuttings must be submerged in this solution before planting. *(Summary by J.L.S.)* E04

0733-0800 CHANT, S. R. **Cassava mosaic.** *In* Nigeria. Department of Agricultural Research. Annual report 1954-55. Lagos, 1957. p.13. Engl.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Diasease control. Virus transmission. Virus inhibition. Hot water treatments. Bemisia. Vectors. Nigeria.

Brief notes are given about research on cassava mosaic virus. There are 3 main types of symptoms: mosaic only, crinkling (with mosaic), and distortion and asymmetry (with mosaic). There is a greater incidence of the symptoms of crinkling and distortion in the older leaves than in the younger, while the opposite is true of leaves displaying mosaic only. **Bemisia** sp. was confirmed as the disease vector. All attempts at mechanical transmission of the virus by inoculation of healthy seedlings with sap from infected leaves have failed. Two treatments were tested in attempts to control the virus: hot water treatment of cuttings and chemotherapy. Both treatments were unsuccessful. *(Summary by H.J.S.)* E04

0734-3360 RAMAKRISHNAN, K., NAMIBIAR, K. K. N. and ALAGIANAGALINGAM, M. N. **Physiology of virus infected plants.** Proceedings of the Indian Academy of Sciences (Section B) 69(3):104-114. 1969. Engl., Sum. Engl., 24 Refs., Illus.

Cassava. Cassava mosaic virus. Pests. Plant physiology. Iron. P. Minerals. Analysis. Leaves. Enzymes. Cytology. Plant respiration. Viroses. Diseases and pathogens. India.

Little information is available on the sequence of physiological changes from virus inoculation to full development of disease symptoms. The following aspects are discussed in this paper: (1) activity of chlorophyllase, (2) ferrous and ferric iron changes, (3) inorganic and organic phosphorus, and (4) respiration in pigeon pea sterility, mosaic-infected pigeon pea plants and cassava nosaic-infected cassava plants. In both healthy and diseased plants, chlorophyll "a" and "b" increased with age; however, these levels were significantly lower in diseased plants than in healthy plants, from early stages. Chlorophyllase activity increased with age, especially in diseased plants. There appeared to be a progressive conversion of ferrous Fe to ferric Fe in diseased leaves. Diseased leaves at all ages had higher levels of total P. There was a greater conversion of inorganic P to the organic form as the disease progressed. Respiration increased as the disease progressed, up to the production of full symptoms; it dropped, thereafter, reaching levels lower than those in healthy leaves of corresponding age. In PSMV-affected pigeon pea leaves, activity of catalase, peroxidase, ascorbic acid oxidase and cytochrome oxidase increased whereas while polyphenol oxidase decreased. Mitochondrial N was much higher in diseased leaves than in healthy leaves. *(Author's summary)* E04 C00

0735-0738 STOREY, H. H. and NICHOLS, R. F. W. **Studies of the mosaic diseases of cassava.** Annals of Applied Biology 25(4):790-806. 1938. Engl., Sum. Engl., 33 Refs.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Virus transmission. Vectors. Bemisia. Aleyrodidae. Leaves. Entomology. Etiology.

The symptoms of mosaic disease in cassava, although generally typical of the mosaic group, show wide variations, due in part to the varietal reaction of the plant, to its stage of development, and to the environment. The most important cause of variations, however, is differences in the strains of the virus, of which two groups of severe and mild strains have been recognized. The viruses are transmitted across a graft, but mechanical transmission by needle or hypodermic injection was not possible. A **Bemisia** sp. can transmit both groups of strains; it can inoculate the plant only through immature leaves, less than about one quarter of their full length. So inoculated the virus does not pass out of the leaf until about 8 days later. On the basis of this knowledge, a convenient and reliable single-leaf cage technique has been developed. After the virus has entered the stem, it passes rapidly to the base of this stem, but only slowly into side branches or into other stems arising from the same original cutting. Infection of a plant with a mild strain of virus failed to confer immunity from infection by severe strains introduced by grafting. If the severe strains were inoculated by insects, there was an indication of some conferred resistance, but this was insufficient to make the procedure useful in control. *(Author's summary)* E04

0736-0999 KITAJIMA, E. W. and COSTA, A. S. **Elongated particles found associated with cassava brown streak.** East African Agricultural and Forestry Journal 30(1):28-30. 1964. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Leaves. Pests. Diseases and pathogens. Viroses. Cassava brown streak virus. Cassava mosaic virus. Laboratory experiments. Etiology. Brazil. Africa.

Electron microscope preparations were made from dried samples of infected leaves representing cassava mosaic and cassava brown streak from Africa and cassava mosaic from Brazil. No elongated particle was found associated with the African cassava mosaic. An elongated particle was present in the preparations from cassava brown streak, the normal length of which is tentatively considered to be around 600 μ. The results with the cassava mosaic from Brazil indicate that particle measurements made on preparations obtained from dried samples of infected leaves show a wider distribution curve than that from fresh leaves, with a secondary peak at about half the normal length. Based on the observations reported in this paper and on data from literature, it is suggested that cassava mosaic from Brazil is different from cassava mosaic from Africa and is not related to cassava brown streak, although the two viruses are elongated. *(Author's summary)* E04

0737-1714 THANKAPPAN, M. and CHACKO, C. I. **Changes in free amino acids and amides induced in cassava plants by cassava mosaic virus.** Indian Journal of Plant Physiology 13(1):99-105. 1970. Engl., Sum. Engl., 10 Refs.

Cassava. *Manihot esculenta.* **Plant physiology. Diseases and pathogens. Cassava mosaic virus. Viroses. Amino acids. Analysis. Pests.**

Free amino acids and amides present in healthy and mosaic-infected plant parts were qualitatively and quantitatively determined in 5 cassava strains. It was found that in diseased plant parts, both the total number and quantity of amino acids and amides present were considerably greater than those present in the corresponding parts of healthy plants. *(Author's summary)* E04 C00

0738-0304 LEFEBRE, P. **Quelques considerations sur la "mosaïque du manioc".** *(Some considerations on cassava mosaic).* Bulletin Agricole du Congo Belge 26:442-447. 1935. Fr., Illus.

Cassava. Resistance. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Productivity. Zaire.

The author presents a summary of the mosaic disease, its symptoms, its transmission, the possibility of resistant varieties, the influence of mosaic on yields, and practical methods for obtaining a healthy cassava plant with higher per-hectare yields. *(Summary by P.A.C.)* E04

0739-0252 NORMANHA, E. S., BOOCK, O. J. and CASTRO J., B. DE. **Observações de campo como contriuição ao estudo do superbrotamento ou envassouramento da mandioca.** *(Field observations as a contribution to the study of "witches'-broom disease" in cassava).* Revista de Agricultura (Brazil) 21:271-302. 1946. Port., Illus.

Cassava. Pests. Diseases and pathogens. Cassava common mosaic virus. Viroses. Brazil.

This article describes field observations of a new disease of cassava known as witches'-broom disease; this work was carried out in thenorthwestern region of the state of Sao Paulo from 1941 by scientists of the Instituto Agronômico. In addition to describing field symptoms in detail, mention is made of some promising resistant varieties. *(Summary by F.M.)* E04

0740-0594 EKANDEM, M. J. and A. W. **A method for scoring the leaf symptoms of cassava mosaic virus disease.** Nigeria. Federal Department of Agricultural Research. Memorandum no. 62. 1964. 10p. Engl., 13 Refs., Illus.

Cassava. Cassava mosaic virus. Leaves. Diseases and pathogens. Pests. Viroses. Nigeria.

The mosaic virus disease of cassava is an important factor in the reduction of yield. Therefore, it is essential to have a standard method of disease assessment in a breeding program. A chart for scoring the disease symptoms is presented and explained. *(Author's summary)* E04

0741-0237 CHANT, S. R. and BECK, B. D. A. **The effect of cassava mosaic on the anatomy of cassava leaves.** Tropical Agriculture, Trinidad 36(3):231-236. 1959. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Plant anatomy. Pests. Diseases and pathogens. Cassava mosaic virus. Leaves. Viroses.

Symptoms in cassava leaves infected with mosaic virus were found to differ somewhat from those hitherto described. The palisade tissue in chlorotic lesions is undifferentiated, and the chloroplasts in infected leaves are fewer in number and tend to line the cell wall. The phloem tissue in the midrib of infected leaves is restricted to small bundles although there is no evidence of necrosis of the sieve tubes. No inclusion bodies were found in the epidermal tissues of infected leaves. *(Author's summary)* E04 B00

0742-0324 CHANT, S. R. **Studies on the transmission of cassava mosaic virus by Bemisia spp. (Aleyrodidae).** Annals of Applied Biology 46(2):210-215. 1958. Engl., Sum. Engl., 15 Refs.

Cassava. Aleyrodidae. Entomology. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Virus transmission. Vectors. Bemisia.

Whiteflies, which had originated from a mixed culture of **Bemisia** spp. collected from cassava (*Manihot utilissima* Pohl) in the field, needed to feed for at least 4 h on the young leaves of a cassava plant with mosaic before they acquired the virus. Whiteflies that acquired the virus in 4-6 h required another 4 h to become viruliferous. Once viruliferous, they could infect healthy plants in a 15 min feeding period but longer periods produced more infections. Adult whiteflies remained infective for more than 48 h after ending their infection feed. Cassava fed upon by only one viruliferous fly sometimes became infected. The virus-vector relationships of cassava mosaic virus resemble those of cotton leaf curl virus, but the first could not be transmitted to cotton, or the second to cassava. *(Author's summary)* E04

0743-0249 CHANT, S. R. **A note on the inactivation of mosaic virus in cassava (*Manihot utilissima* Pohl) by heat treatment.** Empire Journal of Experimental Agriculture 27(105):55-58. 1959. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Disease control. Cassava mosaic virus. Cuttings. Laboratory experiments. Temperature. Viroses.

Cassava mosaic virus has been inactivated by growing infected cuttings at temperatures ranging from 35-39°C for periods of 28-42 days. Treatment at 39°C gave a greater proportion of healthy plants than treatments at lower temperatures, but fewer plants survived at the higher temperature. When green shoots produced during the heat treatment were removed immediately after treatment and rooted separately,they gave healthy plants later although the parent plants developed symptoms after some weeks in the greenhouse. *(Author's summary)* E04

0744-0604 COSTA, A. S. *et al.* **Molestias de virus e de micoplasma da mandioca no Estado de São Paulo.** *(Virus and mycoplasma diseases of cassava in the state of São Paulo).* Campinas, Brazil, Secretaria da Agricultura, 1970. 18p. Port., 15 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Viroses. Mycoplasmoses. Cassava mosaic virus. Cassava common mosaic virus. Brazil.

Neither virus nor mycoplasma diseases of cassava are of great importance in the state of São Paulo (Brazil). Cassava common mosaic virus may cause great losses when vegetative propagation is made by means of infected planting material. Witches'-broom disease, which was recorded in past years, has completely disappeared, which is very strange since the virus is perpetuated and transmitted by cuttings. The following diseases are described: (1) Mycoplasmas: Witches'-broom; witches'-broom from the region of Santa Barbara do Rio Pardo; and (2) Viruses: cassava common mosaic virus, cassava vein mosaic virus and an infection caused by a bacillus-like virus. Comments are made on viruslike infections caused by thrips *(Scirtothrips manihoti* I.) and mites. *(Summary by J.L.S.)* E04 E05

0745-0787 PASCALET, M. **La mosaïque ou lèpre du manioc.** *(Cassava mosaic disease).* Agronomie Coloniale 21:117-131. 1932. Fr., 14 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Disease control. Kenya. Congo. Java.

Notes on the diseases are presented. Data given refer to general characteristics of the virus; signals and symptoms of cassava mosaic disease; histological and cytological studies; development of the disease and damage caused in Africa and Java; control. *(Summary by H.J.S.)* E04

0746-0722 MENON, M. R. and RAYCHAUDHURI, S. P. **Cucumber: a herbaceous host of cassava mosaic virus.** Plant Disease Reporter 54(1):34-35. 1970. Engl., Sum. Engl. 4 Refs. .

Cassava. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Vectors. Bemisia. Aleyrodidae. Virus transmission. Entomology.

Cassava mosaic disease is a serious problem in Kerala (India); it causes mosaic symptoms, crinkling, distortion and reduction in size of lamina of infected plants. The sweet potato whitefly, *Bemisia tabaci*, is reported as the vector of the virus. The virus did not infected the euphorbiaceous and herbaceous plants tested, except for cucumber. Infected cucumber showed yellow mosaic symptoms with green areas. *(Author's summary)* E04

0747-2052 ALAGIANAGALINGAM, M. N. and RAMAKRISHNAN, K. **Studies on a virus disease of tapioca (*Manihot esculenta* Crantz). I. Water relations and mineral metabolism** Madras Agricultural Journal 56(6):406-411. 1969. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Minerals. Metabolism. Leaves. Dry matter. Diseases and pathogens. Pests. Viroses. Water content. Mineral content. Composition. Plant physiology. P. Ca. K. Magnesium. Iron. Sodium.

Mosaic-infected cassava leaves had a lower moisture content and fresh weight| dry weight ratio. The leaves also transpired more rapidly. The diseased leaves contained higher quantitites of P' Ca, K and Na; Mg and Fe were found lesser than in healthy leaves. *(Author's summary).* E04 C00

0748-0487 CHANT, S. R., BATEMAN, J. G. and BATES, D. C. **The effect of cassava mosaic virus infection on the metabolism of cassava leaves.** Tropical Agriculture (Trinidad) 48(3):263-270. 1971. Engl., Sum. Engl., 27 Refs., Illus.

Cassava. Metabolism. Leaves. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Plant physiology. Photosynthesis. Plant respiration. Plant physiological processes.

Respiration rate and peroxidase activity were increased in cassava leaves as a result of infection with cassava mosaic virus. No new virus-specific peroxidase isozymes were found as a result of infection, but one isozyme apparently occurs in greater quantity in virus-infected leaves. Photosynthetic activity of immature and senescent leaves was not affected by cassava mosaic virus infection but was reduced by approximately 23% in infected mature leaves. Chloroplasts of virus-infected mesophyll cells were irregular in shape and contained numerous swollen starch grains. *(Author's summary)* E04 C00

0749-3065 FORSTENEICHNER. **Die Mosaikkrankheit des Manioks.** *(Cassava mosaic).* Tropenpflanzer 35:349-350. 1932. Germ.

Cassava. Diseases and pathogens. Cassava mosaic virus. Pests. Disease control. Viroses. Leaves.

Symptoms on leaves a few weeks old: The leaf margins disappear partly or completely with or without discoloration. The discolored parts are clearly separated by the vein. Spots on the leaves can occur. In the leaves the palisade parenchyma cells are greatly shortened and unrecognizable. A hypertrophy of the mesophyll occurs. The number of chloroplasts is reduced, and the starch granules are smaller. The disease is spred mainly through Africa (reported since 1895) and Java. Resistance in American clones is reported. The disease is probably transmitted by insects. Infested soil can remain infectious for 2 years. True seed of healthy plants may produce infected seedlings. Hybrids seemed to be more susceptible. Control is recommended by using resistant varieties, especially the introduction of new varieties from Central America. *(Summary by A. van S.)* E04

0750-3069 CHANT, S. R. and MARDEN, J. A. **Cassava mosaic.** *In* Nigeria. Department of Agricultural Research. Annual report 1956-1957. Lagos, 1958. pp.29-30. Engl.

Cassava. Diseases and pathogens. Cassava mosaic virus. Viroses. Entomology. Pests. Injurious insects. Bemisia. Vectors. Nigeria.

Techniques for handling whiteflies have been improved. The insects can be anesthetized with carbon dioxide for approximately one minute without deleterious effects and immediately introduced to feeding cages on cassave seedlings. Two types of these cages are described. Using the method of feeding vectors on the stem apices it has been shown that a single whitefly can transmit cassava mosaic virus. Whiteflies starved as long as 15 hours were still capable of transmitting the virus. **Bemisia** can transmit the virus to healthy seedlings after feeding on them for 15 minutes. Seedlings were still being infected 72 hours after **Bemisia** had fed on an infected plant. Further attempts to transmit mosaic virus mechanically have failed, possibly owing to the presence of an inhibitor in the cassava sap. *(Summary by H.J.S.)* E04 F00

0751-0235 JENNINGS, D. L. **Observations on virus diseases of cassava in resistant and susceptible varieties. I. Mosaic disease.** Empire Journal of Experimental Agriculture 28(109):23-34. 1960. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Hybrids. Pests. Diseases and pathogens. Cassava mosaic virus. Cultivars. Resistance. Field experiments. Research. Viroses.

An account is given of the mosaic disease resistance shown by varieties of cassava in field trials. Experiments showed that a high proportion of the plants of the moderately resistant varieties became infected in field trials, in which they were exposed to infection by a very large vector population. When conditions favored the resistance mechanism of the host, no symptoms of infection became evident; and the virus moved to the base of the plant, leaving the upper parts apparently free. Mosaic symptoms appeared more frequently if the growth of the host was interrupted at a time when there was a large vector population. *(Author's summary)* E04

0752-0298 COSTA, A. S. and NORMANHA, E. **Nota sobre o tratamento de manivas de mandioca (*Manihot utilissima* Pohl) em água aquecida a diversas temperaturas.** *(Notes on treating cassava Manihot utilissima Pohl, cuttings in water heated at various temperatures).* Revista de Agricultura (Brazil) 14:227-230. 1939. Port., Sum. Engl.

Cassava. ***Manihot esculenta.*** **Pests. Cassava mosaic virus. Diseases and pathogens. Viroses. Disease control. Virus inhibition. Hot water treatments. Cuttings. Brazil.**

An attempt was made to control a type of cassava mosaic present in São Paulo (Brazil). This mosaic is different from the African type caused by **Manihot** virus 1. The virus is perpetuated by the cuttings in 100% of the cases. Cuttings were subjected to hot water treatments and then planted in the field in the usual way. The treatment was made by immersing the cuttings in water for half an hour, the temperatures tried being 40, 45, 50, 55 and 60°C. The 40, 45 and 50°C treatment killed many cuttings and retarded sprouting. The 60°C treatment was fatal to the cuttings. No temperature treatment proved effective in destroying the virus. This result was expected since the virus is able to withstand a temperature of 65°C for 10 min in vitro (extracted sap). It is suggested that the treatment may prove valuable in the control of other cassava viruses with a death point near 50°C or for bacteriosis of this plant. *(Author's summary)* E04

0753-0229 GOLDING, F. D. *Bemisia nigeriensis* **Corb., a vector of cassava mosaic in southern Nigeria.** Tropical Agriculture (Trinidad) 13(7):182-186. 1936. Engl., Sum. Engl., 6 Refs.

Cassava. Entomology. Vectors. Bemisia. Virus transmission. Cassava mosaic virus. Diseases and pathogens. Pests. Viroses. Nigeria.

A series of transmission experiments with *Bemisia nigeriensis* Corb. adults, collected from mosaic-infected cassava in the field and placed in cages con. ·ing healthy plants proved that this species is a vector of cassava mosaic. Positive results were obtained in 5 out of 12 experiments. In one experiment, 814 adults were introduced into a cage containing 2 healthy and 2 diseased plants; both the healthy plants developed mosaic. In two other experiments, 606 and 400 adults were placed in two cages containing 4 and 2 healthy plants, respectively; all six plants became infected. In the 2 other experiments, 26 and 64 adults were introduced into lamp chimneys, each containing one healthy plant; both plants developed the disease. In 2 experiments, mosaic symptoms appeared 27 days after adult **Bemisia** had been placed in the chimneys. In the other 3 experiments, the vectors were introduced on several days; the maximum intervals between the introduction of **Bemisia** and the first appearance of mosaic symptoms were 13, 19 and 21 days, respectively. The number of vectors utilized was much greater in the last 3 experiments than in the first 2. Attempts to transmit mosaic from cassava to *Manihot glaziovii* and *Euphorbia heterophylla* gave negative results. The incidence of adult whiteflies on 19 varieties of cassava was studied over a period of 34 weeks. It was found that varieties which showed resistance to mosaic were almost invariably more lightly infested by **Bemisia** adults than susceptible varieties. An experiment in which 1802 adults were placed in a cage containing 4 susceptible mosaic-infected plants and 10 healthy resistant plants 2 of each of 5 varieties did not result in the healthy plants becoming infected. It was concluded that the varieties which did not develop mosaic owed their apparent immunity to an inherent resistance to the virus rather than to a repellent effect upon the aleurodid vector. It was noted that the 7 varieties which were most resistant to mosaic were characterized by a purple coloration of the petiole. Of the 10 most susceptible varieties, 5 had green petioles and 5 purple or purplish petioles. Immature **Bemisia** were present on all varieties; but were less numerous on 7 exotic varieties form Sierra Leone and Trinidad than on 11 indigenous and on one Gold Coast variety. Except on 4 varieties, there was close agreement between the incidence of adult and immature **Bemisia**. Breeding was continuous from August 13, 1935 to March 31, 1936. Evidence was obtained that the mechanical action of unusually heavy rain showers destroys many adults. No parasites were found. *(Author's summary)* E04

0754-3108 JAMESON, J. D. **Cassava mosaic disease in Uganda.** East African Agricultural and Forestry Journal 29:208-213. 1964. Engl., Sum. Engl., 31 Refs.

Cassava. Cultivation. History. Diseases and pathogens. Cassava mosaic virus. Viroses. Pests. Cultivars. Productivity. Human nutrition. Uganda.

The history of cassava cultivation in Uganda is briefly traced, and a reason is suggested for the rapid spread of mosaic disease during the period from 1926-41. Details are given of the rigorous methods adopted in 1942 to test clones for resistance to mosaic, based on the work of Storey and Nichols at Amani in Tanganyika. The systematic propagation and distribution of new varieties in a district where the standing crop was heavily infected with mosaic is described. The most important steps in this work are summarized, and certain limitations in the final result are noted. *(Author's summary)* E04

0755-0824 NICHOLS, R. F. W. **The brown streak disease of cassava.** East African Agricultural Journal 15:154-160. 1950. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. Clones. Hybrids. Leaves. Roots. Pests. Diseases and pathogens. Viroses. Cassava brown streak virus. Etiology. Kenya.

So far as is known, the distribution of the brown streak virus disease of cassava in East Africa and some adjacent territories is limited to the coastal plains and certain areas inland not exceeding an altitude of about 3,500 feet above sea level. The absense of the disease at higher altitudes is not fully understood. Severely diseased plants are known to die at these altitudes during the cool season, but no satisfactory answer has yet been found to explain the absence of secondary spread by the insect vector in these regions. High temperatures tend to inhibit development of disease symptoms, which normally make their appearance in infected plants only when seasonal temperatures begin to fall. The effects of the disease are more pronounced during cold weather, which results in a measure of partial control through the elimination from cultivation of highly intolerant clones. This is brought about either through death of severely affected plants or more commonly through deliberate selection by cultivators. Susceptibility to the disease ranges from what appears to be complete field immunity in some clones through a series showing varying degrees of resistance and tolerance to clones which are so severely affected that they are killed when seasonal temperatures are low. These variations in susceptibility and tolerance are attributed to genetical factors. Symptoms are recognized in leaves, stems, fruits and roots of the plant; they may occur in only one of these organs or in two or more depending on the susceptibility of individual clones. The presence or absence of symptoms in these organs is constant for any given clone. Mosaic disease is of universal occurrence in all brown streak areas; therefore, the breeding of clones immune or highly resistant to brown streak alone is of little use in these areas. High resistance to both diseases has been attained in some cassava clones, but yield capacity is low. Control of both virus diseases is being sought by interspecific hybridization. *(Author's summary)* E04 G01

0756-1895 OKUSANYA, B. A. O. and EKANDEM, M. J. **A review of cassava mosaic virus research in Nigeria.** Ibadan, Nigeria, Federal Department of Agricultural Research, 1973. 14p. Engl., Sum. Engl., 38 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Virus transmission. Vectors. Bemisia. Aleyrodidae. Grafting. Entomology. Etiology. Disease control. Plant physiology. Virus inhibition. Leaves. Stems. Plant assimilation. Nigeria.

Cassava leaf mosaic was first recorded near Ijebu-Ode (Nigeria) in 1926. The whitefly, *Bemisia nigeriensis* Corb, is the insect vector of the cassava mosaic. A single whitefly can transmit the disease, and transmission by the viruliferous whitefly to healthy plants can take place within 15 minutes after a minimum infection feed of 4 hours. The whitefly population reaches a peak at the onset of the rains, and it has been shown that cassava plants with red petioles support a very low population of whiteflies. Whiteflies breed easily on Ceara rubber, cotton, pepper and tobacco. Whiteflies on cassava are effectively controlled by Rogor 40 and endrin. The causal agent of cassava mosaic is inactivated by heat treatment at a temperature between 35-39°C for about 42 days. Infection with cassava mosaic caused a reduction in root yield, leaf area, total fresh weight, total dry weight and net assimilation rate of the cassava plant. Infection is also accompanied by a decrease in total carbohydrate content and an increase in N content, the total carbohydrate: N ratio, and crude protein content of the leaf. Shading reduced the effect of cassava mosaic on the plant. Respiration rate and the moisture content of infected leaves are increased. The anatomy of infected tissue is affected. *Manihot glaziovii* is an alternate host to cassava mosaic. There were no significant differences in the HCN content of peeled roots from healthy and infected plants. Acquisitions based on *M. glaziovii M. esculenta* crosses have given the highest percentage of mosaic resistant types, and the highest proportion of resistant lines were derived from the variety 58308. *(Author's summary)* E04

0757-0477 KITAJIMA, E.W. and COSTA, A. S. **Microscopia electronida de tecidos foliares de mandioca infetados pelo virus do mosaico comum da mandioca.** *(Electron microscopy of cassava leaf tissues infected with common mosaic virus).* Bragantia 25:23-28. 1966. Port., Sum. Engl., 9 Refs.

Cassava. Leaves. Plant tissues. Cassava common mosaic virus. Viroses. Pests. Diseases and pathogens. Analysis. Laboratory experiments. Brazil.

Ultrathin sections of leaf tissues of cassava plants, infected with cassava common mosaic virus (CCMV) were examined in the electron microscope. Fibrous masses, variable in shape and dimensions, were found in the cytoplasm of practically all cell types, except tracheids and sieve tubes, of leaves infected with CCMV. These inclusions were not seen in control preparations made from healthy plant leaves nor in those infected with the cassava vein mosaic virus, which is spherical. The inclusions associated with CCMV are composed of particles, 10-15 mu in diameter, (length could not be determined) arranged in loose parallel order; they were found mostly in the chlorotic area of infected leaves. No association of fibrous masses with cell structures was observed. The particles making up these fibrous masses are considered as CCMV in situ, because of their similarity to those found in vitro (15 mu x 500 mµ) and because of their constant association with the diseased material. *(Author's summary)* E04

0758-0473 SILVA, D. M. **Obtenção do antissoro contra o virus do mosaico da mandioca.** *(The development of an antiserum against cassava mosaic virus).* Bragantia 21:99-102. 1962. Port., Sum. Engl.

Cassava. Pests. Diseases and pathogens. Disease control. Cassava mosaic virus. Viroses. Virus inhibition. Antisera. *Manihot esculenta.* **Analysis. Brazil.**

This paper reports the development of an antiserum against cassava mosaic virus. Two rabbits were immunized with 12 intravenous injections of clarified juice from **Euphorbia** infected with cassava mosaic virus, applied at 3-day intervals. The sera were collected after 10 days of rest, and precipitating tests were made at 37°C. Antigens used for the tests were clarified juices from healthy and infected *Euphorbia prunifolia* Jacq., *Manihot utilissima* Pohl, *Chenopodium amaranticolor* Coste et Reyn., *Chenopodium quinoa* Wild. and eventually purified virus preparations from **Euphorbia**. The results obtained and presented in Table 1 show induced antibody formation. The reactions against the antiserum absorbed with clarified juice from healthy **Euphorbia prunifolia** Jacq. were positive with clarified juice from 4 diseased plants in a dilution ranging from 1:8 to 1:64. All control preparations gave negative reaction. *(Author's summary)* E04

0759-0540 KITAJIMA, E. W. and COSTA, A. S. **Particulas esferoidais associadas ao virus do mosaico das nervuras da mandioca.** *(Spheroidal particles associated with the cassava vein mosaic virus).* Bragantia 25(18):211-221. 1966. Port., Sum. Port., Engl., 19 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Cassava vein mosaic virus. Viroses. Laboratory experiments. Plant tissues. Leaves. *Manihot esculenta.* **Brazil.**

Spheroidal particles (50-60 mµ in diameter) were found in quick preparations and in ultrathin sections for electron microscopy made from leaves of cassava plants infected with the cassava vein mosaic (CVMV). These particles, considered as representing the virus, were not found in preparations made from healthy plants nor in symptomless leaves of infected plants. In ultrathin sections of leaf tissues, CVMV particles were found dispersed in certain areas of the cytoplasm, which is rich in ribosomes but poor in other cytoplasmic organelles, where small sporadical bundles of dense fibrils (7-10 mµ x 100-300 mµ) occur. Dense and fine granular masses 0.3-3 µ in diameter) were, in a few instances, found in association with the particles. It is likely that both fibrils and the dense masses are primarily involved in the CVMV synthesis. *(Author's summary)* E04

0760-3335 STOREY, H. H. and NICHOLS, R. F. W. **Virus diseases of East African plants. VII. A field experiment in the transmission of cassava mosaic.** East African Agricultural Journal 3(6):446-449. 1938. Engl., 1 Ref., Illus.

Cassava. Viroses. Field experiments. Cassava mosaic virus. Diseases and pathogens. Pests. Timing. Resistance. Virus transmission. Kenya.

General field observations indicate that there may be seasonal differences in the rate of spread of the mosaic disease of cassava. Also the age of the plant at the time that it becomes exposed to infection may influence its susceptibility. These two points were tested. Healthy plants were planted every month in a plot surrounded by mosaic-diseased plants. Records were made at the beginning of each month for 2 years. Nearly 100% of the plants became infected. Plantings made at the beginning of June remained largely uninfected for the longest time, and plantings from December to April were largely diseased after 3 months of growth. The probabilities of infection are high from February to May (81% of plants could be infected) and low from

August to October. This might bear some relation to climate: the first semester of the year is hotter (mean monthly maximum of 33°C from February to March) than the second (mean monthly minimum of 19°C during July and August). July and August are dry months; April and May are rainy months. A statistical analysis of the figures failed to show that plant susceptibility varies with its age. *(Summary by H.J.S.)* E04

0761-3133 KUFFERATH, H. and CHESQUIERE, J. **La mosaique du manioc.** *(Cassava mosaic).* Annales de Gembloux (Belgium) 38(11):365. 1932. Fr., 1 Ref.

Cassava. Diseases and pathogens. Viroses. Vectors. Injurious insects. Aleyrodidae. Cassava mosaic virus. Pests. Noxious animals. Zaire.

Brief notes are given on a cassava mosaic disease, its symptoms and means of infection. The causal agent is not known, but it seems that it is a virus whose vector is a Hemiptera of the Aleyrodidae. *(Summary by H.J.S.)* E04

0762-0242 SILBERSCHMIDT, K. and CAMPOS, A. R. **Estudos relativos á doença "superbrotamento" ou "envassouramento" da mandioca.** *(Studies on witches'-broom,a disease of cassava).* Arquivos do Instituto Biológico 15:1-26. 1944. Port., Sum. Engl., 29 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Cassava common mosaic virus. Cassava mosaic virus. Viroses. Virus transmission. Grafting. ***Manihot esculenta. Manihot glaziovii.*** **Field experiments. Research. Brazil.**

Experiments were carried out on the causal agents of witches'-broom, a disease of cassava (*Manihot utilissima* Pohl), which was observed in Brazil for the first time in 1939. The symptoms of the disease consist principally of a severe stunting of the whole plant, a shortening of the internodes and the production of an extra number of side branches by the auxiliary buds. The leaf blade, the area of which is sometimes diminished, often shows a slightly chlorotic surface. Cassava plants originating from cuttings of diseased shoots manifest clear symptoms of witches'-broom. These symptoms were even found in plants produced by cuttings taken from healthy-looking specimens, grown in contaminated fields. It was not possible to transmit the disease either by growing healthy plants next to diseased ones or by sap inoculation. However, the disease could be transmitted by grafting experiments using infected scions and healthy stock. The period was 3-4 months. Results of similar graft experiments, performed with plants that thad been periodically sprayed and dusted with fungicides and insecticides during the months preceding the graft process are also given. No delay in the appearance of the first symptoms on the stock was observed. Healthy check plants of cassava, grafted with healthy scions, never displayed the symptom pattern. Some graftings were made of scions from diseased plants of *Manihot utilissima* and healthy stocks of Ceará rubber, *Manihot glaziovii.* A transmission of the disease to the healthy component was observed. The incubation period in these experiments was at least twice as long as in intraspecific graftings. The results of all these experiments are in accordance with the supposition that a virus in the causal agent of witches'–broom. It was stressed, however, that for the perfect identification of the causal agent, it would be necessary to complete observations by mycological and entomological studies. In a further study of literature referring to other virus diseases of cassava, it was learned that the symptoms agree rather well with those of some types of cassava mosaic, caused by *Manihot virus* I, described by H.R.A. Muller. Further studies will be conducted. *(Summary by T.M.)* E04

0763-0523 GANGULY, B., RAYCHAUDHURI, S.P. and SHARMA, B.C. **Serodiagnostic method for detecting mosaic-infected cassava plants in field.** Current Science 39(8):191-192. 1970. Engl., 6 Refs., Illus.

Cassava. Leaves. Bemisia. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Disease control. Laboratory experiments. Analysis. ***Manihot esculenta.*** **India.**

A simple and rapid serological method, developed in India, to identify mosaic-infected cassava plants is described. The technique is of great help in eliminating diseased plants, thereby ensuring better crop growth and yield. *(Summary by Tropical Abstracts)* E04

0764-0592 SMITH, K. M. **Cassava mosaic virus. Cassava stem lesion virus.** *In* ______. A textbook of plant virus diseases. Boston, Little, Brown, 1957. pp.130-132. Engl.

Cassava. ***Manihot esculenta.*** **Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Leaves. Stems. Chlorosis.**

Descriptions of virus and disease symptoms are given. Cassava mosaic virus seems to be transmitted by a **Bemisia** insect and it infects only **Euphorbiaceae** species. The insect vector of cassava stem lesion virus, if any, is not known. The disease has so far only been recorded in Amani (Kenya). *(Summary by H.J.S.)* E04

0765-0546 KITAJIMA, E. W. *et al.* **Morfologia do virus do mosaico comun da mandioca.** *(Morphology of cassava common mosaic virus).* Bragantia 24(21):247-260. 1965. Port., Sum. Port., Engl., 26 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Cassava common mosaic virus. Viroses. Research.

Elongated, flexible particles, measuring 15 mμ in diameter and having a normal length (NL) of about 500 mμ were found in preparations made by the dipping method from different host plants infected with cassava common mosaic virus (CCMV), whereas none were seen in noninoculated control plants. Particles with similar morphology were the only components of highly purified and infective preparations. These particles when negatively stained, showed no internal details. Comparative measurements between CCMV and potato virus X (PVX) indicated consistently that the NL of CCMV is about 17 mμ shorter than that of PVX. In serological cross reaction tests with antisera to CCMV and PVX of relatively high titer (1|4096), no common antigenic groups between both viruses could be found. Because of the morphology of the particles, CCMV can be ranged among the PVX relatives of group 4-6 of the classification scheme for elongated plant viruses as proposed by Brandes and Wetter. The particles of these viruses have been described as flexible threads, ranging in normal length from 480-580 mμ. The slight, but detectable difference in morphology, the fact that no common antigenic group could be demonstrated, and the differences in the diseases induced by CCMV and PVX suggest that these viruses are not closely related. CCMV should be regarded, therefore, as a distinct entity within the taxonomic group of elongated plant viruses represented by PVX. *(Author's summary)* E04

0766-3021 STANER, P. **Mosaique des feuilles de manioc.** *(Cassava leaf mosaic).* Bulletin Agricole du Congo Belge 22(1):75-80. 1931. Fr., 4 Refs., Illus.

Cassava. Diseases and pathogens. Pests. Cuttings. Leaves. Mosaic diseases. Viroses.

A bacteria appears to be the causal agent of cassava leaf mosaic. A description is given of research carried out to determine the causal agent. Trials deal with microscopic analysis of leaves, observations of insects around the plants and infections on cuttings and leaves. *(Summary by H.J.S.)* E04 .

0767-0547 BECK, B. D. A. and CHANT, S. R. **A preliminary investigation on the effect of mosaic virus on** ***Manihot utilissima*** **Pohl in Nigeria.** Tropical Agriculture (Trinidad) 35(1):59-64. 1958. Engl., Sum. Engl., 14 Refs.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. ***Manihot esculenta.*** **Productivity. N. Leaves. Mineral content. Carbohydrate content. Composition. Plant respiration. Plant physiological processes. Leaf area. Petioles. Nigeria.**

Observations over an 8-month period on a selected cassava variety have shown that primary infection with cassava mosaic virus significantly reduced yield; but no significant differences in stem and petiole weights or HCN content of peeled tubers were recorded. There was a highly significant positive correlation between leaf area and yield in healthy plants, but no such correlation was found in infected plants when symptom expression was at its maximum. At this time there is also a significant difference between the leaf areas. The carbohydrate| N ratio of leaves taken from infected plants was greater than in comparable leaves taken from healthy plants although the actual percentages of carhohydrate and N were less. This may be an indication of a greater rate of breakdown of carbohydrate and N compounds in the leaves of infected plants. This may be supported by the fact that the respiration rate of leaves from infected plants kept in the dark was found to be significantly greater than that of comparable leaves from healthy plants. *(Author's summary)* E04

0768-3018 PASCALET, M. **Nota over mozaiekziekte van cassave (cassave-lepra) in Kameroen en Noord-Gaboen.** *(Cassava mosaic disease in Cameroon and North Gabon).* Buitenzorg, Java. Institut Voor Plantenziekten. Bulletin no. 24. 1931. pp. 13-15. Dutch.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Virus transmission. Vectors. Grafting. Sweet cassava. Bitter cassava. Cultivars. Resistance. Cameroon. Gabon.

In Cameroon in 1921 the author encountered cassava with mosaic-like symptoms on leaves, distorted leaves, shortened internodes, excessive flowering and reduced yield. The disease was widespread. Yields of disease-free stakes introduced from America were 130 quintals| ha; of heavily attacked stakes, only 15| ha. A field from which heavily diseased cassava was harvested remained unsuited for cassava cultivation for years. Scales and termites may transmit the disease. Grafting healthy plants on diseased ones infects the graft, and grafting a diseased graft on a healthy plant infects the plant. Bitter as well as sweet cassava varieties were susceptible, but some resistant bitter varieties were found. Introduction of disease-free stakes from Central America and the French colonies, increased yields; however, after some years they became infected, but not as severely as the local varieties. Heavy fertilization marks the disease. Severe attacks are found on both heavy and light soils; on recently reclaimed forest, the disease occurs less frequently. *(Summary by A. van S.)* E04.

0769-3650 DUBERN, J. **A contribution to the study of African cassava mosaic disease.** *In* IDRC| IITA Cassava Mosaic Workshop, Nigeria, 1972. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. 1972. pp13-17. Engl., Sum. Engl., Illus.

Cassava. Diseases and pathogens. Viroses. Pests. Cassava mosaic virus. Aleyrodidae. Leaves. Virus transmission. Africa.

A pathogenic agent was transmitted to different herbaceous plants from African mosaic-diseased cassava seedlings. In one of them *(Capsicum annum)*, mycoplasm-like particles were observed. *(Author's summary)* E04

0770-3109 JOLY, R. L. **Les consequences de la mosaique du manioc.** *(The consequences of cassava mosaic).* Revue de Botanique Appliquée et d'Agriculture Tropicale 11(114):99-104. 1931. Fr.

Cassava. Viroses. Diseases and pathogens. Pests. Cassava mosaic virus. Disease control. Resistance. Africa.

Mosaic caused great damage in several African countries, especially in the Congo and Cameroon. Disease symptoms are given, as well as the efforts made by both private and governmental institutions to solve the problems. It seems that using seeds instead of cuttings makes the plants stronger and more resistant to the mosaic disease. *(Summary by H.J.S.)* E04

0771-2203 CHANT, S. R. **Cassava mosaic.** *In* Nigeria. Department of Agricultural Research. Annual report 1955-1956. pp. 16-17. Engl.

Cassava. Diseases and pathogens. Pests. Viroses. Cultivars. Leaves. Cassava mosaic virus. Nigeria.

In 4 cassava varieties, there were significant differences between areas of leaves of the same petiole length and age, depending on whether they were (a) symptomless, (b) displaying mosaic only, (c) displaying crinkling (with mosaic) or (d) displaying distortion (with mosaic). A field experiment was designed to assess the association between symptom expression and the growth rate and yield of 3 varieties and also to observe whether applications of ammonium sulfate affected these relationships. Results did not permit any definite conclusions. *(Summary by H.J.S.)* E04

0772-2342 ABRAMIDES, E. **Estudo estatístico da queda de produção de raízes de mandioca, devida a um tipo de superbrotamiento no sul do Mexico.** *(Statistical study of the decrease in cassava root yields caused by a witches'-broom disease in southern Mexico).* Campinas. Instituto Agronômico. Boletim no. 143. 1965. 12p. Port., Sum. Port., Engl., 1 Ref.

Cassava. Productivity. Tuber productivity. Diseases and pathogens. Pests. Cassava common mosaic virus. Viroses. Brazil.

A statistical analysis was made of the effect of a new type of cassava witches'-broom disease upon root production. Analyzing the yield of roots from plants obtained from cuttings kept for 1 day, the hypothesis of there being no difference between the average yield of roots (kg| plant) from healthy and sick plants was tested. The value obtained was t= 21.68, significant at the 1% level, thus disproving the hypothesis. The decreases in yield ranged from 9.04-11.12 kg| plant (77-94%) due to witches'-broom, whereas the average production of healthy plants was equal to 11.80 kg. *(Author's summary)* E04 D03

0773-0541 OPSOMER, J.E. **De invloed van de mozaiekziekte op de opbrengst van de cassave.** *(The influence of mosaic on cassava yield).* Bulletin Agricole du Congo Belge 29(2):317-322. 1938. Dutch, Sum. Dutch, Fr.

Cassava. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Productivity. Disease control. Cuttings. Propagation materials.

The influence of cassava mosaic on yield was studied; there was a 44.4% reduction in yield in fields planted with diseased material. This percentage, however, does not indicate real losses as this depends upon the quality of the infected material. Losses were negligible when healthy cuttings were used. When no previous selection of cuttings is made, losses were in the range of 5-10%. These experiments demonstrate the importance of selecting healthy cuttings. *(Summary by J.L.S.)* E04

0774-2459 AMARAL, S. F. DO. **Finalidades do levantamento fitossanitário.** *(Aims of a plant sanitation program).* Biológico 11(9):237-244. 1945. Port., 3 Refs., Illus.

Cassava. Diseases and pathogens. Pests. Cassava common mosaic virus. Pest control. Viroses. Brazil.

The methodology followed to prevent and control plant diseases and pests affecting large areas is described. The program consisted of two phases: geographical distribution of causal agents and the damage caused and the ecological conditions affecting the development of diseases and pests. Two methods can be followed to accomplish the first phase: quarantine and eradication. The methodology is explained with several examples, mainly those dealing with the witches'-broom disease of cassava and with *Leucinodes elegantis* in tomatoes. *(Summary by H.J.S.)* E04

0775-3076 BOURIQUET, G. **Madagascar: phytopathological and entomological notes.** International Review of Agriculture 28:118-199. 1973. Engl.

Cassava. Cassava mosaic virus. Viroses. Diseases and pathogens. Pests. Aleyrodidae. Entomology. Vectors. Malagasy Republic.

MOSAIC. During the rainy season of 1935-36, in many parts of the island (South, Lake Alaotra, environs of Anjiro), a considerable diffusion of mosaic and a concurrent pullulation of **Aleyrodidae**, taking no doubt the part of vectors, were observed. On some farms, symptoms of disease were noted in all plants of the variety known as Malagasy cassava. The agricultural stations are breeding and distributing the most resistant types of cassava, having at the same time the necessary qualities for industrial uses. "FIRE." A disease; which has been designated by us under the name of "fire" and which appears to have been present in the country for some considerable time, has caused in some regions a heavy leaf fall in young cassava plants. The disease commences with small angular spots, of a light chestnut color on the upper surface of the leaf, and bluish on the under side. In transparence they resemble the "taches d'huile," characteristic of the downy mildew of the vine *(Plasmopara viticola)*. On the surface, very minute drops of light yellow color soon make their appearance. Then the injury spreads and causes the drying up of a considerable part of the folioles, which then appear to have been touched by a flame. This last stage is observed in the lower leaves which may cause a premature leaf fall. *(Full text)* E04

0776-0880 SAM RAJ, J. **Varieties of tapioca (cassava) tolerant to the mosaic virus.** Science and culture 32(8):419. 1966. Engl.

Cassava. Bemisia. Injurious insects. Entomology. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Cultivars. Resistance. Aleyrodidae. Vectors. India.

Symptoms showed by several cassava varieties infected by a mosaic virus are described. The disease was noted in Kerala (India) for the first time in 1952 and is now found practically thoughout the State. **Bemisia** sp. was the vector. The adoption of the Rottikappa variety with a high degree of tolerance is recommended. *(Summary by H.J.S.)* E04

See also *0551 0659 0822 0911 0913 0926 0935 0939 0948 0960 0963 0971 0973 0978 0980*

E05 Mycoplasmal Diseases

0777-0486 KITAJIMA, E. W. and COSTA, A.S. **Micoplasma: possivel agente etiológico de certas molestias de plantas.** *(Mycoplasma: a possible etiological agent of some plant diseases).* Ciencia e Cultura 22(4):351-363. 1970. Port., Sum. Engl., 64 Refs., Illus.

Cassava. Pests. Diseases and pathogens. Mycoplasmoses. Etiology. Laboratory experiments. Analysis.

Mycoplasmas (= PPLO) are known as being pathogenic to cattle, small rodents, poultry and men; but their role as the causal agent of some plant diseases was suggested only in 1967 by Japanese workers. Since then, a relatively large number of reports on the association of mycoplasma-like organisms with several plant diseases (presently up to 20), thus far considered as viral, appeared throughout the world. The inference that mycoplasmas and not viruses are the causal agent of such diseases is based on: (1) the presence of relatively large (0.1-1μ in diameter), pleomorphic bodies within the phloem of affected plants or in tissues of viruliferous insect vectors and their corresponding absence in healthy tissues. These bodies are limited by a unit membrane without a cell wall and contain ribosome-like granules and DNA-like threads, being morphologically very similar to mycoplasmas found in animals; (2) the response of infected plants to treatment with antibiotics of the tetracyclin family. Symptom expression of affected plants was delayed or suppressed, following tetracyclin administration. Sensitiveness to this type of antibiotic is also a character of animal mycoplasmas; (3) most of the diseases to which such mycoplasma-type organisms have been associated belong to the so-called yellows group. They all have very similar pathological characters, suggesting a common causal agent. Circumstantial evidence, —(although insufficient according to Koch's postulate)— indicates that mycoplasms are the causal agent of the yellows type of plant diseases. There are, however, some preliminary reports on isolation, cultivation and successful inoculation of plants with mycoplasmas cultured in vitro. In state of São Paulo at least 3 different diseases have been associated with mycoplasma-like organisms: tomato big bud, stunt corn and cassava witches'-broom based on pathological and electron microscopical observations. *(Author's summary)* E05

See also 0744

0778-3128 HOGGER, C. **Nematodes on cassava.** Ithaca, N. Y., Cornell University, Department of Plant Pathology, 1968. 8p. Engl., 34 Refs.

Cassava. Manihot. Nematodes. Noxious animals. Pests. Pest control.

This is a survey of literature on nematodes associated with cassava. A list of 34 references is presented. Topics discussed are history, geographical range, etiology, pathogenicity, epiphytology and control. Thirty-nine nematodes are reported from different parts of the cassava plant or from the soil around the roots. *(Summary by J.L.S.)* E06

0779-0632 HOGGER, C. H. **Plant-parasitic nematodes associated with cassava.** Tropical Root and Tuber Crops Newsletter no. 4:4-9. 1971. Engl., 32 Refs.

Cassava. Pests. Noxious animals. Pest control. ***Manihot esculenta.*** **Nematodes.**

This paper surveys literature (32 references) including 3 bibliographies on the history and geographical range, pathogenicity, parasitism, life cycle, epiphytology and control of plant parasitic nematodes associated with cassava *(Manihot esculenta)*. Nematode species found on the crops are tabulated. *(Summary by Tropical Abstracts)* E06

0780-3288 RAHM, G. **Nematodes parasitas e semi-parasitas de diversas plantas culturales do Brasil. V. Nematodes encontrados nas raizes de mandioca.** ***(Parasitic or semiparasitic nematodes in different crops in Brazil. V. Nematodes found in cassava roots).*** Arquivos do Instituto Biológico 2:107-108. 1929. Port.

Cassava. Tubers. Nematodes. Noxious animals. Pests. ***Manihot esculenta.*** **Brazil.**

The following nematodes were found in the roots of cassava (*Manihot utilissima* Pohl): *Diploscapter rhizophilus* Rahm; *Cephalobus rigidus* A.Schneider; *Cephalobus elongatus* De Man; *Isonchus radicicola* Cobb; *Tylenchus dipsaci* Kuehn. *(Summary by J.L.S.)* E06

0781-3135 LUC, M. **Nematological problems in the former French African tropical territories and Madagascar.** *In* Smart, F.C., ed. Tropical hematology. Gainesville, University of Florida Press, 1968. pp.93-112. Engl., 76 Refs.

Cassava. Nematodes. Resistance. Pest control. Malagasy Republic. Ivory Coast. Togo.

Problems caused by nematodes in the tropical regions of Africa are not different from those of other tropical regions of the world. Only a few species are unique to Africa: *Hirschmanniella spinicaudata* and *Heterodera oryzae*, parasites of rice; *Mesotylus taomasinae*, a parasite of bananas in Madagascar; and certain **Rotylenchulus** spp. from the Congo and the Ivory Coast. The most serious and widely distributed are the **Meloidogyne** sp. and *Pratylenchus brachyurus*, a widespread species of parasite on many plants constituting a real danger to certain crops, notably pineapple. Cassava as a food crop is widely distributed throughout West Africa and Madagascar. The Ivory Coast is the main producer. There, cassava is intercropped with other plants; and nematode attack is not serious, except when mixed with suitable hosts such as okra or eggplant in soils where *Meloidogyne incognita* is present. In Togo among 12 parasitic species identified, *Pratylenchus brachyurus* and **Helicotylenchus** cf. **erithrinae** were most abundantly and frequently encountered in cassava. Some varieties resistant to *Pratylenchus brachyurus* were recorded. *P. brachyurus* is also present in the Lake Alaotra region of Madagascar. *(Summary by J.L.S.)* E06.

0782-0485 MERNY, G. **The plant parasitic nematodes associated with some tuber crops of West Africa.** Dakar, Senegal, Office de la Recherche Scientifique et Technique Outre-Mer, 1971. 8p. Engl.

Cassava. Yams. Nematodes. Pests. Noxious animals. Pest control.

The majority of the article deals with root rot and root lesion nematodes on yams. Nematodes parasitizing cassava are almost the same as those found on yams. *Pratylenchus brachyrus, P. coffeae* and *Scutellonema bradys* are reported as root lesion nematodes in Togo. High populations of **Helicotylenchus** and **Pratylenchus** were found in soils where cassava had been grown for years and where yields were considerably lowered. When soil was treated with DBCP, yields increased 8%. Resistant varieties could be used, but better control can be achieved by crop rotation with nonhosts of *P. brachyurus, Stylosanthes gracilis* is recommended. *(Summary by T.M.)* E06

0783-5101 FASSI, B., MANCINI, G. and MORETTI, F. *Meloidogyne incognita* **(Kofoid e White, 1919) Chitwood, 1949 su** *Manihot utilissima* **Pohl.** [*Meloidogyne incognita (Kofoid and White, 1919) Chitwood, 1949 on Manihot utilissima Pohl.*]. Rivista di Agricoltura Subtropicale e Tropicale 68(7|12):261-265. 1974. Ital., Sum. Engl., Ital., 8 Refs., Illus.

Cassava. *Manihot esculenta.* **Roots. Nematodes.**

The occurrence of *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949 on plants of cassava (*Manihot utilissima* Pohl), obtained by cuttings from Tanzania and rooted in Italy, is reported. *(Author's summary)* E06

0784-3126 GOODEY, T. **On** *Cylindrogaster cursii* **n. sp., a saprophagous nematode.** Journal of Helminthology 13(1):19-24. 1935. Engl., 8 Refs., Illus.

Cassava. Tubers Nematodes. Noxious animals. Pests.

The nematode *Cylindrogaster cursii* n. sp. appears to be saprophytic on cassava roots. It is described and differentiated from the other Cylindrogaster spp. *(Summary by A. van S.)* E06

F00 PEST CONTROL AND ENTOMOLOGY

0785-0255 BALLOU, H. A. **Cassava stem borer.** Agricultural News 14(340):155. 1915. Engl., Illus.

Cassava. Entomology. Pests. Injurious insects. Noxious animals.

This article gives a short general description of the cassava stemborer (**Cryptorhyncus** spp.) found in the West Indies. *(Summary by P.A.C.)* F00

0786-0256 LEONARD, M. D. **A little-known root-weevil of cassava (*Coelosternus sulcatulus* Boheman).** Journal of the Department of Agriculture (Puerto Rico) 14:159-165. 1930. Engl., Illus.

Cassava. Entomology. Pests. Injurious insects. Noxioûs animals.

This article describes a root weevil of cassava, *Coelesternus sulcatulus* Boheman, its history and distribution, its host plant (*Manihot Manihot* (L) Cockerell), the nature of injury, and the stages of the weevil. It also contains a description of a longicorn twig borer (**Lagochirus** spp.). *(Summary by P.A.C.)* F00

0787-3379 TAPIA,E. A. **El girasol, nuevo hospedador para un homóptero conocido.** *(The Sunflower, a new host for a known homopterous pest).* Argentina. Instituto de Patología Vegetal. Hoja Informativa no. 25. 1968. 2p. Span.

Cassava. Helianthus. *Manihot esculenta.* Pests. Injurious insects. Entomology. Bemisia. Argentina.

Bemisia tabaci (Gennadius), which attacks tomatoes in the Province of Tucuman and cassava *(Manihot esculenta)* in Misiones (Argentina), has been found on the leaves of the sunflower *(Helianthus annus)* in Misiones. This appears to be the first record of the Aleyroid on sunflowers. *(Summary by Review of Applied Entomology)* F00

0788-0225 MYERS, I. H. **Notes on parasites of the gall-midge (*Jatraphobia brasiliensis* Rübs.) of cassava in Trinidad.** Bulletin of Entomological Research 21:309-313. 1930. Engl., 2 Refs.

Cassava. Entomology. *Eudiplosis brasiliensis.* Cecidomyiidae. Injurious insects. Noxious animals. Pests. *Manihot esculenta.* Trinidad and Tobago.

This article gives results of field observations and collections carried out in Trinidad on the parasites of the gall midge (*Jatrophobia brasiliensis* Rübs.) of cassava, *Manihot esculenta* Crantz. *(Summary by P.A.C.)* F00

0789-3013 NORMANHA, E. S. and ESPINO, A. **Um tipo de superbrotamento em mandioca no sul do Mexico.** *(Witches'-broom disease in cassava in southern Mexico).* Ciencia e Cultura 16(2):143-144. 1964. Port.

Cassava. Diseases and pathogens. Pests. Injurious mites. Noxious animals. Thrips. Mexico.

A description is given of symptoms of the disease. It is different from the witches'-broom disease reported in Brazil. Thrips (genus **Frankliniela**) and some abundant mites could be involved as causal agents of this disease, which reduced cassava tuber production by 15%. *(Summary by H.J.S.)* F00

0790-1745 MARSHALL, G. A. K. **New injurious Curculionidae (Col.) from Malaya.** Bulletin of Entomological Research 26:565-569. 1935. Engl.

Cassava. Injurious insects. Entomology. Noxious animals. Pests. Malaya.

A description is given of beetles belonging to the family of Curculionidae. *Corigetus corbetti* is reported as a pest of cassava. *(Summary by A. van S.)* F00.

0791-1774 BONDAR, G. **Aleyrodideos do Brasil.** *(Aleyrodidae from Brazil).* Bahia, Brazil, Imprensa Oficial do Estado, 1923. 182p. Port., 5 Refs., Illus.

Cassava. Aleyrodidae. Injurious insects. Pests. Noxious animals. Bemisia. Entomology. Brazil.

A description is given of whiteflies occurring in Brazil. The following are reported as pests of cassava: *Bemisia tuberculata, Aleurothrixus aepiun* Goeldi (on sweet cassava) and *Asterochiton manihoti. (Summary by A. van S.)* F00.

0792-0224 CHINA, W. E. **A new species of Erythroneura (Homoptera, Jassoidea) injurious to cassava in East Africa.** Bulletin of Entomological Research 21:267-268. 1930. Engl., Illus.

Cassava. Entomology. Pests. Injurious insects. Noxious animals. Africa.

This article describes a new species, *Erythroneura cassavae,* which is injurious to cassava (*Manihot esculenta* Crantz). The study is based on material from the Amani Institute, Tanganyika (Tanzania). *(Summary by P.A.C.)* F00

0793-2040 ANANTANARAYANAN, K. P., SUBRAMANIAN, T. R. and MUTHUKRISHNAN, T. S. **A note on the tapioca scale (*Aonidomytilus albus* Cockerell).** Madras Agricultural Journal 44(7):281-286. 1957. Engl., 3 Refs., Illus.

Cassava. Entomology. Injurious insects. *Aonidomytilus albus.* Insecticides. Noxious animals. Insect control. Pest control. India.

In Madras (India), cassava is free from insect attack, except for the cassava scale insect, which was recently reported there. The wingless, legless female deposits the eggs and then dies. The eggs hatch in 4 days, and the nymphs are very active (crawlers). After 20-25 days, the female nymphs settle on the stems, lose their legs and cover themselves with an excretion. Because the scales extract sap with their proboscis, a heavy infestation can result in desiccation of the stems and death of the plant. Lesser degrees of infestation result in stunted plants; leaves yellow and fall. The infestation is spread by the crawler or via man. Removal of infected plants and DDT were ineffective in controlling the disease. Parathion, Systox and DDT-kerosene emulsion (phytotoxic) were effective. Uninfested stakes should also be used. *(Summary by A. van S.)* F00 F01

0794-0227 BEZZI, M. **Two new Ethiopian Lonchaeidae, with notes on other species (Dipt.).** Bulletin of Entomological Research 9:241-254. 1918. Engl., 37 Refs., Illus.

Cassava. Injurious insects. Galls. Entomology. *Carpolonchaea chalybaea.* Pests. Noxious animals. Ethiopia.

Some **Lonchaea** species pass larval stages in fruits and may be confused with fruit flies, or with **Myiodaria.** A key is given for 8 species of **Lonchaea;** *L. mochii* (forming galls on grasses), and *L. phemosissima* are described as new species. Other **Lonchaea** species descriptions are compared. **Lonchaea** larvae feed only on vegetable matter, whether decaying or not. The primitive larval habit seems to be saprophytic or in excrement on the ground, or under the bark of tress. Some **Lonchaea** larvae have evolved to feed on living plant tissue as well; e.g., *L. chalybaea* does great damage to cassava in the West Indies, boring into the soft tissues of the growing plant which it comp'.tely destroys. Another group evolved into gall-making species on grasses (**Dasyops**); others attack fruit; however, this may be a secondary infestation. *(Summary by A. van S.)* F00

0795-0232 URICH, F. W. **Cassava insects.** Bulletin of the Department of Agriculture, Trinidad and Tobago 14(2):38-40. 1915. Engl., 5 Refs.

Cassava. Entomology. Pests. Injurious insects. Noxious animals. *Carpolonchaea chalybea. Erinnyis ello.* **Corynothrips. Trinidad and Tobago.**

A brief description is given of some cassava insects occurring in Trinidad and Tobago. The description covers the bud maggot (**Lonchaea** sp.), the leaf mite, the cassava hornworm (*Erinnys ello* L.), the gall midge (**Lastopteryx** sp.), thrips (**Corynothrips** sp.) cassava lacewing bud (Fam. **Tingitidae**) and parasol ants (*Atta cephalotes* L.). A record of cassava insects in other countries is also included. *(Summary by J.L.S.)* F00

0796-1743 LEEFMANS, S. **Biological notes on** *Dasynus manihotis Blote.* Zoologische Mededeelingen 18:237-240. 1935. Engl. Illus.

Cassava. Injurious insects. Pests. Noxious animals. Entomology. Java.

The damage of the coreid bug *Dasynus manihotis* shows at the tip of the stems. The tissue shrinks and leaves wither; heavily punctured stems die. Punctured areas in the stems show as irregular sunken patches, brownish in color. The eggs are laid on the undersides of leaves or on the stems. Larvae emerge in 7 days and molt 3 days later. The molting into adult takes place 55-57 days after eclosion of the eggs. In the laboratory larvae could be bred on pods of **Centrosema** but not on cassava. It is concluded that cassava is not their usual host. The damage was not found in subsequent years. *(Summary by A. van S.)* F00

0797-1851 FERNANDEZ Y., F. and TERAN B., J. B. **Presencia de** *Chilomina clarkei* **(Amsel) y** *Chilozela bifilalis* **(Hampson) (Lepidoptera, Pyralidae) en yuca (***Manihot esculenta* **Crantz) en Venezuela.** [*Chilomina clarkei (Amsel) and Chilozela bifilalis (Hampson) (Lepidoptera, Pyralidae) in cassava (Manihot esculenta Crantz) in Venezuela*]. Agronomía Tropical (Venezuela) 23(4):407-411. 1973. Span., Sum. Span., Engl., 7 Refs., Illus.

Cassava. *Manihot esculenta.* **Noxious animals. Injurious insects. Pests.** *Chilomina clarkei. Chilozela bifilalis.* **Entomology. Venezuela.**

Chilomina clarkei (Amsel) and *Chilozela bifilalis* (Hampson) are reported in relation to cassava (*Manihot esculenta* Crantz) in Venezuela; the former is a stemborer and the latter is a leaf roller. The erroneous reports of *Asciodes gordialis* Guenée and **Asciodes** spp. in cassava in Venezuela, both corresponding to *C. clarkei*, are corrected. Records are given of the distribution in the country for both species. *(Author's summary)* F00

0798-4348 KORITOWSKI, C. A. and OJEDA P., D. **Revisión de las especies de la familia Lonchaeidae en el Perú (Diptera: Acalyptratae).** [*The species of the family Lonchaeidae in Peru (Diptera: Acalyptratae*]. Revista Peruana de Entomología 14(1):87-116. 1971. Span., Sum. Span., Engl., Illus.

Cassava. *Manihot esculenta.* **Pests. Injurious insects. Noxious animals.** *Capolonchaea chalybea.* **Entomology. Maps.** *Silba pendula.*

This is a revision of the systematic status of the species of Lonchaeidae from Peru, collected mostly in the northern part of the country in 1967-70. Previously described species by Hennig (1948) and McAlpine (1964), from material collected in the south and southeastern part of the country were also included in this revision. Most of the species were collected by McPhail traps and no data on larval habits were recorded; however, the species *Silba pendula* (Bezzi), because of its economic importance as a fruit pest, was thoroughly studied. All the species treated are included in the 3 known neotropical genera: **Dasiops, Lonchaea** and **Silba.** Of 46 neotropical species of *Dasiops rondani*, 19 species were collected in Peru, including 2 new species, *D. chotanus* n. sp., and *D. ahusatus* n. sp.; of 24 neotropical species of **Lonchaea** fallen, 12 species were collected in Peru, including 2 new neotropical species, *L. longistila* n. sp. and *L mealpinei* n. sp.; and of the 10 neotropical species of **Silba** Macquart, 6 species were collected in Peru, including a new species *S. pseudopendula* n. sp. A key of genera, based on McAlpine's (1960), a catalog for the neotropical species of the family, a key for the Peruvian species and a map of their distribution in the national territories are included. Descriptions are accompanied by drawings of male genital armatures and| or female ovipositors. *(Author's summary)* F00

0799-1715 HAMBLETON, E. J. **Notás sobre Pseudococcinae de importancia economica no Brasil com a descripção de cuatro especies novas.** *(Pseudococcinae of economic importance in Brazil and a description of four new species).* Arquivos do Instituto Biologico (Brasil) 6:105-120. 1935. Port., Sum. Engl., Illus.

Cassava. Pests. Injurious insects. Noxious animals. Entomology. Brazil.

Notes are given on the biological characteristics, occurrence and host plants of 18 species of **Pseudococcinae** from Brazil. In view of the fact that several of the species reported herein constitute serious pests in other parts of the world, the author desires to call attention to their presence in Brazil. The following species have been described as new to science: *Pseudococcus magnoliae* on *Magnolia grandiflora* (**Magnoliaceae**), *Pseudococcus inamabilis* on *Cupressus glauca* (**Coniferae**): *Pseudococcus tibouchinae* on *Tibouchina mutabilis* (**Melastomaceae**); and *pseudococcus sociabilis* from *Hedera helix* (**Araliaceae**) and *Erythrina reticulata* (Leguminosae). *Phenecoccus gossypii* (Town and Ckll) was found on cassava. *(Author's summary)* F00

0800-2039 SWAINE, G. **The biology and control of the cassava scale.** East African Agricultural Journal 16:90-93. 1950. Engl., Illus.

Cassava. Injurious insects. *Aonidomytilus albus.* **Insect control. Insecticides. Noxious animals. Pest control. Entomology.**

Descriptions are given of the damage caused by the cassava scale insect; young plants are more adversely affected than old ones. The life cycle and brief descriptions of the different stages are given, and the means by which dispersal is brought about in the field by the infective crawler stage are indicated. Bundling of clean with infested planting material is considered to be the most important factor in this dispersal. Control methods are discussed in detail. The beneficial effect of a DDT| oil emulsion is largely vitiated by the very poor germination of the infested cuttings. The main line of control is by the selection of clean planting material and the uprooting and prompt burning of any infested cassava remaining in the field at the time of planting. *(Author's summary)* F00 F01

0801-1840 CARDENAS D.,L. and GARZON Q., E. **Estudio de dos posibles causas de resistencia varietal al ataque de trips en yuca** (*Manihot esculenta* **Crantz**). *(Study of two possible causes of varietal resistance to thrips attack in cassava, Manihot esculenta Crantz).* Agr. Eng. Thesis. Palmira, Colombia, Universidad Nacional de Colombia, Facultad de Ciencias Agropecuarias, 1974. 63p. Span., Sum Span., Engl., 18 Refs., Illus.

Cassava. Noxious animals. Injurious insects. Pests. Resistance. Cultivars. Entomology. Colombia.

A trial was carried out at the Centro Internacional de Agricultura Tropical, CIAT, Palmira (Colombia) with 50 cassava varieties from Colombia, 1 from Venezuela and 1 from Ecuador—attacked in varying intensities by thrips—to study the correlation among pubescence, HCN content and the number of thrips according to the degree of damage (varietal resistance), as well as the species of thrips attacking these varieties. The varieties with a high pubescence on shoot leaves were less severely attacked than the beardless varieties; thus It seems that there is a correlation between the degree of damage and the amount of pubescence. The resistant pubescent varieties were also resistant to this attack in bloom. It seems that there is no relationship between the degree of damage and the HCN content. There was no relationship between the number of thrips and the degree of damage, possibly because of the amount of rain that fell during the trial. The species of thrips found were *Carynothrips stenopterus* Williams, *Caliothrips masculinas* Hood and **Frankliniella** sp. *(Author's summary)* F00.

0802-3359 KAPIL, R. P. **Effects of feeding different host plants on the growth of larvae and weight of cocoon of** ***Philosamia ricini*** **Hutt.** Indian Journal of Entomology 29(3):295-296. 1967. Engl., 5 Refs.

Cassava. Entomology. Laboratory experiments. Research. Leaves.

A preliminary evaluation was made of the suitability of the castor-oil plant and cassava as principal hosts of *Philosamia ricini.* Larval weight increases and pupal weights were compared. It was found that larval weight was not significantly affected by the feeding on different types and ages of leaves. Larvae fed on cassava leaves produce cocoons of poor weight; the analysis of variance shows that the results are significant. *(Summary by A. van S.)* F00

0803-2397 GALLO, D. *et al.* **Pragas das pequenas culturas; mandioca, (*****Manihot utilissima*** **Pohl).** *(Pests of minor crops; cassava, Manihot utilissima Pohl). In* ________. Manual de entomologia. São Paulo, Brasil, Editora Agronómica Ceres, 1970. pp.485-487. Port., Illus.

Cassava. Noxious animals. Injurious insects. Pests. *Erinnyis ello. Silba pendula. Coelosternus granicollis.* **Entomology. Pest control.** *Manihot esculenta.* **Brazil.**

Notes are given on the description, biology, damage and cultural and chemical control of the following pests of cassava: hornworm (*Erinnyis ello* L.); whitefly (*Silba pendula* Bezzi); and the stemborer (*Coelosternus granicollis* Pierre). *(Summary by J.L.S.)* F00

0804 3188 PERACCHI, A. L. and NUNES, W. DE O. **Sôbre um diplópodo prejudicial a cultura da mandioca,** *Manihot esculenta. (A millipede injurious to cassava).* Pesquisa Agropecuaria Brasileira. Serie Agronomia 7:181-183. 1972. Port., Sum. Port., Engl., 7 Refs.

Cassava. Injurious insects. Noxious animals. Pests. Entomology. Brazil.

Field and laboratory observations, conducted at Sao Joao da Barra in the state of Rio de Janeiro, (Brazil), showed that the millipede, *Orthoporus fuscipes* (Porrat, 1883), occasionally damages cassava *Manihot esculenta. (Author's summary)* F00

0805-3185 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT). **Pests of cassava in the world.** Palmira, Colombia, 1972. 5p. Engl.

Cassava. Entomology. Noxious animals. Pests. Nematodes.

About 150 pests of cassava are cited. About 110 are insects and the rest are nematodes (38), arachnids (3) and chilopods (1). Insects are listed by orders; the stage causing damage, type of damage, and distribution are listed as well. *(Summary by H.J.S.)* F00

0806-0243 NIJVELDT, W. **Two gall midges from Surinam.** Natuurwetenschappelijke Studiekring voor Suriname en de Nederlanse Antillen no. 48:61-66. 1968. Engl., 4 Refs., Illus.

Cassava. *Manihot esculenta.* **Injurious insects. Cecidomyiidae. Entomology. Surinam.**

The author describes the adult male and female of *Huradiplosis surinamensis* gen. et sp. n., reared from leaf galls on *Hura crepitans* in Surinam. The immature stages are not known. Another Cecidomyiid from Surinam, which was reared from leaf galls on cassava *Manihot esculenta (utilissima),* was identified provisionally as *Dolycholabis lantanae* Tavares,*(Summary by Review of Applied Entomology)* F00.

0807-1736 HARGREAVES, E. **Some insects and their food-plants in Sierra Leon.** Bulletin of Entomological Research 28:505-519. 1937. Engl.

Cassava. Injurious insects. Sierra Leona.

A list is given of insects attacking economic crops in Sierra Leone. Those attacking cassava *(Manihot utilissima)* are *Araecerus fasciculatus,* de Geer. Coleoptera, Anthribidae; *Apate monachus,* F. Coleoptera, Bostrychidae; *Monohammus ruspator,* F. Coleoptera, Lamiidae; *Ceratina viridissima,* D.T. Diptera, Apidae; *Andraphisia subfascia,* Wlk. Lepidoptera, Lasiocampidae; *Ferrisiana virgata,* Ckll. Rhynochota, Coccidae; *Afrius purpureus,* Wests. Rhynchota, Pentatomidae; *Bolothrips marshalli,* Pries, Thysanoptera; *Machatothrips braueri,* Karny, Thysanoptera. *(Summary by L.C. Trans. by T.M.)* F00

See also 0294 00750 1924

F01 Injurious Insects and their Control

0808-0234 ZIKAN, W. **A mosquinha dos mandiocais,** *Lonchaea pendula,* **Bezzi, 1919.** *(The little fly, Lonchaea pendula, Bezzi, 1919).* Chacaras e Quintais 70:489-492. 1944. Port., 13 Refs., Illus.

Cassava. Injurious insects. Entomology. Pests. Noxious animals. Pest control. Insect control. *Silba pendula.* **Brazil.**

The shoot fly is one of the most important pests attacking cassava (**Manihot**). The larvae is found in **Citrus** spp., *Mammea americane* L., *Mangifera indica* L. and in some **Rubiaceae.** The larvae feed on cassava buds. The holes made by the larvae are where the fungus begins to spread, causing the bud to rot. A description of this pest and its control measures are given. *(Summary by J.L.S.)* F01

0809-0231 OTOYA A., F.J. **Plagas de principales cultivos del país; sistemas de represión e insecticidas usados. II. Insectos de la yuca y sus insecticidas.** *(Pests of the main crops in Colombia; repression systems and inssecticides used. II. Cassava insects and insecticides).* Agricultura Tropical (Colombia) 1(12):147-148. Span., Illus.

Cassava. Insecticides. *Trichogramma minutum.* **Entomology. Pests. Injurious insects. Noxious animals.** *Erinnyis ello.* **Insect control. Pest control. Biological control. Colombia.**

The most important pest for cassava growers is the larva of the hornworm *(Erinnyis ello* L.), which feeds on the leaves. Damage varies from 10 to 50% of the total yield. Control by arsenates is very effective. Biological control is also effective, especially by *Trichogramma minutum* Riley, a parasite of the eggs. In the Cambao region, 90% parasitism was verified. To control this pest, sound cultural practices are important. Light traps or small bonfires early at night are used to destroy the adult. *(Summary by J.L.S.)* F01

0810-0056 BONDAR, G. **Pragas da mandioca.** *(Pests of cassava).* Boletim do Laboratorio de Pathologia Vegetal 3:67-71. 1926. Port., Illus.

Cassava. Pests. Noxious animals. Injurious insects. Entomology. *Euthrips manihoti. Eudiplosis brasiliensis.* **Cecydomyiidae. Galls. Brazil.**

Cassava leaves often show the following symptoms: Leaves are poorly developed, distorted and sometimes abort. The leaves have irregular, elongated chlorotic spots, which cause imperfect leaf development and expansion. These symptoms are caused by larvae and adults of thrips, *Euthrips manihoti,* living in the growing points of expanding leaves. The feeding of the insects causes cell mortality in addition to the above symptoms. Due to foliage loss, yield reduction is expected. It is a pest, especially during the dry season; rains reduce the pest population and the plants recover. Control is practiced by breaking off affected shoots to stimulate new growth, which may be effective in the rainy season, but in the dry season new shoots are also affected. Destruction of weeds, especially **Amaranthus,** is recommended, using an application of nicotine extract. A morphological description of the male and female is given. Cassava leaves often have yellow to red-green galls which vary in size from 5-15 mm long by 3-5 mm wide. They are caused by a dipterous, *Eudiplosis brasiliensis* Rbs, which is found throughout Brazil in varying intensity. Eggs are laid singly. The young larvae cause plant cells to multiply and form galls in which they live for a few weeks until they pupate. The larvae measure 3.4 mm, the adults 2.5 mm. It is assumed that they do not influence yield. Leaves with galls may be destroyed. *(Summary by A. van S.)* F01.

0811-0043 VAIVANIJKUL, P. **Die mit Tapioka Mach Deutschland eingeschleppten Vorratsschädlinge und ihre Bedeutung für die Lagerhaltung.** *(Pests of stored products brought to Germany with cassava and their significance in the storage process).* Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg. 4(81):351-394. 1973. Germ., Sum. Germ., 117 Refs., Illus.

Cassava. Processed products. Tubers. Cassava flour. Storage. Pests. Injurious insects. Noxious animals. Entomology. Germany.

For optimal development, *Dinoderus minutus* and *Rhyzopertha dominica* from Angola require a 75% relative humidity (RH) at 35°C; *Latheticus oryzae* needs 85% RH at 30°C and *Tribolium castaneum*, 75% RH at 30°C. The last 2 species showed greater temperature and humidity tolerance than did the first 2, which also need a firm substrate in which to bore, an activity for which *L. oryzae* and *T. castaneum* are not suited because of their insufficiently developed oral apparatus. Cassava roots and flour yielded the worst results in culture experiments. This was due to their relatively low content in N, vitamins and trace elements. *(Summary by Biological Abstracts)* F01 102.

0812-0228 CARDEN, P. **Insectos y enfermedades de la yuca en Cuba.** *(Cassava pests and diseases in Cuba).* Cuba. Estación Experimental Agronómica. Boletin no. 20. 1910. 28p. Span., Sum. Span., Illus.

Cassava. Pests. Noxious animals. Injurious insects. *Erinnyis ello.* **Insect control. Pest control.** *Microgaster flaviventris. Lagochirus obsoletus. Carpolonchaea chalybea. Tetranychus telarius. Gloeosporium manihotis. Cercospora henningsii.* **Mycoses. Entomology. Chlorosis. Mite control. Cuba.**

Insects we believe to be most important in order of importance are the stemborer *(Lagochirus obsoletus)*, the shoot fly *(Lonchaea chalybca)* and the cassava hornworm *(Dilophonota ello).* These pests should be controlled as soon as they appear. Abandoned cassava fields should be burned if they are not to become breeding grounds for pests. In order to destroy the cassava hornworm insect when it appears, we recommend spraying the foliage with lead arsenate, which is also beneficial in controlling the adult stemborer insect. To control the stemborer, the plants should be pruned and burned in the dry season, just before the beginning of the wet season. To control the shoot fly, the shoots should be cut off, collected in a can without holes and burned immediately. Leaf blight is an important disease. Shoots on healthy plants only should be used as a source of cuttings to avoid diseases. *(Author's summary)* F01 F03

0813-2363 NORMANHA, E. S. **Come folha, prejudica raiz.** *(It eats the leaf and spoils the root).* Coopercotia 22(190):39-40. 1965. Port., Illus.

Cassava. Injurious insects. *Erinnyis ello.* **Entomology. Leaves. Insect agents.** *Trichogramma minutum.* **Insecticides. Biological control. Noxious animals. Insect control. Pest control. Brazil.**

A brief description is presented of the morphology and biology of *Erinnyis ello*, a neotropical moth occurring from northern Argentina to Canada. Its polyphagous caterpillars are a serious pest of cassava in the state of São Paulo (Brazil), reducing the yield and starch content of the tubers. Outbreaks occur only in the rainy season with maximum incidence in Dec.-Feb. and are favoured by dry weather in the preceding months. Most of the time the pest population is kept down by its natural enemies. Among these is the egg parasite *Trichogramma minutum*, which is already being reared as a parasite of sugar cane borers and may be used as a biological control agent. Meanwhile, the pest can be chemically controlled by spraying or dusting with one of several insecticides; BHC should be used only if the tubers are not destined for human consumption. *(Summary by Tropical Abstracts)* F01

0814-2372 LYON, W. F. **A plant-feeding mite** *Mononychellus tanajoa* **(Bondar) (Acarina: Tetranychidae) new to the African continent threatens cassava** *(Manihot esculenta* **Crantz) in Uganda, East Africa.** Pans 19(1):36-37. 1973. Engl., 3 Refs.

Cassava. *Manihot esculenta.* **Noxious animals. Injurious mites. Pests. Leaves. Entomology.** *Mononychellus tanajoa.* **Uganda.**

During the first months of 1972, a heavy outbreak of a newly introduced plant-feeding mite appeared in cassava in several parts of Uganda and severely stunted the plant. It is suspected to be the first known attack on the African continent. Previously, spider mite attack had been recorded only from South America. Studies are being conducted regarding the ecology, distribution limits throughout Uganda, acaricidal control, natural predators and parasites of this mite, and cassava host variety resistance. Heavy infestations of this mite caused blotching and bronzing of leaves, later accompanied by premature leaf fall. Major damage to the cassava plant appeared somewhat suppressed during the cool season in September and October, 1972, however, mites were present and easily found. The leaves exhibit white spots due to the loss of chlorophyll and other pigments and appear malformed, with the margins turned upwards. Plant tops normally die when the mite population increases rapidly. The mite was identified as *Mononychellus tanajoa* (Bondar) (Acarina: Tetranychidae). The synonyms are *Tetranychus tanajoa* Bondar; *Mononychus tanajoa* (Bondar) Fletchmann & Baker. *(Summary by J.L.S.)* F01

0815-0052 DIAS, C. A. C. **Inimigos da mandioca tem contrôle.** *(Control of cassava pests).* Fir 10(-., 42. 1967. Port.

Cassava. Pests. Noxious animals. Injurious insects. Insect control. *Erinnyis ello.* **Insecticides. Brazil.**

Brief descriptions and control measures are given for shoot fly, hornworm, stemborer and ants, all cassava pests. Shoot fly can be controlled by destroying affected shoots, adjusting planting data or using a 200 ga dieldrin 50% with 5 kg sugar of molasses in 100 liters water as bait for adult flies. The hornworm (attacking mainly in Jan-March) can be controlled by toxaphene 20% kg| ha or Sevin 7.5% or endrin 1.5% BMC at 3% controls young larvae. Stemborers are controlled by using undamaged planting material or burning attacked plants. A 5% DDT or 2% dieldrin or 20% toxaphene at the first symptoms of attack are effective. Various species of ants are controlled by BHC 1% or aldrin on top of the nests. Fumigation can be made with methyl bromide (4 cm^3), carbon bisulfide (75 cm^3) per m^2: aldrin 5% (30 g), chlordane 10% (30 g), heptachlor 5% (30 g) per m^2. The liquid forms are also effective: aldrin 40% (5 cm^3| l), chlordane 75% (10 cm^3| l) or heptachlor 40% (10 cm^3| l). Granular aldrin (2 or 4%) at a rate of 5 g m^2 is effective as well. *(Summary by A. van S.)* F01

0816-3201 HALL, C. J. J. VAN. **Ziekten en plagen der cultuurgewassen in nederlandsch Indie in 1922.** *(Diseases and pests of crops in Dutch Indonesia in 1922).* Buitenzorg, Java. Institut voor Planteziekten. Mededeelingen no. 58. 42p. 1922. Dutch.

Cassava. *Tetranychus telarius.* **Acaricides. Injurious mites. Mite control. Noxious animals. Entomology. Pests. Java.**

Information about cassava covers pp. 10-12. The cassava mite *Tetranychus bimaculatus* was reported as a minor problem in certain areas. However, heavy damage was done by wild hogs. A phosphate-based insecticide was successfully used for control. Drought also caused losses on some plantations. *(Summary by A. van S.)* F01

0817-3151 FONSECA, J. P. DA. **Mandarová da mandioca.** *(The cassava hornworm).* Biológico 8(8):210-215. 1945. Port., Illus.

Cassava. Pests. Injurious insects. Noxious animals. Insect control. Pest control. Insecticides. Biological control. Insect agents. Entomology. *Erinnyis ello.* **Brazil.**

Control measures are discussed. (1) Preventive control: check the fields regularly in the hornworm season (Dec.-March), especially after low infestation years when control measures are lax. Material for chemical control must be available. (2) Curative control: lead arsenate at 400 g| 100 liters water; Paris green at 500 g| 500 liters water, with 3,000 g lime adhesive or 15-19 g oil per 20-liter tank. Other adhesives are casein, cassava starch or oils. Wet the plants well; do not apply before or immediately after it has rained. Applications to control young larvae are more effective than for older larvae. (3) Mechanical control: Larvae and pupae can be collected and destroyed, and fields separated by 3-4 m alleys. (4) Natural enemies:

Predators are *Calosoma retusum* (Carabidae). One adult preys upon many larvae per day. *Aleorhynchus grandis* (Pentatomidae) sucks the larvae empty. **Polistes** preys upon larvae in their first stages. **Oxysarcodexia** (Stephanostomatidae) and **Delnosia** (Tachinidae) are dipterous parasites. Microhymenopterous parasites are **Apanteles** (Braconidae) and species of Chalcididae and Elachertidae. Birds are also frequent predators of larvae. *(Summary by A. van S.)* F01

0818-1973 NAKANO, O., PEDROSO, A.S. and PARRA, J. R. P. **Ensaio de campo visando o contrôle da "broca dos brotos" dos mandiocais através de iscas tóxicas.** *(Toxic baits in the control of the fly Silva pendula).* Solo 61(2):15-17. 1969. Port., Sum. Engl., 3 Refs.

Cassava. Injurious insects. Pests. Pest control. Insecticides. Insect control. *Silba pendula.* **Entomology. Brazil.**

This work gives results obtained with toxic baits in the control of the fly *Silba pendula* Bezzi, 1919, a pest of cassava (mandioca). The following insecticides were used with the addition of 5% molasses: 0.25% DDT (50 WP), 0.08% diazinon (40 WP), 0.1% fenthion (50 EC), 0.15% Malathion (50 EC) and check (water + 5% molasses). Applications were made by brushing the liquid on the plants. The results obtained in the different counts permit the following conclusions: Infestations of the fly pest were reduced in areas treated with insecticides; but it is not known whether the differences in yield are economically feasible for these treatments. Molasses (5%) plus malathion did not differ statistically from the check although it gave the best results; 5% molasses plus DDT was the second best treatment. *(Author's summary)* *F01*

0819-2221 COMMONWEALTH INSTITUTE OF ENTOMOLOGY. **Pest:** *Aonidomytilus albus.* **Hosts: Cassava (Manihot** spp.). *In* ———— Distribution maps of insect pests. Map no. 81. 1957. 2p. Engl., Illus.

Cassava. Maps. Entomology. *Aonidomytilus albus.* **Injurious insects. Noxious animals. Pests. Manihot.**

A small map of the world shows the areas of distribution of *Aonidomytilus albus,* a pest of cassava (**Manihot** spp.) and **Solanum** sp. A list of the countries in which this pest is known to occur is also given, as well as information about the sources (museums, bibliographies) from which the distribution data were gathered. *(Summary by H.J.S.)* F01

0820-2302 MONTE, O. **Observações biológicas sôbre** *Coelosternus granicollis* (Pierce) **broca da mandioca.** *(Biological observations on Coelosternus granicollis* (Pierce), *a pest of cassava).* Arquivos do Instituto Biológico 16:89-110. 1945. Port., Sum. Engl., 17 Refs. Illus.

Cassava. *Coelosternus granicollis.* **Pests. Injurious insects. Noxious animals. Entomology. Insect control. Pest control. Brazil.**

During the years 1942 to 1944, the author made some ecologic investigations of the cassava borer *Coelosternus granicollis* (Pierce). This weevil has been identified as a pest of cassava (*Manihot utilissima* Pohl) since 1916. Seven species of **Coelosternus** have been recorded as borers of cassava, four of which are found in Brazil. The list of the American and Brazilian species is given. Other host plants are unknown; all the species of **Coelosternus** having been found on **Manihot.** The adults feed on the stems and the young larvae bore into the center of the stems, damage to the plants resulting from the galleries bored by the larvae. Technical descriptions of the adult and immature stages are given, and the life cycle of the species is described. The proportion of sexes is approximately equal. Under insectary conditions, oviposition is made in or on the stems: Sometimes the female bores a hole in which the eggs are laid; other times the insect lays its eggs in one of the tips preferably. The grub bores into the host tissues and stays there until ready to pupate. The first stage covers 2 days; the second, 6 to 11 days; the third, 5 to 9 days; and the last, 11 days. The construction of the cell is begun from the 38th to the 59th days of life; and the time from the construction of the cell to pupation varies from 7 to 9 days. The average number of eggs to a female is 1.101 daily. The time from emergence to first mating is 2 days, and oviposition begins from 3 days after copulation. Methods suggested for pest control are: the removal of infested stems, which should be burned, and destruction of the remains of plants left in the fields after harvest; crop rotation; ploughing to expose parts of plants remaining underground to the air. *(Author's summary)* F01

0821-1710 ZIKAN, W. **Notas sobre *Lonchaea pendula* (Bezzi) (Diptera) *Belonuchus formosus* Gravenh (Staphylinidae, Coleoptera)**[*Notes on Lonchaea pendula (Bezzi) (Diptera) and Belonuchus formosus Gravenh (Staphylinidae, Coleoptera*]. Boletim do Ministerio da Agricultura (Brazil) no. 32. 1943. 10p. Port., Sum. Port., Illus.

Cassava. Injurious insects. pests. Noxious animals. ***Silba pendula*****. Entomolgy. Brazil.**

In addition to cassava, other host plants of *L. pendula* include *Mammea americana, Mangifera indica,* **Eugenia** sp. (Myrtaceae), **Citrus** sp., **Rubiaceae** and uncultivated plants; the fruits of all these plants are attacked. In cassava growing points, only *L. pendula* and *Anastrepha manihoti* were found. It is frequently observed that female flies use areas damaged by other fruit flies to oviposit in. In each location one egg is placed: in cassava the eggs are placed near the top of the growing point. The ovipositor is used to make a small hole, where the egg is then laid. About three-fourth's of the egg protrudes from the tissues. The author supports other reports that *L. pendula* is a primary pest of cassava. Larvae tunnel in at the growing point, producing a whitish excretion and possible death. Latter the stems can be infested by fungi causing rotting. Control is achieved by collecting affected shoots or trapping adult flies in traps baited with fruits. *Anastrepha manihoti* larvae are also found in cassava shoots. This insect is also known as a pest of cassava fruits. *Belonuchus formosus* was never found in cassava terminals, as these possibly lack attractive odors for the adult flies in contrast to attacked fruits. *L. pendula* larvae are attacked in their first instar by larvae and adults of the **Staphilinid**. One adult female was observed to consume 4 larvae in 18 hours. *(Summary by A. van S.)* F01

0822-2494 GOLDING, F. D. **A probable vector of cassava mosaic in southern Nigeria.** Tropical Agriculture (Trinidad) 12:215. 1935. Engl., 2 Refs.

Cassava. ***Manihot esculenta.*** **Noxious animals. Injurious insects. Pests. Aleyrodidae. Bemisla. Entomology. Vectors. Cassava mosaic virus. Nigeria.**

An experiment was carried out to obtain evidence of the transmission of mosaic by the Aleyrodidae, *Bemisia nigeriensis* Corb. Two infected and two uninfected cuttings of bitter cassava, *Manihot utilissima,* were planted in each of 2 cages covered with muslim. Collected from infected plants in the field, 814 adult Aleirodids were introduced into one of the cages. Mosaic symptoms were found on two young leaves of one of the healthy plants, while no symptoms were obtained in the control cage. An indication was obtained that *Bemisia nigeriensis* Corb. can operate as a vector of cassava mosaic. *(Summary by J.L.S.)* F01 E04

0823-1583 SCHOONHOVEN, A. VAN. **Resistance to thrips damage in cassava.** Journal of Economic Entomology 67(6):728-730. 1974. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Pests. Noxious animals. Injurious insects. Frankliniella.** ***Corynothrips stenopterus.*** **Clones. Leaves. Entomology. Resistance. Colombia.**

Part of the germplasm bank of cassava at the Centro Internacional de Agricultura Tropical (CIAT) was evaluated at the end of each of 2 successive dry seasons for resistance to thrips, **Frankliniella** sp. and *Corynothrips stenopterus* Will. Clones were classified in 6 resistance groups on the basis of damage symptoms. About 20% of the 1,254 clones evaluated showed no symptoms of thrips damage. Thrips damage and the number of thrips present in the terminal buds were related. A strong relationship existed between pubescence of unexpanded leaves and thrips resistance; plants with pubescent leaves were resistant to thrips attack. At flowering, leaf pubescence decreased and thrips susceptibility increased. Resistance was not associated with plant cyanide content. Thrips may cause symptoms similar to those of viral or mycoplasmic organisms. *(Author's summary)* F01

0824-1792 LEPAGE, H. S. and GIANNOTTI, O. **Experiencias preliminares de alguns inseticidas no contrôle de várias lagartas daninhas.** *(Insecticidal trials in the control of hornworms).* Biológico 11:182-186. 1945. Port.

Cassava. Pests. Injurious insects. Noxious animals. Insect control. Pest control. Insecticides. *Erinnyis ello.* **Brazil.**

Two insecticidal trials were conducted against 5 lepidopterous larvae. The cotton-attacking species were susceptible to Gesarol M-10 (DDT) by contact action. *Erinnyis ello* was resistant to the product, except the first 3 instar larvae of *E. ello,* were susceptible. *E. ello,* was very susceptible to DNOP as a stomach poison. This product is under study to determine the lethal dose for this insect. *(Summary by A. van S.)* F01

0825-0696 LEFEVRE, P.C. **Note sur quelques insectes parasites de "*Manihot utilisima* Pohl" dans la région de Kasenyi (Lac Albert).** *(Note on some insects attacking Manihot utilissima Pohl in the region of Kasenyi, Lake Albert).* Bulletin Agricole du Congo Belge 35(1|4):191-201. 1944. Fr., 9 Refs.

Cassava. *Manihot esculenta.* **Stems. Pests. Injurious insects. Noxious animals. Entomology. Zaire.**

This is a brief description of the main insects found in the region of Kasenyi in 1939. The entomological characteristics of the following insects are given: *Chilocorus distigma, Heterobostrychus brunneus, Sinoxylon brazzai, Calandra oryzae,* **Stephanoderes** sp., **Brachymeria** sp., *Xylocopa senior,* **Ceratina** sp., **Sturmia** sp., *Eldana saccharina, Pieris mesentina, Aegocera rectilinea. (Summary by S.S. de S.)* F01

0826-0875 PINGALE, S. V., MUTHU, M. and SHARANGAPANI, M.V. **Insect pests of stored tapioca chips and their control.** Bulletin. Central Food Technological Research Institute (India). 5(6):134-136. 1956. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Storage. Entomology. Pests. Injurious insects. Noxious animals. Insect control. Insecticides. Cassava chips. Dried tubers. Cassava products. India.

The susceptibility of stored cassava chips to the common stored-product insects in India was investigated. It was found that *Araecerus fasciculatus* (De G) and *Stegobium paniceum* (L) are the main insects responsible for bringing about deterioration and reducing the chips to dust in a short time. Storage of the chips in jute bags impregnated with a lindane-dieldrin mixture was found to offer protection from insects for 6 months. Furthermore, the effect of common fumigants on the two destructive insects was also studied, and the effective concentrations and exposures for the control of existing insects are mentioned. *(Author's summary)* F01 I02

0827-2132 LEEFMANS, S. **De Cassava-Mijt.** *(Cassava mite).* Buitenzorg, Java. Department van Landbouw. Mededeelingen van het Laboratorium voor Plantenziekten no. 14. 1915. 35p. Dutch., 9 Refs., Illus.

Cassava. Injurious insects. Entomology. Leaves. *Tetranychus telarius.* **Injurious mites. Noxious animals. Pests. Insect control. Pest control. Java.**

Damage symptoms of *Tetranychus bimaculatus* are yellow dots on leaves, which turn rusty and subsequently drop off. The growing tip can die causing heavy branching. This all occurs in the dry season. The infestation is spread by fallen leaves, workers' clothes or by crawling mites; it is not spread via wind or infested stakes. The mites are preyed upon by a predator mite who consumed (on the average) 53 eggs and 8 adults per day, but whose reproduction was too slow to be effective. **Coccinellid** larvae consumed an average of 126 eggs and 38 adults. However, mass releases of 150,000-180,000 adults were ineffective because of rapid emigration of the beetles. Control by leaf clipping (completely defoliated 5 times in 2 months) reduced yields 50% or more. Of the various insecticides, sulfur powder was effective. General control recommendations: clip leaves at earliest infestion; rotate cassava with other crops; and plant in a location with a less pronounced dry season. *(Summary by A. van S.)* F01

0828-2330 FONSECA, J.P. DA. **Relação das principais pragas observadas nos anos de 1931, 1932 e 1933, nas plantas de maior cultivo no estado de São Paulo.** *(List of main pests of the principal cultivated plants in the state of São Paulo, during the years 1931-1933).* Arquivos do Instituto Biólogico 5:163-189. 1934. Port., Sum. Engl.

Cassava. *Manihot esculenta.* **Pests. Noxious animals. Injurious insects. Entomology.** *Erinnyis ello.* **Brazil.**

This paper discusses entomological conditions of the principal plants cultivated in the state of São Paulo (Brazil) during the years 1931-33. The following pests were recorded in cassava (*Manihot esculenta* Crantz): *Erinnyis ello* L.; *Lonchaea pendula* Bezzi; *Antherigona excisa* Thoms, and *Aleurothrixus aepim* Goeldi. *(Author's summary)* F01

0829-2435 FRAPPA, C. **Notes biologiques sur quelques insectes nouveaux ou peu connus et nuisibles aux plantes cultivées á Madagascar.** *(Biological notes on some new or little known insects of cultivated plants in Madagascar).* Bulletin de la Société Entomologique de France 12:186-192. 1931. Fr., 9 Refs.

Cassava. Pests. Injurious insects. Noxious animals. Entomology. Malagasy Republic.

A brief note is given on several insects on various crops. Cassava pests mentioned are **Orthoptera,** *Finotina radama:* **Hemiptera,** *Mytilapsis dispar;* **Coleoptera,** *Seria catanea. (Summary by A. van S.)* F01

0830-3082 BAHIA. SECRETARIA DE AGRICULTURA. **Pragas da mandioca; doença mosaica nas folhas de mandioca.** *(Cassava pests; mosaic disease of cassava leaves).* Boletim do Laboratorio de Pathologia Vegetal 3:67-74. 1925. Port., Illus.

Cassava. Pests. Injurious insects. Entomology. *Euthrips manihoti. Eudiplosis brasiliensis.* **Pest control. Noxious animals. Insect control. Galls. Brazil.**

A mosaic disease of cassava leaves is widespread in Bahia (Brazil). Attacks are stronger during the dry season. A new insect of Thysanoptera, *Euthrips manihoti* Bondar, has been found on diseased plants. Weeding and choosing healthy cuttings are recommended to prevent the disease. It is also recommended to wash the cuttings using an insecticide based on tobacco leaf extractions. Leaf galls caused by *Eudiplosis brasiliensis* Rbs., affect cassava plantations throughout the country. Larvae on the leaves seem to excrete some substance, irrigating the neighboring cells, which reproduce abnormally, forming an excrescence where the larvae live and develop. Diseased leaves are submerged in water, burned or buried to control the pest. *(Summary by H.J.S.)* F01

0831-2133 CORSEUIL, E. **Mandarová da mandioca.** *(The cassava hornworm).* Boletim do Campo 10(75):3-8. 1954. Port., 10 Refs., Illus.

Cassava. *Manihot esculenta.* **Pests. Injurious insects. Noxious animals. Entomology.** *Erinnyis ello.* **Insect control. Biological control. Insect agents. Pest control. Insecticides. Agricultural equipment. Brazil.**

A principal pest of cassava is the hornworm, *Erinnyis ello.* Other host plants of *E. ello* are *Manihot dulcis, Carica papaya, Araujia sericifera, Allamanda cathantrica, Euphosbia gymnoclada* and *Hevea brasiliensis.* The pest is most abundant from Dec. - March and can defoliate large areas. Eggs are laid on leaves and hatch within a week. The larvae, occurring in different colors, mature in 15 days. The pupae hatch in 2-3 weeks, and there are usually 3 generations per hornworm season. The pupae of the last generation hibernate until the next spring. Larval predators include *Alceorhynchus grandis* (Pentatomidae), *Calosoma retusum* (Carabeidae), and **Polistes** (Vespidae). Dipterous larval parasites are **Oxysarcodexia** and **Delvosia;** egg parasites are various microhymenoptera of the families Braconidae, Chalcidae and Elacheridae. Control is achieved by checking the crop regularly. Larvae may be killed mechanically or by applying Paris green. Arsenates are also popular; toxaphene (10%, 15-20 kg| ha), BHC and endrin are also used. Poor control was obtained with parathion, DDT and malathion. Toxaphene dusting is recommended and dusting equipment is discussed. *(Summary by A. van S.)* F01

0832-3009 MALLAMAIRE, A. **Les insectes nuisibles au manioc en Afrique noire.** *(Insect pests of cassava in Africa). In* Congrés du Manioc et de Plantes Féculentes Tropicales, Marseille, 1949. Marseille, Institut Colonial, 1949. pp.72-73. Fr.

Cassava. Pests. Injurious insects. Noxious animals. Leaves. Africa.

The following insects have been found on the leaves of cassava: *Schistocerca gregaria* Forsk; *Anacridium moestum* var. **Melanorhodon** Walk.; *Nomadacris septemfasciata* Serv.; *Zonocerus variegatus* L.; *Anoploenemis curvipes* F.; *Helopelthis bergrothi* Reuther; *Helopelthis westwoodi* White; **Bemisia** sp.; *Pseudococcus citri* (Risso) Fern.; and *Saissetia nigra* Nietn. *(Summary by J L.S.)* F01

0833-1772 MONTE, O. **Coleobrocas da mandioca.** *(Stemborers of cassava).* Biológico 6:15-18. 1940. Port., Illus.

Cassava. Pests. Injurious insects. Noxious animals. Entomology. ***Coelosternus granicollis.*** **Insect control. Pest control. Brazil.**

The species of stemborer that attack cassava are *Coelosternus rugicollis, C. manihoti, C. notaticeps* and *Eulechriops manihoti;* adults of all are briefly described. *E. manihoti* differs from Coelosternus sp. in that it attacks the cortex, not the pith. The Coelosternus species bore in the pith but do not reach the underground portions of the plant. Several larvae per plant can be found. The adult lays her eggs on the cortex, the larvae tunnel in the central part of the stem, and mature in about a month. The excretions are pushed out of the entrance holes. Larvae pupate in the stem and adults may stay there until the rainy season. Control is obtained by burning infested and old planting material. *(Summary by A. van S.)* F01

0834-2109 CORSEUIL, E. **Una lagarta em batata doce e mandioca.** *(A caterpillar in sweet potato and cassava).* Boletim do Campo 11(80):3-7. 1955. Port.

Cassava. Pests. Injurious insects. Noxious animals. Entomology. Insect control. Pest control. Insecticides. Brazil.

The southern armyworm *Xylomyges eridania (Prodenia eridania)* is widely distributed in North and South America. Besides sweet potato and cassava, it attacks several other plant species such as *Ricinus communis, Aleurites fordii,* tomatoes, cotton and maize. In cassava it attacks the leaves, stems and roots. About 6-8 days after mating, the female starts oviposition. A total of about 400 eggs are laid in masses. In 16-28 days, the larvae are full grown and measure 5 cm. The larvae occur in many colors. The larvae pupate in the soil in 12-27 days. In Rio Grande do Sul, heavy attacks occur at the end of April. **Tachinidae** larval parasites are rather abundant. Control is achieved by toxaphene or a bait of 4 kg toxaphene (40%, 30-55 kg wheat flour, 1.5 kg molasses, and 15 liters water|ha). This has to be applied late in the day to avoid the sun as the larvae are active at night. *(Summary by A. van S)* F01

0835-1785 OEI-DHARMA, H. P. **Maize, cassava, soybeans, peanuts, sweet potatoes and potatoes.** *In* ———. Use of pesticides and control of economic pests and diseases in Indonesia. Leiden, The Netherlands, E. J. Brill, 1969. pp.32-48. Engl., 31 Refs., Illus.

Cassava. Pests. Injurious mites. Noxious animals. Acaricides. Mite control. Pest control. ***Tetranychus telarius.*** **Indonesia.**

This is a literature review of the control of the common red spider mite *(Tetranychus telarius)* on cassava. The attacked plants suffer from stunted growth and have wilted young leaves and yellow to reddish brown patches on older leaves. Good results in the control of this pest have been obtained by using the following formulations: 5% mixture of sulfur or lime, 0.8% white spraying oil, 0.02% Folidol E605 46.7% EC, toxaphene 50% EC + derris (0.3% + 0.5%). Good control of the scale insect *Saissetis nigra* on cassava has been obtained by using the following formulations: California mixture, 8-10% carbolineum plantarium and 0.2% Folidol E605 46.7% EC. *(Summary by J.L.S.)* F01

0836-2879 LYON W.F. **A green cassava mite recently found in Africa.** Plant Protection Bulletin 22(1):11-13. 1974. Engl., 3 Refs., Illus.

Cassava. *Manihot esculenta.* Noxious animals. Injurious mites. Mite control. Pests. Entomology. *Mononychellus tanajoa.* Acaricides. Uganda.

In 1972 a heavy outbreak of an unknown spider mite appeared on cassava in several parts of Uganda and severely stunted the plants. Heavy infestations caused blotching and bronzing of leaves, later accompanied by leaf fall. This mite was identified as *Mononychellus tanajoa* (Bondar) (Acarina: tetranychidae). The mite lives on the apical bud and feeds from embryonic and new leaves. Consequently, leaves develop abnormally, exhibit a large number of yellow spots, lose their green color and become distorted, resembling mosaic-like damage caused by *Scirtothrips manihoti* (Bondar). The infested plants lose their leaves, die from top to bottom, become exhausted and fail to produce roots and finally die unless rainfall washes the mites off. Control measures involve removal of the top of infested plant parts, and sprays of nicotine solution of sulfur. Cuttings should be treated with nicotine prior to planting. Chemical control involving dicafol and chlorobenzilate has proved fairly effective. Host resistance appears to be the best solution to this problem. *(Summary by J.L.S.)* F01

0837-2167 BLANCHE, D. **Les fourmis-champignonnistes ou fourmis-manioc á la Guadeloupe.** *(The mushroom-grower ants or cassava ants in Guadalupe).* Revue Agricole Sucrière et Rhumière des Antilles Françaises (Guadeloupe) 3(1):59-68. 1958. Fr., 12 Refs., Illus.

Cassava. Entomology. Injurious. Insects. Insecticides. Noxious animals. Insect control. Pest control. Pests. Guadeloupe.

These leaf-cutter ants belong to the genera *Atta gyphomyrmex* and *A. acromyrmex* (Fam. Myrmicidae). One is *Atta sexdens* L. The ant was probably introduced accidentally into Guadalupe around 1950. In a nest one finds wingless soldiers and workers, winged sexual form and the queen. The nests are distinguished by small heaps of sand, in which the entrance holes are found guarded by soldiers. The workers carry the leaf sections using their mandibles above their heads. Small workers stay in the nest. The sexual forms leave the nests at the time of swarming, fly and mate; the males die, the females start a new nest. The ants eat the fungus *(Rhozites gongylophora)* which they grow on the leaves brought into the nest. They defoliate a wide variety of plants: *Cajanus cajan*, cassava, sugar cane, cocoa, Citrus, etc. Control can only be obtained by continuous efforts. Fumigants introduced into the nests may be effective. Insecticides such as chlordane, heptachlor, aldrin, and dieldrin are effective. Up to 2-3 liters of a 2% solution can be poured into the main entrance holes and the entrances closed off. The method of eradication in Guadalupe is described: The infested area is searched carefully for nests. Each nest is destroyed with insecticides; effectiveness of treatment is checked 2 weeks later. In a short time, 50,000 nests were destroyed. Continued searches for nests are made. *(Summary by A. van S.)* F01

0838-3319 NEGRETE L., F. M. **Control químico de trips en yuca, *Manihot utilissima* Pohl, y evaluación de la colección Costeña al ataque de los mismos.** *(Chemical control of thrips on cassava, Manihot utilissima Pohl, and evaluation of the Costeña collection for resistance to their attack).* Thesis Ing. Eng. Montería, Colombia, Universidad de Córdoba, Facultad de Agronomía, 1973. 52p. Span., Sum. Span., Engl., 11 Refs., Illus.

Cassava. Entomology. Pest control. Cultivars. Resistance. Insect control. Pests. Injurious insects. Insecticides. Leaves. Frankliniella. Colombia.

This research was done at the Centro Nacional de Investigaciones Agropecuarias "Turipaná" (Cereté, Colombia). The purpose was to classify the thrips which attack cassava (*Manihot utilissima* Pohl); to determine their population dynamics; to describe their attack; and to evaluate the Costeña collection for resistance to their attack and to evaluate the effectiveness of the following insecticides: Dibrom-800 E 60 (600 cc| ha a.i.), Gusathion E 25 (200 cc| ha a.i.), Sevin PM 85 (1 g| ha a.i.), DDT PM 50 (420 g| ha a.i.), Roxion S-50 E38 (160 cc| ha a.i.), Malathion E 57 (450 cc| ha a.i.), Methyl parathion E 48'(400 cc| ha a.i.), Meta-

Systox E 25 (175 cc| ha a.i.), Toxaphene DDT 40-20 (1000 cc| ha a.i.), Dipterex SP-80 (420 g| ha a.i.) and Ekatin E 25 (112.5 cc| ha a.i.). The following results were obtained: (1) The species, according to K. O'Neill of the National Museum of Natural History from Beltsville (U.S.), is **Frankliniella** sp. Thysanoptera: Thripidae. (2) The highest population level of this species is found in the rainy months. (3) The damage is caused when nymphs and adults pierce their stylets in the under surfaces of the leaves and then feed on exudates. This damage is done in tender leaves, shoots and buds. (4) Characteristic symptoms are generally elongated, chlorotic spots, deformation of the leaf margin and diminishing of the leaf area and, finally, germination of side buds. (5) Statistical analysis of the effectiveness of insecticides showed differences between each treatment and control but not among the insecticides themselves. (6) The greatest residuality was found for the systemics like Roxion and Ekatin. It is important to note that during the first 90 days, damage is under the critical level (15% of the leaf area lost). (7) Number of varieties in the various resistant clones: Resistant 51, Highly resistant 9, Moderately resistant 8, Susceptible 4, Highly susceptible 0. The hybrid CMC 15 11-35 was highly susceptible. *(Author's summary)* F01

0839-1769 LEPAGE, H.S. GIANNOTTI, O. and ORLANDO, A. **Combate ao mandarová da mandioca** (*Erinnyis ello* L.). *(Control of cassava hornworm, Erinnyis ello L.)* Biológico 13:76-80. 1947. Port., Illus.

Cassava. Pests. Injurious insects. Noxious animals. *Erinnyis ello*. **Entomology. Insect control. Pest control. Insecticides Brazil.**

The cassava hornworm usually attacks from Nov. regularly to Mar. with large yearly fluctuations. During these months the crop has to be checked for hornworm presence. Mechanical control is possible, but commonly Paris green, at 400 g| 100 liters water is used. Other products are lead or arsenium arsenates and dinitrocyclohexylphenol. The latter product at 0.5% was most toxic to hornworms while DDT was only toxic to the larvae in their first three instars. *(Summary by A. van S.)* F01

0840-0181 CALLAN, E. McC. **Notes on cassava weevil-borers of the genus Coelosternus (Col. Curculionidae).** Revista de Entomologia (Brazil) 13(3):304-308. 1942. Engl., Sum. Engl., 7 Refs.

Cassava. *Manihot esculenta.* **Pests. Noxious animals. Injurious insects. Insect control. Pest control. Entomology. Brazil.**

Previous records of cassava weevil borers, **Coelosternus** spp., are reviewed. *Coelosternus alternans* Boh. and *C. tardipes* Boh. are recorded as pests of cassava in Trinidad, B. W. I. An account of observations on these species is given and recommendations made for their control. *(Author's summary).* F01

0841-0226 MANSFIELD-ADERS, W. **Insects injurious to economic crops in the Zanzibar protectorate.** Bulletin of Entomological Research. 10:145-155. 1919. Engl.

Cassava. *Manihot esculenta.* **Pests. Injurious insects. Noxious animals. Zanzibar.**

Insects injurious to the following crops are included: cloves; coconuts; cotton; cereals (rice, maize and millet); vegetables (cabbages, eggplant, cucurbitaceae, pigeon peas, ladies' fingers, sweet potatoes, cassava); fruit trees (citrus, mango, banana, soursop); shade and timber trees; and stored products. Cassava plants habe been observed to be infested with **Pseudococcus (Dactylopis) virgatus** var. **madagascarensis,** Newst. The red mite (**Tetranychus** sp.) is abundant in some plots and causes wilting and curling of the leaves. *(Summary by P.A.C.)* F01

0842-2298 FRAPPA, C. **Les insectes nuisibles au manioc sur pied et aux tubercules de manioc en magasin à Madagascar. II. Insectes nuisibles au manioc en magasin.** *(Insects harmful to cassava plants and to stored cassava tubers in Madagascar. II. Insects harmful to stored cassava).* Revue de Botanique Appliquée et d'Agriculture Tropicale 18:104-109. 1938. Fr., 17 Refs.

Cassava. Storage. Injurious insects. Tubers. Cereals. Noxious animals. Cassava chips. Processed products. Africa. Asia.

The following insects are found to be noxious to stored cassava roots, chips and slices: *Tenebroides mauritanicus, Lophocateres pusillus, Cathartus advena, Necrobia rufipes* de Guer, *Rhizopertha dominica* Fab., *Dinoderus bifoveolatus* Woll., *Minthea obsita* Woll., *Minthea rugicollis* Walk., *Sinoxylon conigerum* Gerst, *Lyctus brunneus* Steph., *Lyctus africanus* Les., *Tribolium ferugineum* Fab., *Tribolium confusum* Dur., *Alphitobius piceus* Ol., *Calandra oryzae* Linne = *Calandra quadrimaculatus* Walker, *Araeocerus faciculatus*. Brief notes are given on their morphology, damage and distribution. *(Summary by J.L.S.)* F01

0843-2186 BRADLEY, W. G. **Dominio de insectos en plantaciones de yuca.** *(Insect control for cassava plants.)* Agricultura (Dominican Republic) 44(206):15-18. 1955. Span., Sum. Span., Illus.

Cassava. Noxious animals. Entomology. Injurious insects. *Carpolonchaea chalybea.* **Pests. Insect control. Pest control. Insecticides. Dominican Republic.**

Damage to cassava in the Dominican Republic is due to two insects. A caterpillar that attacks cassava leaves is described, but it is not identified by name. This caterpillar completely defoliates the plant, thus minimizing tuber yield. DDT, applied at 1|4-1|3 lb| ha, was the best control measure. The other pest is a bud maggot identified as *Lonchaea chalybea*. A description of the damage it does is included. Malathion is recommended for destroying this fly since DDT was unsatisfactory. *(Summary by J.L.S.)* F01

0844-2291 GUAGLIUMI, P. **Contributo alla conoscenza dell'entomofauna nociva del Venezuela.** *(Contribution to the knowledge of harmful insects from Venezuela).* Rivista de Agricoltura Subtropicale e Tropicale 49(7-9):376-408. (Cont.). 1965. Ital.

Cassava. Entomology. Injurious insects. *Coelosternus granicollis.* **Noxious animals.** *Erinnyis ello.* **Pests. Venezuela.**

Notes on the historical development and present stage of entomology in Venezuela are presented. Several crops, such as maize, rice, sugar cane, cotton, citrus spp., vegetables, potatoes, sweet potatoes, tobaco and cassava are briefly described. The most important harmful insects affecting some of the aforementioned crops are treated in detail; less important pests are mentioned briefly. *(Summary by H.J.S.)* F01

0845-0631 KROCHMAL, A. and CUBERO, J. **A cassava insect.** World Crops 19(6):23. 1967. Engl., Illus.

Cassava. Entomology. Pests. Noxious animals. Injurious insects. Insect control. Pest control. *Erinnyis alope.* **Virgin Islands.**

Larvae of the Sphingid *Erinnyis alope* (Dru.) are recorded attacking cassava *(Manihot esculenta)* in St. Croix (U. S. Virgin Islands). A spray of DDT or carbaryl (Sevin) applied at the beginning of an attack gave control. *(Summary by Review of Applied Entomology)* F01.

0846-3116 **INSECT PESTS and fungoid diseases in Barbados, 1912-13.** Agricultural News 13(315):170-172. 1914. Engl.

Cassava. Injurious insects. *Erinnyis ello.* **Insecticides. Insect control. Pests. Noxious animals. Pest control. Insect agents.**

This paper contains information mainly on cotton and sugar cane pests. For cassava it describes a serious attack of *Erinnyis* (**Dilophonota**) *ello*. Four broods were observed 30 days apart. Effective control was obtained with lead arsenate and Paris green. Caterpillars, pupae and adults were preyed upon by birds. **Polistes** sp. preyed on larvae. No tachina flies or others were found. *(Summary by A. van S.)* F01

0847-0391 ROMERO S., J. I. and RUPPEL, R. F. **A new species of Silba (Diptera, Lonchaeidae) from Puerto Rico.** Journal of Agriculture of the University of Puerto Rico 57(2):165-168. 1973. Engl., Sum. Engl., Span., 9 Refs.

Cassava. Injurious insects. Noxious animals. Pests. Entomology. Puerto Rico.

Silba perezi n. sp., a fly that attacks cassava tips, is described and illustrated, and characters are given to separate it from *S. batesi*, the most closely related species. *(Author's summary)* F01

0848-3386 COMBATA **A broca. Queime os restos de cultura de mandioca.** *(Fight the stemborer. Burn cassava waste materials).* São Paulo. Coordenadora de Assistencia Tecnica Integral. Instruções Práticas no. 90. 1972. 2p. Port., Illus.

Cassava. Injurious insects. Entomology. Pest control. Pests. Brazil.

A coleopterous stemborer ("Broca das ramas") causes great damage to cassava. Leaf tips atrophy and dry up; eventually the plant dies. The insect is white (body) and light grown (head). It makes tunnels and round perforations in the branches. Infected plant should be pruned during the cold season, and the waste material should be burned. *(Summary by H.J.S.)* F01

0849-0205 CARDENAS, R. **Principales plagas de la yuca y su control.** *(Major pests of cassava and their control).* *In* Instituto Colombiano Agropecuario. Curso intensivo del cultivo de yuca. Palmira, Colombia, Centro Nacional de Investigaciones Agropecuarias, 1972. pp.14-19. Span.

Cassava. Noxious animals. Injurious insects. Pests. Entomology. *Erinnyis ello*. Aleyrodidae. Bemisia. *Silba pendula*. *Tetranychus telarius*. *Mononychus planki*. Pest control. Insect control. Insecticides. Colombia.

A description is given of the main pests of cassava and their control. The following species are considered as potential pests: stemborers, *Acanthoderes nigricans* Lammeere, *Eulechriops manihoti* Monte, **Eubulus** sp., **Coelosternus** sp.; and foliage insects, *Vatiga manihotae* (Drake). *(Summary by J.L.S.)* F01

0850-2296 FRAPPA, C. **Description de *Bemisia manihotis* nov. sp., Aleurode nuisible au manioc a Madagascar.** *(Description of Bemisia manihotis nov. sp., an Aleyrodidae which is harmful to cassava in Madagascar).* Bulletin Economique de Madagascar no. 11:267-268. 1937. Fr., 1 Ref.

Cassava. Noxious animals. Injurious insects. Bemisia. Leaves. Pests. Vectors. Entomology. Cassava mosaic virus. Diseases and pathogens. Aleyrodidae. Malagasy Republic.

This insect has been observed only on the underside of the cassava leaf. It seems to be related to the attack of cassava mosaic disease. A description is given of mature and immature stages of the insect. *(Summary by H.J.S.)* F01

0851-0055 REINIGER, C. H. **O marandová dos mandiocais.** *(The cassava hornworm).* Boletim do Campo 3(16):1-3. 1947. Port., Illus.

Cassava. Injurious insects. *Erinnyis ello*. Insect control. Pests. Noxious animals. Pest control. Brazil.

The cassava hornworm *Erinnyis ello* is a cassava pest in Rio Grande do Sul, Sta. Catalina, Rio de Janeiro and the Federal District. The pest status varies according to ecological conditions but is most important from November-March. There are 3 generations of hornworms per season. The eggs, (measuring 1.4 mm) are laid at night and hatch in 4-7 days. The larvae, variable in color, develop in 15 days into a pupa, from which the gray-striped adults emerge. Mechanical control of eggs, larvae and pupae is possible. Chemical control is possible with lead arsenate (350-500 g| 100 liters water). Kryocide dusted at 0.75% is also recommended. Adults can be attracted to light. *(Summary by A. van S.)* F01.

0852-1838 KORYTKOWSKI, G., A. and SARMIENTO P., A. **Hyperdiplosis sp. (Dipt.: Cecidomyiidae), un insecto formador de agallas en las hojas de yuca.** *(Hyperdiplosis sp. (Dipt., Cecidomyiidae) a gall-forming insect on cassava leaves).* Revista Peruana de Entomología 10(1):44-50. 1967. Span., Sum. Span., Engl., 9 Refs., Illus.

Cassava. Noxious animals. Injurious insects. Pests. Galls. Cecidomyiidae. Entomology.

Larvae of a Cecidomyiid fly, identified as **Hyperdiplosis** sp., were found making galls on cassava leaves in increasing proportion, mainly on the northwestern coast of Peru where it is possible to find plants showing heavy damage. The work includes description of imago and immature stages, biology and life cycles, damage symptomatology and a list of natural enemies. *(Author's summary)* F01

0853-1750 CALLAN, E. McC. **The gall midges (Diptera, Cecidomyidae) of economic importance in the West Indies.** Tropical Agriculture (Trinidad) 18(6):117-127. 1941. Engl.,Sum., Engl., 15 Refs., Illus.

Cassava. *Manihot esculenta.* **Pests. Injurious insects. Noxious animals.** *Eudiplosis brasiliensis.* **Cecidomyiidae. Entomology. Trinidad and Tobago.**

The following 8 species of gall midges are considered of economic importance in the West Indies: *Contarinia sorghicola* Coq. (sorghum), *C. lycopersici* Felt (tomatoes), *C. gossypii* Felt (cotton), *Porricondila gossypii* Coq. (cotton), *Iatrophobia brasiliensis* Rubs. (cassava), *Erosomyia mangiferae* Felt (mangoes), *Asynapta mangiferae* Felt (mangoes) and *A. citrinae* Felt (citrus). The life cycles of these species are analyzed; the nature and extent of the damage caused, together with recommended control methods, are discussed. *(Summary by T.M.)* F01

0854-2041 SIVAGAMI, R. and NAGARAJA-RAO, K.R. **Control of the tapioca scale,** *Aonidomytilus albus* **Ckll.** Madras Agricultural Journal 54(6):325-327. 1967. Engl., 3 Refs.

Cassava. Injurious insects. *Aonidomytilus albus.* **Insect control. Insecticides. Noxious animals. Pest control. India.**

Descriptions are given of the damage caused to plants by the cassava scale insect. Two field experiments using 9 chemicals were conducted to develop a method to control the pest. In both experiments, Meta-Systox (1% spray) was found to be the most effective in minimizing scale incidence on cassava. Parathion and malathion (premium grade) at 0.05 and 0.1% concentrations were also found to be equally effective. For more effective control, it is advisable to use healthy, uninfested planting material; diseased plants should be removed promptly and destroyed. In cases of severe attack, application of the chemical may be repeated to ensure maximum pest reduction. *(Summary by H.J.S.)* F01

0855-1543 COSTA, J. M. DA. **Resultados experimentais obtidos no contrôle do ácaro da mandioca, "***Mononychus tanajoa***" (Bondar, 1938).** *(Control of the cassava spider mite, Mononychus tanajoa).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):25-30. 1973. Port., Sum. Port., Engl., 8 Refs.

Cassava. *Manihot esculenta.* **Noxious animals. Injurious mites. Pests. Mite control. Pest control. Acaricides.** *Mononychellus tanajoa.* **Entomology. Brazil.**

The cassava leaf mite *Mononychus tanajoa* becomes a very serious pest during dry and hot weather in the northern areas of Brazil, especially in the state of Bahia. One experiment was carried out at the Escola de Agronomia, P.P.-1, Brascan Nordeste Project using 2 specific acaricides (Zolone and Chlorobenzilate) and 2 insecticides-acaricides (Rhodiatox and diazinon). Both phosphorous compounds, 1 clorinate insecticide (endrin) and a fungicide-acaricide (Dithane M-45) were used in spray to control the cassava mite. The results obtained led to the following conclusions: (a) All insecticides presented good results when compared statistically with control lots; (b) The insecticides Dithane M-45 and endrin gave the same results; (c) Rhodiatox and diazinon gave similar results with a high percentage of efficiency; (d) The best insecticide was

Zolone, which gave the highest percentage of control, 100. Phytotoxic action of the insecticides on the leaves was not observed. *(Author's summary)* F01

0856-3892 PIGATTI, A., FIGUEIREDO, M. B. and ORLANDO, A. **Experiencias de laboratorio sobre a atividade de novos inseticidas contra o mandarová da mandioca.** *(Performance of new insecticides in the control of the cassava hornworm, Erinnyis ello).* Biologico 26(3):47-51. 1960. Port., Sum. Engl., 12 Refs.

Cassava. Pests. Injurious insects. Noxious animals. *Erinnyis ello.* **Insect control. Pest control. Laboratory experiments. Insecticides. Brazil.**

During a hornworm outbreak in the state of São Paulo, there was an opportunity to test several new insecticides for its control. Larvae of last instar were dusted with 12 different products in the partial-vacuum apparatus described by Farrar et al. By contact, endrin (1.5%) and Sevin (10%) caused higher mortality than did toxaphene (20%), which has been used so far for the control of this pest. The other chemicals tested were less efficient. *(Author's summary)* F01

0857-0156 CALLAN, E. McC. **Some economic aspects of the gall midges (Diptera, Cecidomyidae) with special reference to the West Indies.** Tropical Agriculture (Trinidad) 17(4):63-66. 1940. Engl., Sum. Engl., 7 Refs.

Cassava. Entomology. Pests. Injurious insects. Noxious animals. *Eudiplosis brasiliensis.* **Cecidomyidae. Galls. Trinidad and Tobago.**

The larval feeding habits and economic importance of the **Cecidomyidae** are discussed, and control measures are reviewed. The West Indian gall midge fauna is discussed with reference to the sources from which it has been derived. The following 8 species are considered as pests of West Indian crops: *Contarinia gossypii* Felt (cotton), *C. lycopersici* Felt (tomatoes), *C. sorghicola* Coq. (sorghum), *Porricondyla gossypii* Coq. cotton), *Iatrophobia brasiliensis* Rubs. (cassava), *Asynapta citrinae* Felt (citrus), *A mangiferae* Felt (mangoes) and *Erosomyia mangiferae* Felt (mangoes). *(Author's summary)* F01

0858-2067 KAUFMANN, T. **Biology and feeding habits of** *Zonocerus elegans* **(Orthoptera: Acarididae) in Central Tanzania.** American Midland Naturalist 87(1):165-171. 1972. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Entomology. Pests. Noxious animals. Injurious insects. Tanzania.

Zonocerus elegans Thunberg breeds once a year and its nymphal eclosion is correlated with the onset of the rain. No mass migration, either of nymphs or adults, takes place in this species. Males matured first, but their mating attempts were rejected until females became receptive about 2 weeks later. Oviposition followed 2-3 weeks after the first mating. *Z. elegans* feeds on a wide variety of plants, many of which are economically important; but herbs are preferred to grasses. Although cassava, *Manihot utilissima*, is extensively eaten in cultivated fields of Tanzania, adults having no access to this plant as a part of their diet during the nymphal period, rejected it altogether in captivity. Dietary experiments showed that individuals reared on garden flowers yielded better results with respect to development, body size, mortality, fecundity and longevity of Ale than those fed on wild plants. *(Author's summary)* F01

0859-1819 FONSECA, J. P. DA. **Combate ao "Mandarová" da mandioca.** *(Control of the cassava hornworm).* Notas Agricolas (Brazil) 6:389- 294. 1943. Port.

Cassava. Injurious insects. Pests. Insect control. *Erinnyis ello.* **Noxious animals. Pest control. Brazil.**

In São Paulo two principal pests of cassava are the hornworm and the stemborer. The hornworm, *Erinnyis ello*, oviposits at night on cassava; eggs are placed singly. In 4-5 days the eggs hatch. The larvae are variable in color. In 14-17 days the larvae matu and pupate under plant debris. About 15-18 days later, the moths appear. When older plants are attacked, their root starch content is lowered while young plants may die. It is necessary to check plantations for presence of larvae. Heavily infested areas should be controlled. Besides removing larvae and pupae, chemical control of larvae may be needed. The best products are lead arsenate and paris green. Lead arsenate is sprayed at 400 g | 100 liters water, Paris green at 500 g | 500 liters water, with 3,000 g lime added as an adhesive. Another adhesive is cassava starch at 500 g | 100 liters water, 100 ml oil per 100 liter water can also be used as adhesive. Soap solutions may also be used to control larvae; plants should be well wetted. Older larvae are more difficult to control and have caused more damage by then. Observed insect resistance to these products is probably due to small dosages or applications in prepupal stages. Digging canals and filling them with plant debris will attract the larvae to pupate there, where they can be destroyed easily. Good mechanical weed control will kill many larvae and pupae. *(Summary by A. van S.)* F01

0860-1768 **CASSAVA STEM borer.** Agricultural News (West Indies) 14(340):155. 1915. Engl., Illus.

Cassava. Pests. Injurious insects. Noxious animals. Insect control. Entomology.

Specimens of an insect attacking the stem of cassava plants in St. Vincent were recently received at the office of the Imperial Department of Agriculture. Cassava growing at the Experiment Station was rather seriously attacked, and a considerable amount of injury resulted. The insect has been identified as a species of **Cryptorhynchus**, a genus which is credited with an unusual number of species in the West Indies and the American tropics. The most common and abundant **Crytorhynchus** is probably the scarabee or Jacobs of the sweet potato, *C. batatae*. Another form is *C. corticalis*, which is known as a borer in ornamental crotons in St. Vincent and Grenada, while another species sometimes causes injury by boring in the wood of orange and similar trees. The cassava stemborer is larger than the scarabee. The adult being 1 | 4 in. the pupa 3 | 8 in. and the full-grown larva about 1 | 2 in length. The pupa very much resembles that of the scarabee. The cassava stemborer is so little known that there has been no opportunity of testing methods that may be used for its control. It is suggested, however, that all material for planting should be quite free from infestation and, in fact, that no plant material should be taken from any field known to be or suspected of being infested by this insect; and all bits of stem in infested fields should be carefully removed from the fields and either burned or deeply buried in order to kill the grubs and beetles in them. *(Full text)* F01

0861-3474 **LUTTE CONTRE le fourmi manioc.** *(Cassava ant control).* Lyon. Pechiney-Progil. Circulaire Technique Hors Séries no. 24. 1956. 3p. Fr.

Cassava. Injurious insects. Noxious animals. Pests. Pest control. Entomology.

The term "cassava ant" applies to many species of the genus **Atta** and sometimes to species of the genus **Acromyrmex**. This pest may be controlled inside the hive with the application of dibromoethane and aldrin; parathion, aldrin and Zithiol are applied on the hillocks. Infested plants are sprayed with Zithiol. *(Summary by J.L.S.)* F01.

0862-2131 LEEFMANS, S. **De cassave-Oerets.** *(The cassava white grubs).* Java Departement van Landbouws. Mededeelingen van het Laboratorium voor Plantenziekten no. 13. 1915. 120p. Dutch., 9 Refs., Illus.

Cassava. Injurious insects. Pests. Noxious animals. Insect control. ***Leucopholis rorida.*** **Biological control. Pest control. Entomology.**

Cassava is grown on sandy soils, which makes white grub control by heavy irrigation impossible. The white grubs were probably present because coffee, one of its host plants, had been planted on these soils previously. The biology of *Leucopholis rorida* Fab, *Lepidiota stigma* and other white grubs is given, as well as a description of their parasites. Insecticides and stake treatments are also discussed. *(Summary by H.P.R.)* F01

0863-4349 FONSECA, J. P. DA. **Mandarová da mandioca.** *(The cassava hornworm).* São Paulo, Secretaria de Agricultura, Instituto Biológico. Folheto no. 98. 1943. 14p. Port., Illus.

Cassava. Injurious insects. Pests. Insect control. *Erinnyis ello.* Insecticides. Noxious animals. Pest control. Entomology. Brazil.

The cassava hornworm, *Erinnyis ello* is one of the 2 principal pests, the other being the stemborer. The hornworm is distributed from southern Brazil to Canada. It has been reported since 1896 on various Euphorbiaceae and is most abundant in Jan. and Feb. The female lays an average of 30 eggs, singly on the upper surface of cassava leaves. Eggs measure 1.3 x 1.5 mm and hatch in 4-6 days. Upon hatching larvae measure 5 mm; they molt several times. Larvae show color polymorphism. On the 12th day of the larval instar, they enter the prepupal stage, and 3 days later the pupae are formed. The male and female moths are briefly described. Generally an attack starts on the younger leaves but complete defoliation can occur, including consumption of shoots. Larvae may crawl some distance to find a place to pupate under plant debris. The pupal stage lasts 16-18 days. Young plants can die from a hornworm attack, while starch content of the roots may be reduced in older plants. It is necessary to check cassava fields constantly for the presence of hornworm larvae. Infested spots should be treated, followed by a general preventive treatment. Insect constrol is possible with lead arsenate (400 g| 100 liters water or Paris green 500 g| 500 liters water). For the latter, 3,000 slaked lime| 500 liters water is recommended as a sticking agent; for lead arsenate 100 ml oil is recommended. Other sticking agents are casein, various oils, cassava starch or soap. One has to spray the whole plant, rains will render sprays ineffective. Mature larvae are resistant to the insecticides because they have stopped feeding. Mechanical control of the larvae is possibly by collecting and destroying them. Pupae can be collected and destroyed by digging ditches and filling them with plant debris, where larvae will pupate and pupae can be collected. These ditches also serve to prevent spreading of infestations. Other control measures include weed control, which kills many pupae, and construction of wide alleys to separate fields. Predatory insects include *Calosoma retusun* (Carabeidae) and *Alcoeorrhynchus grandis* (Hemiptera). One **Calosoma** can destroy dozens of larvae per day. *A. grandis* sucks larvae empty. Other predators are **Polistes** wasps. The fly **Oxysarcodexia,** as well as the Tachinid fly **Delnosia** sp., parasitizes larvae. Parasites include other microhymenopterus of the **Apanteles** and species of **Elachertidae** and **Chalcidae.** Birds prey on larvae too. *(Summary by A. van S.)* F01

0864-3078 BODKIN, G. E. **The cassava hawk moth (*Diplodia phonota* Ello).** Journal of the Board of Agriculture of British Guiana 6:17-27. 1912. Engl.

Cassava. Injurious insects. Pests. Insect control. Insecticides. Noxious animals. Pest control. Entomology.

Synonyms of the hornworm are *Sphinx ello, Anceryx ello* and *Dilophonota ello.* Besides cassava, it attacks rubber and several other plants; the host range is restricted to Euphorbiaceae. Under laboratory conditions the life cycle is as follows: Eggs are generally laid on the upper surface of leaves. An average of 200 eggs|female was found. Eggs hatch in 5 days. The larval stages last 17 days. Larvae show color polymorphism and lose their horn in the 4th instar. Several full-grown larvae can be heard feeding at a distance. Full-grown larvae descend the plant to find a place to pupate under plant debris. Heavy egg parasitism by *Telenomous dilophonotae* was observed. Larval parasitism by a Tachinid was also observed Control by lead arsenate spray is effective. Lead arsenate or Paris green is also effective when lighly dusted. Further control is achieved by removing larvae by hand. Eggs should be destroyed; those with parasites should be kept until parasites emerge, when they can be released. Pupae can also be collected and destroyed. *(Summary by A. van S.)* F01

0865-3320 **COMBATA A broca do broto da mandioca.** *(Control of cassava shoot fly).* São Paulo, Brasil. Coordenadoria de Asistencia Técnica Integral. Instruções Prácticas no. 127. 1972. 2p. Port., Illus.

Cassava. Injurious insects. Noxious animals. Pests. Insect control. Pest control. Entomology. Brazil.

This is a pamphlet addressed to farmers. It deals with the damage caused by a cassava shoot fly and its control in Brazil. *(Summary by H.J.S.)* F01

0866-1817 ZACHER, F. **Kafer an Tapiokawurzeln.** *(Beetles in cassava roots).* Mitteilungen der Gessellschaft für Vorratsschutz E. V. 6(5):53-56. 1930. Germ., 11 Refs., Illus.

Cassava. Injurious insects. Storage. Deterioration. Pests. Noxious animals. Dried tubers. Entomology.

A brief explanation is given of cassava production and its uses. Seven beetles were found attacking stored, dried roots. There were **Sinoxylon** sp. (*S. cornigerum* is reported in the literature), *Sitophilus oryzae* (L.) (*S. exarata* is reported), *Laemophoeus ferrugineus* Steph, *Latheticus oryzae* Woth. and *Necrobia rufipes* Dg. The 2 most important species were *Araeocerus fasciculatus* (the coffee bean weevil) and *Rhizopertha dominica* F.; especially the latter destroyed roots rapidly. A brief description of the species is given. *A. fasciculatus* develops in 5-6 weeks; the adults live for several months. *R. dominica* females may lay 300-500 eggs among the stored products. The larvae feed on many different foods including flour. . The insects attacking stored products are divided into 5 groups: (1) those attacking stored grain (*S. oryzae*, *R. dominica* and *A. fasciculatus*), (2) those feeding on waste products (*L. ferrugineus*, *L. oryzae*), (3) those feeding on fungi, (4) predators, and (5) parasites. *S. oryzae* normally attacks grain so the fact that it attacks cassava roots in interesting. The presence of cyanide did not seem to have any influence on the insects in stored roots. *(Summary by A. van S.)* F01

0867-0511 URUETA, E. J. *Mononychus planky*, **a potential pest to Manihot in Colombia.** Tropical Root and Tuber Crops Newsletter no. 3:14. 1970. Engl.

Cassava. Noxious animals. Injurious mites. Manihot. Mite control. Pest control. Pests. Entomology. Insecticides. Colombia.

Production of **Manihot** as a food and for industrial purposes has increased in Colombia. The following pests are considered as the most important: the hornworm *Erinnyis ello*, a fly **Carpolonchaea** sp. and the mite *Mononychus planky* McG, which has caused considerable damage at the Experiment Station of the Instituto Colombiano Agropecuario, ICA (Palmira, Colombia). This mite, as well as the damage it causes, is described. It retards plant growth and is very serious in the case of small plants. A field test was carried out to check the effectiveness of 9 pesticides. The products used were: 1642, Bidrin, Zolone, Fundal, Roxion, Lannate, Nuvacron, Kelthane and Tedion. Good control was obtained with Nuvacron, Bidrin, Roxion and Fundal. None of the 9 pesticides were phytotoxic. *(Summary by J.L.S.)* F01

0868-3493 DEVEZ, G. **La fourmi-manioc,** *Oecodoma cephalotes.* **Sa destruction méthodique par l'anhydride sulfureux liquifié. III. Procédés de destruction employés.** *(The cassava ant, Oecodoma cephalotes: its control by liquid sulfur dioxide. III. Methods of destruction used).* Agronomie Coloniale 2:13-18. 1914. (Cont.). Fr.

Cassava. Pests. Injurious insects. Noxious animals. Insect control. Pest control. Insecticide.

Carbon disulfide (CS_2) was successfully used to destroy ant nests; it was poured into the nest, followed by water. No damage was done to the trees around the nests. However, it was necessary to apply 20-40 kg for a large nest, which is uneconomical. Less CS_2 can be used by igniting it to produce toxic sulfur dioxide. In this way, 1 kg of CS_2, which expands to 391 liters at 30°C, can be used. *(Summary by A. van S.)* F01

0869-0115 URUETA, E. and LAGOS, E. **Control de un ácaro en yuca.** *(Control of a cassava mite). In* Congreso Nacional de Ingenieros Agrónomos, 4°, Barranquilla, Colombia, 1967. Memorias. Agricultura Tropical (Colombia) 1968:104. 1968. Span.

Cassava. Leaves. Acaricides. Injurious mites. Mite control. Entomology. ***Manihot esculenta.*** **Colombia.**

This article describes briefly an unidentified mite that attacks cassava (*Manihot esculenta* Crantz) found in the collection at the Centro Internacional de Investigaciones Agropecuarias, Palmira (Colombia). Also included is a description of damages caused by the mite and insecticides used to control it. *(Summary by P.A.C.)* F01

0870-2297 FRAPPA, C. **Les insects nuisibles au manioc sur pied et aux tubercules de manioc en Magasin á Madagascar.** *(Harmful insects of cassava plants and stored tubers in Madagascar).* Revue de Botanique Appliquée et d'Agriculture Tropicale 18(197):17-29. (Cont.). 1938. Fr., 23 Refs.

Cassava. Injurious insects. Bemisia. Aleyrodidae. Noxious animals. Entomology. Pests. Insect control. Pest control. Malagasy Republic.

Cassava is the third most important export crop. The most important pests are the following: (1) **Isoptera.** Termites damage recently planted stakes. Of about 12 species, the most important belong to the genus Coptotermes. For control, the stakes should be treated with insecticides; planting should he done during the rainy season to ensure rapid growth. (2) **Orthoptera** (Locustidae ex Acrididae). There are 4 important species; these grasshoppers cause damage hy defoliation. (3) **Hemiptera:** The species *Bemisia manihotis* Fr. is the most important because it transmits the mosaic virus disease. *Mytilaspis dispar* forms colonies on branches and causes severe damage during the dry season; yields amount to only 2-3 tons|ha. Control is obtained by planting uninfested material or by treating stakes with insecticides. (4) **Coleoptera.** This Dynastide destroys stakes and young shoots. Two leaf-eating beetles are also reported. (5) **Lepidoptera.** Only *Prodenia litura* Fab. (noctuid) is widespread and has a great number of host plants. The larvae cut off young shoots emerging from the soil, typical of cutworm damage. *(Summary by A. van S.)* F01

0871-0765 BARRIOS., J.R. **Reacción de veinticinco variedades de yuca,** ***Manihot esculenta,*** **al ataque de ácaros.** *(Reaction of twenty-five cassava, Manihot esculenta, varieties to acarid attack).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1972. 8p. Span., 5 Refs.

Cassava. Cultivars. Injurious mites. Pests. Noxious animals. Entomology. Venezuela.

The Agronomy Institute in Maracay carried out a field trial to test the reaction of several cassava varieties to acarid attack. All the varieties were attacked by an acarid which is possibly *Eotetranychus planki* (McG.). Damage observed included (a) deformation and decoloration of leaves, which dry up and fall off; (b) abnormal growth processes, resulting in a great number of apical buds being formed; and (c) death of apical shoots and sometimes the whole plant. Heavier damage occurs during the dry season when the acarid population is larger. During the rainy season, this population decreases and the plants recover because of the higher moisture contained in the air and the soil *(Author's summary)* F01.

0872-1795 COSTA, R. G. **Mandarová da mandioca.** *(The cassava hornworm).* n.p. Secretaría de Agricultura, Industria y Comercio. Divulgación de Seçao de Informaçoes e Publicidade Agricola no. 73. n.d. 2p. Port.

Cassava. Injurious insects. Pests. Insect control. *Erinnyis ello. Insecticides. Noxious animals. Pest control. Entomology.*

The cassava hornworm, *Erinnyis ello,* causes great damage to cassava plantations. It is a pest from Dec.-April, during which time 3 generations develop. Control is possible with 10% chlorinated camphene at 20 kg|ha; 20% at 15 kg|h; 40% at 500 g|100 liters water with 800-1,000 liters|ha; and in emulsifiable concentrate of 3 liters|ha. Rhodiachlor 20-0 (40%) at 15 kg|ha is also effective. *(Summary by A. van S.)* F01

0873-3193 MONTE, O. **Mandarová da mandioca.** *(The cassava hornworm).* Biologico (Brazil) 7(2):38-39. 1941. Port.

Cassava. *Erinnyis ello.* **Insect control. Insecticides. Entomology. Brazil.**

Due to an increase in cassava production, the attack of the hornworm *Erinnyis ello* has increased. A short description of its biology is given. Besides natural control by birds and other animals, chemical control is possible with lead or calcium arsenates at 400 g|100 liters of water every 15 days as long as the pest occurs. A survey of the fields is necessary to find early attacks. *(Summary by A. van S.)* F01

0874-0615 COSENZA, G. W. and CORREA, H. **Estudo da cochonilha da mandioca na região Centro-Oeste.** *(Sutdy on the cassava scab in the Middle West region).* *In* Reuniao da Comissão Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste. 1971. pp.41-42. Port.

Cassava. Entomology. Leaves. Tubers. Pests. Injurious insects. Noxious animals. Insect control. Pest control. Brazil.

The scale insect, of the Margarodidae (genus **Eurhizococus** or **Monophebus**), appeared in Sete Lagoas (Brazil) some years ago. The insect attacks the leaves and roots of cassava. A description of the insects, as well as methods to control the pest, are given. *(Summary by H.J.S.)* F01

0875-0539 ROBBS, C. F. **O hexacloreto de benzeno (CHC) no combate ao mandarova da mandioca (*Erinnyis ello* L.).** *(Hornworm, Erinnyis ello L., control with benzene hexachloride. BH·* Agronomia (Brazil) 8(3):337-340. 1949. Port., 3 Refs., Illus.

Cassava. Injurious insects. Entomology. *Erinnyis ello.* **Insecticides. Pests. Noxious animals. Insect control. Pest control. Brazil.**

The effectiveness of BHC in the control of *Erinnyis ello* was studied. It was found that 30 kg| ha of BHC (2% gamma isomere) was effective when applied as a spray. Extension work was done in training farmers to use a fumigator. Spraying was done with a light breeze. *(Summary by J.L.S.)* F01

0876-4484 NYIIRA, Z. M. **Biological studies on the cassava mite,** *Mononychellus tanajoa* **(Bondar) (Acarina; Tetranichidae).** Kampala, Uganda, Kawanda Research Station, 1973. 6p. Engl. 6 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta. Mononychellus tanajoa.* **Acaricides. Biological control. Entomology. Uganda.**

Bioecological studies on the cassava mite *Mononychellus-tanajoa* (Bondar) are described. Although the use of acaricides may be deemed desirable for the control of the green cassava mite, they do not present satisfactory long-term solution to the country-wide infestation. The complexity of the problem calls for a carefully conceived, integrated control program in which a diversity of research scientists would participate. *(Summary by D. H. and L. J.)* F01

0877-2383 **PLÁGAS DE la yuca.** *(Cassava pests).* *In* Bogotá. Instituto Colombiano Agropecuario. Control de Plagas. Asistencia Técnica. Manual No. 1 n.d. pp.71. Span.

Cassava. *Carpolonchaea'chalybea. Erinnyis ello.* **Injurious mites. Insect control. Insecticides. Mite control. Colombia.**

This paper consists of a one-page table. Data refer to procedures for chemical control of 3 insects injurious to cassava: *Carpolonchaea chalybea, Erinnys ello* and *Mononychus planki. (Summary by H.J.S.)* F01.

0878-2249 DEFONTAINE. **Destruction de la fourmi Tamagure par le carbure de calcium.** *(Destruction of the Tamagure ant using calcium carbide).* Agriculture Pratique de Pays Chauds 2-3:742-743 1902-1903. Fr.

Cassava. Pests. Injurious insects. Noxious animals. Insect control. Pest control.

The Tamagure ant (leaf-cutting ant) causes great damage to cassava in South America. The female ant, about the size of a fly, is black. In March, after the first rains, the females leave the colony, fly and mate in the evening, bite off their wings and dig a nest about 50 cm deep in the soil. A month later,thousands of workers are born. The ants can defoliate coffee, cacao, cassava, etc. up to more than a kilometer from their nest in few days. A South American planter recommends acetylene gas for their control. Calcium carbide is applied, pulvorized at 10 g|nest with 20 liters of water. After 15-20 minutes, the gas mixture is exploded by a pulverized torch. This is an extremely dangerous method. *(Summary by A. van S.)* F01

0879-4485 BENNETT, F.D. and YASEEN, M. **Investigations on the Cassava mite *Mononychellus tanajoa* (Bondar) and its natural enemies in the Neotropics; report for April 1974-March 1975.** Curepe, Trinidad. Commonwealth Institute of Biological Control. Report. 1975. 14p. Engl., 3 Refs., Illus.

Cassava. *Mononychellus tanajoa*. Mite control. Acaricides. Biological control. Insect agents. Entomology. Trinidad and Tobago.

In April of 1974, a study was carried out in Trinidad to identify the natural enemies of the green spider mite of cassava, *Mononychellys tanajoa* (Bondar), and related cassava mites in the Neotropics and to select promising predators for trials in Africa. The following aspects are dealt with: effect of plant age on levels of infestations, the biology of *M. tanajoa*, methods of dispersal and populations studies. The dominant and most widespread predator was *Oligota minuta;* other natural enemies encountered were an unidentified thrips (Thysanoptera), a Cecidomyiid, 2 unidentified Coccinelids and 2 Phytoseiid mites, *Typhlodromalus limonicus* and *T. rapax*. The effect of an acaricide (Galecron) at the rate of 2.2 g| gal every 3-4 weeks was also studied. Preliminary results suggest that although populations of the mite are reduced initially, they build up again fairly quickly; the predators, however, do not reappear during the first 10 days after treatment. A brief review is also made of field work being carried out in St. Kitts, the Bahamas, Panama and Mexico. *(Summary by L.C. Trans. by T.M.)* F01

0880-0067 DINTHER, J. B. M. VAN. **Insect pests of cultivated plants in Surinam.** Paramaribo, Surinam. Landbouwproefstation in Suriname. Bulletin no. 76. 159p. 1960. Engl., 191 Refs., Illus.

Cassava. Pests. Injurious insects. Noxious animals. Entomology. Surinam.

The pests occurring on cassava in Surinam are briefly described: whiteflies; thrips *(Corynothrips stenopterus); Phlyctaenodes bifidalis; Phoenicoprocta vacillans* and *P. sanguinea;* hornworm, *Erinnyis alope* and *E. ello;* gall midge *(Iatrophobia brasiliensis);* shoot fly *(Lonchaea chalybea); Telenomus delophonatae*, a hornworm egg parasite and leaf-cutter ants *(A. sexdens). (Summary by A. van S.)* F01

See also 0329 0418 0585 0711 0587 0589 0793 0800 1464

F02 Rodents and other Noxious Animals ·

0881-3036 HALL, C. J. J. VAN. **De gezondheidstoestand van onze cultuurgewassen in de Jaren 1920 (1921.** *(Pests occurring in 1920 and 1921).* Teysmannia 33(1-2):15-23. 1922. Dutch., 5 Refs.

Cassava. Noxious animals. Pests.

Wild hogs destroy much cassava, and spide mites also occur. In a long dry season (1918), damage w: considerable. In 1920 and 1921, relatively wet years, damage was less. *(Summary by A. van S.)* F02

0882-3327 DAS, N. M., NAIR, M. R. G. K. and JACOB, A. **On the occurrence and control (Harpurostreptus sp., a new millipede pest of cultivated crops in Kerala.** Indian Journal (Entomology 28(4):563-566. 1967. Engl., Sum. Engl.

Cassava. Pests. Noxious animals. Pest control. Tubers. Insecticides. India.

The millipede **Harpurostreptus** sp. has been recorded as a new pest damaging roots of cassava and chillies i Calicut (Kerala). Baits containing 5% BHC, 5% DDT, 0.625% endrin, 0.625% parathion, 5% Sevin, 5(calcium arsenate or 2.5% malathion, 10% jaggery, and the rest bran gave 82, 92, 96, 72, 52 and 12% mortalit respectively, in 72 hours. Only BHC (0.2% spray) was effective as a contact. Drenching the soil to a depth (2-3 in a 0.2% concentration of BHC gave 93% mortality in 48 h. *(Author's summary)* F02

0883-0260 PAPRZYCKI, P. **Notas sobre los enemigos de la yuca.** *(Notes on the enemies of cassava,* Revista Chilena de Historia Natural Pura y Aplicada 8:146-149. 1945. Span., Illus.

Cassava. *Coelogenis fulvus.* **Pests. Noxious animals. Rodents.** *Dasyprocta variegata.* **Peru.**

In Peru the "samani" *(Coelogenis fulvus* L.) is a small animal (average length 60 cm and weight 15 kg) tha eats cassava *(Manihot utilissima)* plants. Similarly, the "cutpe" *(Dasyprocta variegata)* also destroy: cassava plantations. Retrievers (or setters) can be trained to hunt and kill these animals. Instructions ar(given on how to smoke a "samani" or a "cutpe" out of its burrow. Cassava has totally replaced the potato ir the tropical jungles of Peru. Indian women use cassava to prepare "massato," a native alcoholic drink anc methods are given for preparing it. *(Summary by P.A.C.)* F02

See also 0811

G00 GENETICS AND PLANT BREEDING

0884-3164 MIEGE, J. and MIEGE, M. N. **Recherches sur la sterilité chez le manioc.** *(Research on cassava sterility).* Revue de Cytologie et de Biologie Végetales 15(3):179-194. 1954. Fr., Sum. Fr., 3 Refs., Illus.

Cassava. Cytology. Stamens. Pollen. Plant fertility.

A comparative study was made of meiosis in the staminodes, using a fertile pollen strain and a sterile pollen strain of *Manihot utilissima* Pohl. In fertile cassava, pollen is heterogenous and is comprised of about 40% nonfunctional grains, in spite of the completely normal characteristics of meiosis. In sterile cassava, the meiosis is also normal although the grains degenerate before the final stage of their development. *(Author's summary)* G00

0885-2050 VASUDEVAN, K. N. *et al.* **Radiation-induced mutations in cassava.** Indian Journal of Horticulture 24(1-2):95-98. 1967. Engl., Sum. Engl., 17 Refs. Illus.

Cassava. Mutation. Starch content. HCN content. Developmental stages. Cytogenetics. Chromosomes. Plant breeding. India.

A description is given of the chief attributes of 2 mutants isolated in 2 strains of cassava as a result of irradiation of stem cuttings with gamma rays. The important traits characterizing one of the mutants relate to increase in starch content and decrease in HCN content. It is suggested that such viable morphological mutants can be recovered within a dose range of 4,000 r and 7,500 r; doses ranging from 10,000 r and above result in the disruption of the chromosome mechanism in the material studied. *(Author's summary)* G00

0886-0303 JENNINGS, D. L. **Variation in pollen and ovule fertility in varieties of cassava and the effect of interspecific crossing on fertility.** Euphytica 12:69-76. 1963. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Pollen. Plant breeding. Hybrids. Plant fertility. Ovules. Anthers. Cultivars. Backcrossing. *Manihot melanobasis.* **Genetics. Ovaries. Crossbreeding.** *Manihot esculenta.*

Records of the set of seeds obtained from intraspecific cassava crosses, from interspecific crosses between other Manihot species and cassava, and from backcrosses to cassava of three generations of interspecific hybrids are used to assess the variation in pollen and ovule fertility. It is concluded that the capacity of cassava varieties to set seeds has been reduced since they have envolved from nontuberous, wild forms and have been propagated vegetatively. Fertility was found to be very variable, and the capacity of the pollen of a variety to promote seed-set was not related to the fertility of the variety's female flowers. This situation would be expected if reduction in the fertilities of the two sexes were caused either by loss of balance in the genes controlling the functioning of the male gametophyte or by an unbalance of those concerned with the functioning of the female gametophyte or the tissues that nurture the embryo. Additional causes of sterility, probably including meiotic irregularities, appeared to operate in the F1 interspecific hybrids, but such factors were probably not important after the first backcross generation. *Manihot melanobasis*, a wild form which is normally propagated by seed and whose relationship to cassava should be regarded as subspecific, contributed factors which enhanced the fertility of its hybrids with cassava. This form could be used in cassava breeding as a donor of seed fertility, but use could also be made of some existing varieties which still possess a moderately high capacity to set seed. It is desirable to select these as one parent when making difficult crosses. *(Author's summary)* G00

0887-0586 NICKELL, L. G. and TORREY, J. G. **Crop improvement through plant cell and tissue culture.** Science 166:1068, 1070. 1969. Engl.

Cassava. Cytology. Genetics. Plant breeding. Plant tissues. Laboratory experiments. Plant reproduction. Tissue culture.

General discussions arising from a conference are presented on crop improvement through plant cell and tissue culture. Regeneration of plants from callus and cell cultures has now been accomplished with enough species to consider that it can be done with all plants. Since the somatic tissues in some plants have cells with varying chromosome numbers, some of the regenerated plants would be different from the "parent." No reports are known of successful callus culture of *Manihot. (Summary by H.J.S.)* G00

0888-1794 KRISHNAN, R., MAGOON, M. L. and VIJAYA-BAI, K. **The pachytene karyology of** ***Manihot glaziovii.*** Genética Ibérica 22(4):177-191. 1970. Engl., Sum. Engl., 4 Refs., Illus.

Manihot glaziovii. **Cytology. Chromosomes. Microsporogenesis.**

The pachytene karyology and microsporogenesis of the disease- and drought-resistant species *Manihot glaziovii* Muell. (2n= 36) utilized in the cassava breeding program were studied. The entire haploid complement was identified using such criteria as relative length, arm ratio, nucleolar association, presence of telochromomere, heteropycnotic short arm, etc. The pachytene karyotype was compared to that of *M. esculenta,* bringing out the karyological similarities and differences in the 2 taxa. Further corroborative evidence was obtained on the polyploid origin of 2n= 36 species of the genus **Manihot,** as realized earlier from pachytene karyology of *M. esculenta. (Author's summary)* G00

0889-0372 MERCADO, T. **A comparative study of two bud sports of cassava and their parent varieties.** Philippine Agriculturist 28(4):308-320. 1939. Engl. Sum. Engl., 2 Refs.

Cassava. ***Manihot esculenta.*** **Mutation. Cultivars. Clones. Inheritance. Plant breeding. Tuber productivity. Starch productivity. Composition. HCN content. Stems. Plant height. Plant development. Productivity.**

This paper reports the results of sporting in 2 varieties of cassava (*Manihot utilissima* Pohl)–namely, Sinkong Manis and Java ornamental cassava- and their asexual progeny. Under the first year of culture, sporting was found more frequently in the curly variety and its noncurly mutant than in the variegated variety and its asexual progeny. The noncurly and nonvariegated sports produced significantly more storage roots and starch and larger, longer stalks than did their respective parent varieties. The results of this experiment tend to show that improvement in yield is possible through selection of bud sports. *(Author's summary)* G00

0890-0113 GRANER, E. A. **Tratamento de mandioca pela colquicina. III. Análise comparativa entre clones diplóides e tetraplóides.** *(Treatment of cassava by colchicine. III. Comparative analysis between diploid and tetraploid clones).* Anais da Escola Superior de Agricultura "Luis de Queiroz". 3:99-140. 1946. Port., Sum. Port., Engl., 9 Refs., Illus.

Cassava. Clones. Plant physiology. Chromosomes. Polyploidy. Stems. Leaves. Productivity. Field experiments. Roots. Plant development. Colchicine. Analysis. Starch content. Composition. Cytogenetics. Brazil.

Tetraploid plants of cassava (*Manihot utilissima* Pohl) obtained by colchicine treatment were smaller than diploid plants. An analysis of their growing habits showed that tetraploid clones were not uniform and could be divided into two groups: (1) plants with stalks as thick as, but shorter than the diploid plants; and (2) plants with stalks shorter and thinner than the diploid plants. Production of roots and stalks was studied in one experiment of randomized blocks and one vegetative cycle of the plants (about 10 months). Diploid clones were more productive and the tetraploid clones were very variable. The index stalk| root weight was lower in diploid clones, thus showing that production of roots in relation to stalks in the tetraploid plants was less than in diploid plants. Tetraploid plants were slower in growing habits at the beginning of the development. (3) One experiment of randomized lines of 15 plants each and two vegetative cycles of the plants (about 20 months) confirmed the results obtained in the experiment of one vegetative cycle regarding the production of roots and stalks. However, the index stalk| root in plants with two vegetative cycles was the same (i = 0.30) for all clones (diploids and tetraploids) and was identical to plants with two vegetative cycles, the production of roots in relation to stalks was the same in both diploid and tetraploid clones. The production of roots and stalks were studied in one systematic experiment of 3 clones (diploid clone 8 and tetraploid clones 2 and 6), in blocks of about 100 plants. The results obtained confirm the difference between tetraploid and diploid clones and also between the two tetraploid clones involved in the experiment. The commercial value of tetraploid clones could be established only after other experiments (more tetraploid than diploid plants in the same area) since the production per plant of tetraploid clones is lower. Tetraploid clone 6 has very small plants, low root production and did not support field conditions. It is suggested that this clone should be good for horticultural conditions. The starch content was the same in all tetraploid and diploid clones studied and in two other clones of bitter cassava (9 and 10) included for comparison. *(Author's summary)* G00

0891-0647 MAGOON, M. L. **Problems and prospects in the genetic improvement of cassava in India.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd , Honolulu and Kapaa, Kauai, Hawaii, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v. 1 , pp. 58-61. Engl., 17 Refs., Illus.

Cassava. Manihot. *Manihot glaziovii. Manihot esculenta.* **Plant breeding. Cytogenetics. Resistance. HCN. Hybridizing. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Fertilizers. Productivity. Germplasm. Maturation. Plant development. Proteins. India.**

An extensive research program on local and introduced cultivars and some related **Manihot** species is summarized. Breeding procedures include intervarietal and interspecific hybridization, inbreeding and utilization of induced mutations. Interspecific hybridization has been used for resistance to mosaic disease, utilizing *M. glaziovii*. Cytogenetical studies include genome analysis of *M. esculenta* and *M. glaziovii* and the induction of autotetraploids (4n = 72) and triploids (3n = 54). *(Summary by Plant Breeding Abstracts)* G00.

0892-3385 BAI, K. V., JOS, J. S. and NAIR, R. G. **Amphidiploidy in the genus Manihot.** Chromosome Information Service no. 13:23-25. 1972. Engl., 8 Refs., Illus.

Cassava. Genetics. Ceara rubber. Hybridizing. Cytogenetics. Plant breeding. *Manihot esculenta. Manihot glaziovii.*

Cassava (*Manihot esculenta* Crantz.) is an important starchy root crop in many tropical countries and this genus is reported to be a native of South America. Interspecific hybridization had been effected between a cultivated cassava variety and ceara rubber (*M. glaziovii* Muell) to transfer the desirable characteristics, such as resistance to drought and virus disease, of the latter species into cassava, using cassava as the female parent. The F1 plant was almost male sterile, but female fertility was found to be partial. Hence, an attempt has been made to understand whether the male sterility is actually due to cryptic cytological irregularities or genic through amphidiploidy. It also seems likely that the great store of potential genetic variability associated with the increased number of genes in amphidiploids provides an opportunity to develop radically new genotypes. *(Author's summary)* G00.

0893-0699 GRANER, E. A. **Tratamento de mandioca pela colchicina. II. Formas poliploides obtidas.** *(Treatment of cassava by colchicine. II. Polyploid forms obtained).* Bragantia 2 (2):23-54. 1942. Port., Sum. Port., Engl., 7 Refs., Illus.

Cassava. Colchicine. Chromosomes. Polyploidy. Cytology. Pollen. Plant anatomy. *Manihot esculenta.*

The methods used to obtain polyploid cassava *(Manihot utilissima* Pohl) by colchicine treatment were described in detail. Two solutions of colchicine were tried (one at 0.5% and other at 1.0%), both producing many altered plants. The chromosome number of the altered plants was determined, and a correlation between chromosome duplication and an increase in the major diameter of stomata was found. Size of stomata in cassava serves to identify polyploid individuals if the plant produced by treatment is not a chimera, which frequently occurs in producing polyploid cassava by colchicine. It was emphasized that the plants obtained by treatment were a type of chimera, the aerial part being polyploid and the subterranean base, diploid. The development of polyploid individuals obtained from the polyploid aerial part of the treated plant was analyzed. A comparison between the tetraploid and the diploid control plants was made, the octoploid plant being too slow in development. There are many groups of polyvalents in the first meiotic metaphase of the autopolyploid individuals obtained. From an analysis of the pollen grains, it was assumed that the diploid plant may be a structural hybrid. The production of the tetraploid plants was computed preliminarly; other detailed experiments involving spacing were necessary for estimating commercial production since the diploid produces more branched plants than tetraploids. *(Author's summary)* G00.

0894-0649 ROGERS, D. J. and APPAN, S. G. **Untapped genetic resources for cassava improvement.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd, Honolulu and Kappa, Kauai, Hawaii, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v. 1., pp.72-75. Engl., 5 Refs., Illus.

Cassava. Manihot. *Manihot dichotoma. Manihot saxicola. Manihot glaziovii.* **Plant breeding. Taxonomy. Flowers. Pollen. Plant geography. Plant anatomy. Hybridizing. Crossbreeding. Cultivars.** *Manihot esculenta.* **Genetics.**

An account is given of **Manihot** species and their relationships, assessed by taximetric methods, as a basis for exploiting the available gene pool in breeding programs. There are 74 species native to the neotropics. *M. esculenta* is itself heterogenous, with a large breeding potential. Three groups of wild species which have close morphological affinity to. *M. esculenta* are found in North America (e.g., *M. aesculifolia* I and *M. rubricaulis*), in the Guianas (e.g., *M. saxicola)*) and in the region from Brazil to Argentina . The study suggests that one of the wild species described by Jennings (cf. XXX, 874, XLII, 5807) was incorrectly named *M. melanobasis* (a synonym of *M. esculenta*), but its identity is unknown. *(Summary by Plant Breeding Abstracts)* G00 A00 B00

0895-0651 APPAN, S. G. *et al.* **A strategic program for genetic engineering of cassava.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd, Honolulu and Kapaa, Kauai, Hawaii, 1970, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v.l, pp.79-82. Engl., 16 Refs.

Cassava. Manihot. Cultivars. Identification. Taxonomy. Genetics. Research. Plant breeding. *Manihot esculenta.*

A systems analytical approach is suggested for the design of improvement strategies in *Manihot esculenta.* A computer-aided monographic treatment of the genus is being carried out to detect patterns of genetic structure which form a basis for the breeding strategy. These cultivars and their relationships have been classified and an automated information management system developed. *(Summary by Plant Breeding Abstracts)* G00 A00

0896-1793 JOS, J.S., MAGOON, M. L. and NAIR, S. G. **A cytological and morphological analysis of triploid cassava.** Genetica Iberica 22(1):27-39. 1970. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. *Manihot esculenta.* **Plant breeding. Colchicine. Cytology. Chromosomes. Cytogenetics. Plant anatomy. Microsporogenesis. Pollen. Flowers. Leaves. Polyploidy.**

A triploid hybrid was obtained from a cross between a colchicine-induced tetraploid of a Malayan-4 cassava variety and a cultivated diploid type. The triploid showed somewhat intermediate morphological characters between the progenitors. Meiosis was found to be normal in the diploid parent, resulting in high pollen stainability. On the other hand, microsporogenesis was found to be highly irregular in the triploid hybrid, and different types of meiotic abnormalities were observed. The triploid was highly pollen sterile and did not set any seed on selfing; however, there was very reduced seed fertility under field conditions. The role of triploidy in cassava breeding was also considered. *(Author's summary)* G00.

0897-3356 SINGH, A. P., NAIR, R. C. and MAGOON, M. L. **Palynological studies in *Manihot esculenta* Crantz and *M. glaziovii* Muell. Arg.** Journal of the Indian Botanical Society 47(3-4):358-367. 1968. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. *Manihot esculenta. Manihot glaziovii.* Pollen. Taxonomy, Flowers. Cultivars. Germination. Developmental atages. Anthers. Staminodes.

Detailed palynological studies were made in 30 cultivars (16 indigenous and 14 exotic) of *M. esculenta* Crantz and in 3 collections of *M. glaziovii* Muell. Arg. Pollen grains in all cases are pantoporate and the ectine possess a mosaic pattern. With respect to the pollen characteristics studied, variability among the cultivars is not distinct enough to be used for taxonomic descriptions. However, pollen grains in these species may be grouped as small ($<90\mu$), medium (90 to 150μ) and large ($<150\mu$). Frequent presence of all 3 size groups even within the same plant is attributed to the highly heterozygous nature of the crop. During the course of general screening of the wide germplasm collections at this Institute, male flowers were found to be of 3 types: (a) normal flowers with mostly fertile pollen, (b) abnormal flowers with abortive pollen, and (c) normal flowers with abortive or sterile pollen. Pollen grains of cassava in vivo, germinate within 8 hours, and within 20 hours, germination is complete. However, so far, it has been dificult to germinate them in vitro. *(Author's summary)* G00

0898-1754 TRIVANDRUM. CENTRAL TUBER CROPS RESEARCH INSTITUTE. **Annual report 1971.** Trivandrum, 1972?. 102p. Engl. Sum. Engl.

Cassava. *Manihot esculenta.* Cultivars. Plant breeding. Selection. Hybridizing. Composition. Protein content. Productivity. Cytogenetics. Fertilizers. Nutritional requirements. Manures. Dung. N. P. K. Field experiments. Cultivation. Planting. Spancing. Plant-growth substances. Carbohydrate content. Plant development. Tuber productivity. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Resistance. Mycoses. Injurious insects. Noxious animals. Injurious mites. Mite control. Pest control. *Aonidomytilus albus.* Insecticides. *Cercospora henningsii.* Disease control. Absorption. India.

Qualitative improvement was obtained in one variety of cassava (M-4) through autotetraploidy. The average protein content in the diploid was 2.79%, which increased to 3.97% on a dry weight basis in the tetraploid. Thus, an increase of 42.3% could be obtained in protein content. The yield potential of the tetraploid was not significantly affected. Hybridization and selection programs involving superior exotic and indigenous collections of cassava and sweet potato were continued. Among the hybrids of cassava evolved earlier and evaluated in different trials, hybrids H-2059, H-1843(1), H-1687(1) and H-2304(5) were found to record yields significantly higher than the local varieties. Hybridization work was also initiated among apparently field-resistant genetic stocks of cassava to understand the genetics of mosaic resistance. A large number of crosses were made between mosaic resistant lines and between hybrids derived from 2 exotic parents. Investigations on the cytogenetical aspects of the various tuber crops bearing direct relationship to their genetical improvements were continued. Interspecific hybrids between cassava and ceara rubber were studied for male sterility. In N fertilization trials, hybrid cassava yields were economic at applications of 80 kg N|ha; local varieties responded at 40 kg|ha. Phosphate fertilizers applied to the soil (up to 5 cm below cutting level) were beneficial; application of superphosphate (100 kg P_2O_5 ha) mixed with farmyard manure gave the highest yield. Higher yields were obtained with high levels of fertility (12.5tons FYM + NPK dose at 100 kg each | ha). Vertical planting in a pit followed by the mound method was found to be best in cassava; size of setts should not exceed 30 cm and a 10 cm planting depth. Studies on different sources of P and N in acid laterite soils showed that basic slag and rock phosphate were superior to other phosphatic sources, and urea was better than other nitrogenous sources. In an experiment on N-K interaction, the tuber yield was positively correlated with the uptake of both N and K. In acid laterite soils, it was found that an application of lime at 2,000 kg CaO| ha and at 100 kg P_2O_5 was the optimum for cassava. Application of growth regulators as a spray on the apex of the shoot at fortnightly intervals on one nonbranching and nonflowering strain of cassava (Kanchavuvariayn) helped to induce branching, a precondition for flowering. Presoaking of stem cuttings with growth regulators helped form a greater number of tubers and decreased HCN content. Growth regulators IBA and IPA were better than IAA and NAA. Presoaking treatments of stem cuttings with micronutrient solutions did not increase tuber yield. Carbohydrates in the tuber increased after application of zinc, boron and molybdenum; dry matter and crude protein contents remained unaffected. Cassava mosaic in 5 strains reduced stem girth plant height, petiole length, length and width of mid leaflet and tuber yield ranged from 11-29%, 9-20%, 4-17%, 6-23%, 8-33% and 5-24%, respectively. Regardless of manurial treatment and different doses of NPK, cassava mosaic infection increased when N was applied, but P or K did not increase the severity of the disease. Sap transmission studies with crude sap obtained from virus-infected cassava plants (using 13 plant species) showed that cassava mosaic is not sap transmissible. The chemical Cercobin (0.25% solution) was very effective in controlling **Cercospora** leaf spot, reducing the average number of spots per leaf by 76%. The chemicals Hinosan, Difolatan at 1 and 5 ppm, respectively, and captan, pentachloronitrobenzene (PNCB) and thiram at 25 ppm completely inhibited the in vitro growth of **Sclerotium** sp., which causes tuber rot. Pretreatment of tuber slices by dipping in a 100 ppm solution of Hinosan for 20 min prevented infection and rotting of tubers from **Sclerotium** sp. Monthly sprays with Monocrotophos 0.03% effectively reduced red spider mite *(Tetranychus telarius)* in cassava and 0.03% dimethoate significantly reduced the population of the white fly (**Bemisia** sp.), the vector of cassava mosaic disease. Fortnightly spraying with ethyl parathion (0.03%) reduced scale *(Achimonytillus albus)* infection of stored cassava stems by 93%. *(Summary by T.M.)* G00 C00 E00 J00

0899-3898 GONZALES J., J. D. and LOPEZ R., C. E. **Estudio cromosómico en yuca (*Manihot esculenta* Crantz).** *(Cromosomic study of cassava (Manihot esculenta Crantz).* Thesis Agr. Eng. Medellín, Universidad Nacional de Colombia, Facultad de Ciencias Agrícolas, 1973. 50p. Span., Sum. Span., 15 Refs., Illus.

Cassava. *Manihot esculenta.* **Chromosomes. Cytogenetics. Cultivars. Polyploidy. Colombia.**

The research work for this thesis was carried out with 5 cassava varieties brought from the Centro Internacional de Agricultura Tropical to the Universidad Nacional in Medellín. This thesis analyzes the chromosomic differences and attempts to determine the best methods for chromosomic studies of cassava. The steps followed are the cutting of the apical meristems of the stakes previously planted in pots; immersion in hydroxyquinoline; immersion in a 3:1 fixative substance; squashing and dyeing by several methods; observation under a microscope with an oil immersion objective (1,000 x), and the taking of microphotographs. The number of chromosomes for the analyzed varieties, which are probably triploid hybrids, is 27. The basic number of cassava chromosomes is 9. There is no significant difference in the size and form of chromosomes. *(Author's summary. Trans. by S. de S.)* G00

0900-2244 MAGOON, M. L., JOS, J. S. and APPAN, S. G. **Cytomorphology of the interspecific hybrid between cassava and ceara rubber.** Chromosome Information Service no. 7:8-9. 1966. Engl.

Cassava. Cytology. Plant breeding. Plant anatomy. Developmental stages. Fruits. *Manihot glaziovii.* **Genetics. Hybridizing. Germination.** *Manihot esculenta.* **India.**

Crosses between the cultivated *Manihot esculenta* variety CTCRI-155 and *M. glaziovii* were studied. From the large number of crosses made, only 3 well developed capsules were obtained. Four seeds germinated but only 1 seedling reached maturity. In the F1 hybrid plant, cromosome pairing at midpachytene was normal and complete along the entire length of the bivalents with the exception of 1 bivalent, which exhibited very small terminals as well as interstitial nonpairing segements. One bivalent also showed some loose pairing. At metaphase I 18, bivalents were usually present although occasionally 2 or 3 bivalents tended to separate precociously. A few laggards were also observed at anaphase, and 1 or 2 micronuclei were present at the sporad stage. The F1 hybrid plant was almost male sterile. *(Summary by Plant Breeding Abstracts)* G00

0901-0533 GRANER, E. A. **Genética de Manihot. I. Hereditariedade da forma da folha e da colaboração da película externa das raízes em** *Manihot utilissima* **Pohl.**(*Genetics of Manihot. I. Heritability of leaf shape and of color of the outer layer of roots in Manihot utilissima Pohl*). Bragantia 2:13-22. 1942. Port., Sum. Engl., 6 Refs., Illus.

Cassava. Leaves. Roots. Inheritance. *Manihot esculenta.* **Cortex. Plant anatomy.**

The inheritance of two characters in *Manihot utilissima* Pohl was studied. It was found that the leaves with narrow lobes V are dominant over leaves with large lobes v and that the brown coloration of the roots M is dominant over white m. These two characters segregate independently, according to the data presented in two tables. The phenotypic expression of the form of the leaves is largely dependent on the environment: The leaves with narrow lobes are replaced by leaves with large lobes in plants transported to a shady place under big trees, thus reduction of light causes a change of dominance. *(Author's summary)* G00 B00

See also 0027 0069

0902-2365 **DESCRIPTION DU matériel d'élite sélectionné récemment par la Division des Plantes Vivrières de Yangambi.** *(Description of choice material recently selected by the Yangambi Division of Plant Science).* Bulletin de Information de l'INEAC 6(1):47-65. 1957. Fr., Illus.

Cassava. Cultivars. Selection. Diseases and pathogens. Pests. Plant anatomy. Resistance. Clones. Zaire.

Selected material presented in the experimental garden of the Yangambi Institute in the Belgian Congo is described. The list includes varieties of rice, peanuts, soybeans and cassava clones. Botanical characteristics, agronomy (i.e. resistance to pests) and commercial aspects of cassava clones are dealt with. *(Summary by Tropical Abstracts)* G01 A00

0903-0853 GHANA. ACADEMY OF SCIENCES. **Plant breeding-south; cassava (crops 5| 10 and 5| 11).** Ghana. Academy of Sciences. Annual Report. 1965-66. pp. 69-70. Engl.

Cassava. Starch content. Hybrids. Clones. Crossbreeding. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Resistance. Selection. Cultivars. Ghana.

Seven out of 66 local varieties were selected for further work because of their high starch content and their resistance to mosaic disease. In trials at Kwadaso, Asuansi, Aiyinasi, Pokoase, Ejura and Ohawu, 31 clones, varieties and hybrids were compared with the variety Ankra to asses their resistance to mosaic disease and their yields. All but 3 qualified for inclusion in next year's trials. In the crossing program to combine high yield with high mosaic resistance, 4 promising clones have similarly been set aside for future trials. *(Full text)* G01

0904 0861 KENYA. DEPARTMENT OF AGRICULTURE. **Food crop improvement.** *In* _______. Annual Report 1957-58. v. 1. p.19. Engl.

Cassava. Cultivars. Resistance. Selection. Cassava mosaic virus. Cassava brown streak virus. Kenya.

A cassava variety trial including the most promising varieties from the many tested to date was carried out on the Coast. The variety 46106| 27 reaffirmed its position, outyielding the next best variety by 9 tons of roots| acre as against 7. A preliminary trial of recent releases from Amani has shown them to be very promising in resistance to mosaic and brown streak. A further trial of 25 cassava varieties, not yet released, has been undertaken, following the rundown of breeding work at Amani. *(Full text.)* G01

0905-2101 BATISTA, E. M. and BULOW, J. F. W. VON. **Studo preliminar de um teste precoce de clones novos de mandioca (*Manihot esculenta* Crantz).** *(Rapid propagation tests for obtaining new cassava clones (Manihot esculenta Crantz)).* Agronomia 29: 7-14. 1971. Port., Sum. Engl., Port., 3 Refs.

Cassava. Clones. Rooting. Production. Spacing. Selection. Field experiments. Developmental stages. Tuber productivity. Propagation. Brazil.

Results of the rapid propagation tests for obtaining cassava clones through the evaluation of seedlings planted under strongly competitive conditions (high density): In 1967-68, only 15% of the clones could be used in field experiments. The correlation coefficient (r = − 0.025) between seedling root weights and the root weights of their respective clones was not significant. In 1968-69, 77% of the clones were used. The correlation coefficient was significant (r = +0.3136). The authors believe that the method could be used successfully to select highly productive clones from among the clones selected because if productive capacity is kept at about the same level as the control variety, the method is less valid. *(Author's summary)* G01 D02

0906-0398 DOKU, E. V. **Breeding for yield in cassava. I. Indices of yield.** Ghana Journal of Science 5(1): 42-59. 1965. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Plant breeding. Resistance. Photosynthesis. Leaf area. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. Cultivars. Stems. Plant physiological processes. Leaves. Genetics. Plant assimilation. Ghana.

The percentage of mosaic resistance, number of leaves per plant, green stem area per plant, photosynthetic area index (PAI), net assimilation rate (NAR) and the fresh tuber weights of 5 cassava varieties were determined at monthly intervals from May to October, 1963. While there appeared to be no relationship between the percentage of mosaic resistance and the rest of the above characteristics, NAR appeared to be negatively correlated with the number of leaves per plant, green stem area per plant, PAI, and the weight of fresh tuber per plant. The last 4 characteristics were positively correlated with one another. It was concluded that high-yielding varieties have the ability to retain a large number of leaves and a large green stem area during the most favorable period of growth in the life of the plant. High yields could not be attributed to a high degree of resistance to mosaic. *(Author's summary)* G01

0907-0344 MARTIN, F.W. **Cassava in the world of tomorrow.** *In* International Symposium on Tropical Root and Tuber crops, 2nd, Honolulu and Kapaa, Hawaii, 1970. Tropical root and tuber crops tomorrow. Honolulu, University of Hawaii, 1970. v. 1., pp. 53-58. Engl., 9 Refs.

Cassava. Plant breeding. Uses. Cultivation.

This is a summary of research results with cassava, *Manihot esculenta,* including species under study, plant breeding efforts, and a summary of the author's views of the cassava plant and agronomic systems of tomorrow. *(Summary by P.A.C.)* G01

0908-2172 BOLHUIS, G.G. **Kruisingen bij cassave.** *(Hybridization in cassava).* Buitenzorg, Java. General Agricultural Research Station. Communication no. 94. 1949. 16p. Dutch., Sum. Engl., 3 Refs.

Cassava. ***Manihot glaziovii.*** **Hybridizing. Pollen. Clones. Hybrids. Pollination. Backcrossing. Plant breeding.** ***Manihot saxicola.*** **Seed. Genetics. Fruits. Java.**

Research results reported on hybridization in the genus Manihot are: (1) between clones of the species *Manihot utilissima* Pohl, the ordinary cassava; (2) between *Manihot utilissima* and *Manihot glaziovii,* and (3) between *Manihot utilissima* and *Manihot saxicola* Lanjouw. In order to avoid erroneous conclusions, a large number of pollinations (over 200) were made. In earlier studies made by Koch (1934) and Nichols (1947), the number of pollinations was often far too small and thus misconceptions were not always avoidable. The conclusions reached were: (1) When crossing clones of *Manihot utilissima,* considerable differences could be seen in the fertility of various combinations. There were only four clones that could be successfully used in hybridization work; one of these appeared to be less suitable as a mother clone. The percentage of successful pollinations from which seeds were developed only exceeded 30 in exceptional cases. In many cases these percentages were very low, and sometimes the pollinations did not have any result at all. However, there is no reason to assume that this is caused by incompatibility. When self-pollinating various clones of *Manihot utilissima,* the results were rather poor. (2) The combination between *Manihot utilissima* and *Manihot glaziovii* also showed a small number of successful pollinations. Moreover, their hybrids suffer from a high degree of sterility. Backcrossing these hybrids with *Manihot utilissima,* however, may give rather good results, provided a clone is used which is suited to crossing with other types of the same species. (3) When crossing *Manihot utilissima* with *Manihot saxicola,* the percentage of successful pollinations makes it doubtful as to whether *Manihot saxicola* should be considered as a separate species, since the results of the aforementioned crossing are fairly good. Backcrossing this hybrid with a clone of *Manihot utilissima,* suited to hybridization with other clones of that species, gave exceptionally good results. (4) In the majority of the crosses, the number of seeds in the fruit were very small. A further investigation as to the nature of this phenomenon is very urgent, because so far no reasonable explanation has been given. (5) When based on these methods, breeding work on a larger scale may result in a 20% successful pollination, provided a large number of pollination are made. *(Author's summary)* G01

0909-0332 BECK, B.D.A. **The breeding goals in a cassava breeding programme in West Africa.** Lagos, Nigeria, The Ford Foundation, 1971. 5p. Engl., Sum. Engl.

Cassava. Plant breeding. Genetics. Cassava programs. Cultivars. *Manihot esculenta.* **Manihot. Development. Hybrids. Africa.**

In the next 5 years, it should be possible to combine high yield with resistance to cassava mosaic virus in West Africa. It may well be possible to incorporate a high protein content in the tubers of these new hybrids. The parent material for this program is now available in Nigeria and other West African countries. A sustained effort by a team of breeders, plant pathologists and plant physiologists is required to produce, in the short run, new high-yielding varieties, which will increase the efficiency of production per unit area per man per day. These new varieties will probably result in an initial reduction in cassava acreage, freeing land for other crops; but they will also have the potential to keep up with the current population growth rate by relatively small subsequent increases in the area cultivated. In the breathing space obtained by these empirically developed varieties, it should be possible to identify the pathogens causing cassava mosaic symptoms and to develop breeding programs against specific pathogens. *(Author's summary)* G01

0910-0716 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Tropical Root Crops.** *In* ______. Annual report 1969. Cali, Colombia. 1970. pp. 40-44. Engl., Illus.

Cassava. Cassava programs. Germplasm. Productivity. Cultivation. Cultivars. Nutritive value. Development. Plant breeding. Colombia.

A general description is given of cassava. Data deal with geographical distribution, production, yields and nutritional value, varietal improvement, agronomic practices, diseases and pests. Research activities in cassava are also described. *(Summary by H. J.S.)* G01 D00

0911-0802 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. **Cassava.** *In* ______. Annual Report 1961-1962. Lagos, Nigeria, 1964. pp. 43-49. Engl.

Cassava. Research. Plant breeding. Genetics. Cultivars. Pests. Diseases and pathogens. Viroses. Selection. Starch productivity. Productivity. Cassava mosaic virus. Adaptation. Nigeria.

The root crop program is divided into a short-term and a long-term project. The short-term project aims at producing high-yielding varieties adapted to particular ecological areas and to local consumer preferences. The long-term project will involve the study of the genetics of **Manihot** to create a national collection of high-yielding varieties with less cyanide content and with resistance to mosaic. *(Summary by J.L.S.)* G01 E04

0912-0520 MAGOON, M. L., KRISHNAN, R. and LAKSHMI, K. **Association of plant and tuber characters with yield of cassava.** Tropical Root and Tuber Crops Newsletter no. 5:29-30. 1972. Engl.

Cassava. Hybrids. Tubers. Plant breeding. Genetics. *Manihot esculenta.* **Plant height. Productivity.**

In India, a female cassava *(Manihot esculenta)* parent (originated from Madagascar) was crossed with 3 male parents (1 from Madagascar, 1 from Malaya and 1 hybrid of a Brazilian and an indigenous variety).

The F1 populations showed that tuber number per plant (ranging from 1-12) was significantly and positively correlated with tuber yield per plant in all 3 crosses. Significantly high positive correlations with yield were also found between tuber length (ranging from 6.2 - 46.0 cm), mean tuber circumference (ranging from 9 - 29 cm), plant height (ranging from 61 - 339 cm) and rind thickness. Tuber length was significantly and positively correlated with mean tuber circumference. These findings are considered to be of great validity since these populations were obtained from crosses among genetically divergent stocks representing different geographical areas. *(Summary by Tropical Abstracts)* G01

0913-2042 WILLIAMS, T. L. **Progress made in the production of varieties of cassava resistant to mosaic disease.** *In* West African Agriculture Conference, 3rd, Gold Coast, 1938. Proceedings. pp.45-60 Engl., Sum. Engl., 7 Refs.

Cassava. Clones. Cultivars. Field experiments. Developmental stages. Pests. Cassava mosaic virus. Diseases and pathogens. Resistance. Viroses.

The varieties have been classified into 31 subgroups, each of which consists of very closely allied strains; 36 varieties were also imported. The methods used in the production of pedigree seedlings are described. Difficulty was experienced in obtaining satisfactory germination. It was found that the percentage of fruit set, the percentage of fruits containing seeds, and the percentage of seeds germinating all varied greatly according to variety. The methods adopted for testing seedlings for resistance and tolerance to mosaic disease and for other characters of economic importance are presented. The strains that have survived 3 seasons without mosaic attack at any station and the best of the more resistant and tolerant seedlings are now (in their fourth year) being tested in yield trials against local varieties. During the 1933-34 season, 32 pedigree seedlings were obtained and tested at 3 stations from September, 1934-March, 1936. In March, 1937, 62 seedlings unaffected by mosaic were harvested. These seedlings are now under test at 5 stations and to date approximately 50% of the strains have been attacked. The results to date show that a certain number of seedlings have completely resisted mosaic attack for 3 years when exposed to optimum conditions for infection. Considerable progress has also been made in attacking the problem from the angle of "tolerance," and the best of the remaining seedlings appear to suffer only slightly from the disease and to give high yields in spite of attack. Various peculiarities as regards the incidence of the disease are cited. Large variation in HCN content were found according to locality, period of maturity, etc. To date, however, this variation has never been great enough to alter the classification of a variety from "safe" to "dangerous" or vice versa. Palatability has been assessed by a series of tasting trials. Among the main factors affecting the palatability of any particular variety are the degree of ripeness of the tuber and the length of time between harvesting and preparation. No vegetative or floral character has yet been found which appears to be correlated with resistance to mosaic disease. *(Author's summary)* G01 E04

0914-0764 MONTALDO, A. and BARRIOS, J. R. Descripción de seis variedades de yuca, *M. esculenta. (Description of six varieties of cassava, M. esculenta.)* *In* Jornadas Agronómicas 8, 1972. Maracay, Instituto de Agronomía, 1972. 13p. Span., Sum. Span., 7 Refs.

Cassava. *Manihot esculenta*. Cassava brown streak virus. Resistance. Identification. Cultivars. Productivity. Tuber productivity. Stems. Leaves. Sweet cassava. Bitter cassava. Timing. Venezuela.

A study was made of two bitter and four sweet cassava varieties selected from 221 varieties introduced at the Instituto de Agronomía. Results were as follows: Cacho de Toro Amargo 2078 (bitter) was outstanding for industrial uses, producing a high yield of storage roots and dry matter at 16-18 mo; its large, horizontally growing roots made cultural practices much easier. Tica Amarga 2194 (bitter) produced good yield of roots and dry matter at 16 mo, had good-sized, well-shaped roots, and was highly resistant to brown streak at ambient conditions. Barquisimetana dulce 2062 thrived well at very low moisture levels, producing good yields at 16 mo. Ceibita dulce 2106 was highly resistant to brown streak at ambient conditions and gave good yields at 16 mo. Algodona dulce 2112, an early-maturing variety, gave good yields at 15 mo. Tica dulce had well-shaped roots, gave good yields at 17 mo and was resistant to brown streak at ambient conditions. *(Author's summary)* G01

0915-2287 MEJORAMIENTO DE LA YUCA PARA EL TROPICO. *(Better cassava for the tropics).* Actividades en Turrialba 2(1):3-4. 1974. Span., Illus.

Cassava. *Manihot esculenta.* **Plant breeding. Cassava programs. Development. Costa Rica.**

More than 100 cassava cultivars have been collected from the American tropics. Hybridization and induced-mutation studies are in progress in order to improve the varieties. By pollen irradiation, a new line has been obtained which has attractive root skin color, good flavor and is easy to cook. Cultivars have shown a wide variation in HCN content. *(Summary by Plant Breeding Abstracts)* G01

0916-2952 HRISHI, H. and NAIR, R. G. **Tuber crops in Indian economy.** Indian Farming 22(6):33-37. 1972. Engl., Illus.

Cassava. *Manihot esculenta.* **Hybrids. Plant breeding. Proteins. India.**

Developments and techniques used by the Central Tuber Crops Research Institute, Trivandrum, in the improvement of tuber and rhizomatous crops including cassava **Ipomoea, Maranta** and turmeric, are briefly surveyed. *(Summary by Plant Breeding Abstracts)* G01

0917-2234 COURS, G. **Le manioc a Madagascar.** *(Cassava in Madagascar).* Agronomie Tropicale 6 (1-2):76-77. 1951. Fr.

Cassava. Clones. Stems. Leaves. Cortex. Identification. Taxonomy. Hybridizing. Malagasy Republic.

Research to classify cassava clones at the Lake Alaotra Agricultural Station is described. Eight groups of clones were defined based on stamen color (red or not), petiole length (sessile or not), and other characteristics related to color of the tuber peel, the branches and the perianth. Trials have been carried out to obtain clones which satisfy industrial requirements. Suggestions are made to improve the methodology of hybridization. *(Summary by H.J.S.)* G01

0918-1812 MADHAVA RAO, V. N., SHANMUGAVELU, K. G. and GOPALASWAMI, N. **Grow more tuber crops.** Indian Horticulture 1972:17-19. April-June 1972. Engl., Illus.

Cassava. Cultivars. Productivity. Identification. India.

Recent work on varietal improvement in Tamil Nadu is outlined and the new **Manihot** varieties S2, S5, M4 and Malavella are briefly described. Yield data and brief descriptions are also given for 9 **Ipomoea** varieties. *(Summary by Plant Breeding Abstracts)* G01 D03

0919-2233 COURS, G. **Le manioc a Madagascar.** *(Cassava in Madagascar).* Bulletin Agricole (Madagascar) no. 24:3-12. 1950. Fr.

Cassava. Identification. Cultivars. Productivity. Taxonomy. Cultivation. Plant breeding. Nutritional requirements. Fertilizers. Cassava starch. Processing. Malagasy Republic.

Several items on cassava cultivation are reported. Two problems are discussed: a misunderstanding in cassava manuring and the difficulties of naming and identifying cassava types. The basis for a rational classification of cassava clones according to the color of several organs and their parts is discussed. Some important stages of cassava plant development have been defined. The concept of yield index is discussed. This is the product of the vegetative index (the total weight of DM per unit of area planted) times the utilization factor; that is, the percentage of useful matter. Yield index can be augmented by increasing planting density, by deep plowing and fallowing, and by properly fertilizing and manuring. Starch manufacturing is explained and discussed. Characteristics of local cassava varieties and their improvement are given. *(Summary by H.J.S.)* G01 D03 D02

0920-0275 OBREGON B., R. **Clave para la clasificación de algunas variedades de yuca.** *(Classification key for some cassava varieties).* Agricultura Tropical (Colombia) 23(10):668-669. 1967. Span.

Cassava. Cultivars. Identification. Taxonomy. *Manihot esculenta.* **Colombia.**

A general description of the cassava plant *(Manihot utilissima* Pohl) is given, as well as a key for identifying some varieties based on direct observations of the varietal collection at the National School of Agronomy in Medellín, Colombia. *(Summary by P.A.C.)* G01 A00

0921-1582 SILVA, J. R. DA. and SCHMIDT, N. C. **Clone de mandioca com provável resistência ao tombamento.** *(A cassava clone with probable resistance to lodging).* Ciencia e Cultura 19(2):315. 1967. Port.

Cassava. Clones. Resistance. Lodging. Brazil.

Of six new IAC varieties, IAC7-127 and IAC7-163 had 12.3% and 27.2% lodged plants, respectively, following heavy rains accompanied by high winds. The control, SRT59, had 34.9% lodged plants; and the other IAC varieties produced figures up to 53.7%. *(Summary by Plant Breeding Abstracts)* G01

0922-0258 REA, J. **Inventario de las colecciones de los países andinos y banco de germoplasma de yuca** *(Manihot esculenta* **Crantz).** [*Inventory of the cassava (Manihot esculenta Crantz) collection in the Andean countries and cassava germplasm bank*]. Lima, Perú. Instituto Interamericano de Ciencias Agrícolas. Carta Informativa no. 2. 1970. 6p. Span.

Cassava. Germplasm. Clones. Colombia. Ecuador. Brazil.

A table is given dealing with the number of clones in Bolivia, Colombia, Ecuador, Peru, Venezuela, Brazil, Costa Rica and Paraguay, as well as the types of institutions where the collections are located. *(Summary by H.J.S.)* G01

0923-0635 FLEMING, H. S., ROGERS, D. J. and APPAN, S. G. **Computer information bank of Manihot germ plasm resources.** Tropical Root and Tuber Crops Newsletter no. 4:41-42. 1971. Engl., 4 Refs. Illus.

Cassava. Clones. Manihot. Genetics. Cassava programs. Development. Identification.

Intensive computer-aided studies of the wild species of **Manihot** are being carried out at the Taximetrics Laboratory. The closed gene pools constituting the total genus **Manihot** have been delineated. There are 96 closed gene pools in the genus **Manihot:** 17 in North America and 79 in South America. Their phenotypic characteristics have been defined. The data are being stored in the form of computer banks, which will be readily accesible for easy and rapid retrieval. The salient features of this system are presented in a graph, and some applications of it are given as examples. *(Summary by H.J.S.)* G01

0924-0277 JENNINGS, D. L. *Manihot melanobasis* **Mull Arg.; a useful parent for cassava breeding.** Euphytica 8:157-162. 1959. Engl., Sum. Engl., 10 Refs.

Cassava. Plant breeding. *Manihot melanobasis. Manihot esculenta.* **Crossbreeding. Plant fertility. HCN content. Composition. Genetics. Productivity. Seed. Protein content. Hybrids.**

Crosses between *Manihot melanobasis* and cassava were very fertile, and the fertility was maintained in the hybrids. The first and subsequent generations of these crosses were very high yielding. Undesirable features of the early hybrids included a straggling habit and thin stems which yielded poor planting material, a high HCN acid content in the roots and low virus resistance; all these were rectified by further breeding. Although *M. melanobasis* has a high protein content in its roots, it is a very valuable source of new genes for cassava improvement. *(Author's summary)* G01

0925-1910 ABRAHAM, A. *et al.* **Conservation and evaluation of tuber crop germplasm in Kerala.** Trivandrum, India, Kerala University, 1973. 7p. Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Germplasm. Starch crops. Hybrids. Resistance. Plant breeding. Genetics. India.

As a result of exploration and introduction work during the past 3 decades, a vast collection of germplasm of root and tuber crops belonging to the genera **Manihot, Ipomoea, Dioscorea, Colocasia, Amorphophalus, Coleus** and **Maranta,** including wild species, has been assembled at the Experiment Station attached to the Department of Botany, University of Kerala, Trivandrum (S. India). The genetic diversity available in these plants is discussed, and they are evaluated for economic characters. Work on manuring, storage of planting material, reaction to soil and climatic factors and on development of improved varieties by selection and breeding to achieve higher tuber yields, higher starch and protein content and resistance to disease and pests is also reported. *(Summary by D.H. and L.J.)* G01

0926-2112 DOUGHTY, L. R., GOURLAY, D. W. and JENNINGS, D. L. **Cassava.** *In* East African Agricultural and Forestry Research Organization. Annual Report 1953. pp. 25-27. Engl.

Cassava. Genetics. Plant breeding. Crossbreeding. *Manihot melanobasis. Manihot dichotoma.* **Resistance. Cassava mosaic virus. Diseases and pathogens. Pests. Kenya.**

The aim of the breeding work discussed in this report was to restore fully tuberous roots to disease-resistant, interspecific hybrids by continued backcrossing. Crossing between several lines of ceara hybrids and also crosses of *Manihot dichotoma* and *Manihot melanobasis* with ceara hybrids were carried out. In replicated trials more resistant hybrids were selected for further testing. Observations in the greenhouse indicated that plants may be infected with mosaic virus without showing symptoms; thus, severity of the resistance trials could be increased if planting material was taken from plants of the previous year's elimination rather than from clean Amani stock. Varieties will not be distributed without a further trial. *(Summary by J.L.S.)* G01 E04

0927-2199 **CARACTERISTIQUES DES derniers clones de manioc selectionnés par la Station de Yangambi.** *(Characteristics of the newest cassava clones selected by the Yangambi Station).* Bulletin d'Information de l'INEAC. 6(1):58-59. 1957.

Cassava. Clones. Productivity. Tuber productivity. Plant anatomy. Starch productivity. Resistance. Identification. Leaves. Petioles. Bitter cassava. Sweet cassava. Zaire.

Characteristics of 11 clones are presented. Data concern the origin, morphology, tuber yields, resistance to diseases, taste and starch yields. *(Summary by H.J.S.)* G01 D03

0928-1941 ABRAHAM, A., PANICKER, P. K. S. and MATHEW, P. M. **Polyploidy in relation to breeding in tuber crops.** Journal of the Indian Botanical Society 43(2):278-283. 1964. Engl., 12 Refs.

Cassava. *Manihot esculenta.* **Plant breeding. Colchicine. Polyploidy. Cultivars. Chromosomes. Plant anatomy. Productivity. Crossbreeding. India.**

Four selected varieties of *Manihot utilissima* (accessions 10, 26, 32 and 36), were treated with colchicine. From the 40 plants treated, 7 tetraploids were obtained. The tetraploids were lower in vigor, productivity and hardiness than the diploids, and their stems were more brittle and had a higher water content. They required a greater supply of water for normal development and therefore were less capable of resisting unfavorable conditions than the diploids. By crossing the artificial tetraploids with diploids, several triploids were obtained which exhibited morphological characters intermediate between tetraploids and diploids. The triploids gave higher yields than the tetraploids and one of then outyielded its diploid parent. *(Summary by Plant Breeding Abstracts)* G01

0929-2177 BOLHUIS, G.G. **Enkele voorlopige resultaten van een behandeling van cassave-stekken met colchicine.** *(Some preliminary results obtained by colchicine treatment of cassava cuttings).* Buitenzorg, Java. General Agricultural Research Station. Communication no. 93. 1949. 9p. Dutch, Sum. Engl., 2 Refs.

Cassava. Colchicine. Cuttings. Crossbreeding. Hybridizing. Composition. *Manihot esculenta. Manihot glaziovii.* **Chromosomes. Clones. Shoots. Cytogenetics. Hybrids. Java.**

Toxopeus (1948) mentions cassava (*Manihot utilissima* Pohl) in a list of tropical crops which he considers most suitable for experiments on the doubling of chromosome numbers by colchicine treatment. However, an investigation in this direction had already been started at the Agricultural Institute of the General Agricultural Research Station at Buitenzorg (Java). In 1942 the work was interrupted by the war, and during the Japanese occupation, all the material was lost. Cuttings of various clones were subjected to treatment with a 0.1% aqueous solution of colchicine; even a 10-hour treatment proved effective. When the shoots tended to become normal at a length of about 25 cm, they were cut back to about 10 cm from the base to induce the growth of new shoots, the tissue of which will be completely changed. These new shoots did not show any tendency to return to normal. The results of a chemical analysis of root samples, counts of chromosome numbers and some data concerning the yield of the crop from normal and from treated cuttings are given. Although on the whole these results are disappointing, the experiments should be continued on a larger scale with nonpoisonous varieties, suitable for consumption. Special attention should be paid to increasing the protein value in the roots as this is of great importance in connection with the low protein content of the foodstuffs consumed in those regions in Java, where cassava is the principal food. Good results may be obtained by treating F1 hybrids of the cross *Manihot utilissima* x *Manihot glaziovii* in order to overcome its high degree of sterility. *(Author's summary)* G01

0930-1756 TRIVANDRUM. CENTRAL TUBER CROPS RESEARCH INSTITUTE. **Annual Report 1969. Trivandrum, 1970? 83p. Engl., Sum. Engl.**

Cassava. *Manihot esculenta. Manihot glaziovii.* **Cytogenetics. Chromosomes. Genetics. Hybridizing. Plant breeding. Selection. Hybrids. Nutritional requirements. Manures. Dung. Fertilizers. Cultivars. N. P. K. Field experiments. Cultivation. Spacing. Tuber productivity. Productivity. Minerals. Analysis. Mineral content. Composition. Carbohydrate content.** *Aonidomytilus albus.* **Protein content. Cultivation systems.** *Tetranychus telarius.* **Inter-cropping. Economics. Plant physiology. Injurious mites. Tuber development. Plant development. Injurious insects. Plant-growth substances. HCN content. Pests. Diseases and pathogens. Resistance. Cassava mosaic virus. Disease control. Viroses. Mycoses.** *Cercospora henningsii.* **Bemisia. Virus transmission. Grafting. India.**

Through addition of over 1500 F1 hybrids produced as a result of a carefully planned hybridization program, the total number of intervarietal hybrids made so far has now increased to 24,440. Among the hybrids under semifinal stage of evaluation, H-2059, H-1686, H-1528 etc. with mean tuber yields of 26.2 to 32.8 ton|ha, proved superior in yielding ability to the control variety M-4. Similarly, hybrids H-226, H-165, H-43, H-97, H-57 and H-86, which are in the final stages of evaluation, registered higher tuber yields ranging from 30.5 to 37.6 metric tons|ha in local and multilocation tests and outyielded the control variety M-4, which gave 17.1 metric tons|ha. All these seedling selections and hybrids in both final and semifinal stages are characterized by their better tuber quality, high field resistance to cassava mosaic and their ability to respond profusely to higher levels of fertilization and improved cultural techniques. Considerable data were secured on several cytogenetical aspects of the various tuber crops bearing direct relationship to their genetic improvement. Through karyological and chromosomal homology studies conducted at pachytene, valuable information was elicited on (1) the extent of chromosomal differentiation between cassava and the related species, ceara rubber, which has been used as donor parent for genes conferring disease and drought resistance, (2) the origin and relationship of constitutent genomes of hexaploid sweet potato and tetraploid *Ipomoea biloba*, and (3) the chromosomal make-up and mode of origin of *Amorphophallus campanulatus*. Pollen germination studies were conducted in **Dioscorea**. In cassava, the general combining ability of a number of stocks was assessed and detailed cytomorphic studies of artificially produced tetraploids and triploids carried out. The results of various manurial trials on tuber crops suggest that application of potash at 100 kg|ha in cassava, 100 kg NPK|ha each in sweet potato, and 80 kg N and 100 kg K_2O|ha in *M.*

---

esculenta increased tuber yields significantly. The starch and sugar content in sweet potato tubers reached the maximum at manurial level of 75 kg N and 100 kg| each of P_2O_5 and K_2O. Among the different nitrogenous sources promoting tuber yields in cassava, calcium ammonium nitrate proved superior and was followed by Ammo-Phos and urea. Split applications of N and P(1 | 2 dose as basal and 1 | 2 dose after one month of planting) were found to be superior to other treatments tested. Among different cultural practices adopted in cassava, spacing by 75 x 75 cm for nonbranched varieties and 90 x 90 cm for branched varieties and vertical planting of two setts on mounds raised above pits proved superior to other methods tried. The potash content in plant parts of cassava increased with increasing levels of potash application up to 150 kg| ha. With the addition of lime, the availability of P in plant parts was also markedly higher. With the application of CaO in combination with P_2O_5, the CaO content in plant parts was substantially increased. Application of 2% sucrose solution on apical ends of cassava setts after 12 days of planting enhanced root formation and early tuber differentiation (as judged from starch deposition). A higher number of roots, greater intensity of starch deposition and reduction in HCN content occurred with the application of growth regulators like IAA, IBA, IPA and CCC at 50 µm | ml concentration. Metabolic changes involved in mosa[illegible] infection showed that both the number and quantity of free amino acids and amides in mosaic-inf[illegible] cassava plants were considerably more than those present in healthy plants. In cassava, incidenc[illegible] [illegible] could be, considerably reduced by spraying fungicides such as Bordeaux mixture, coppesan, [illegible], [illegible]tox, forham, thiram, etc. Considerable reduction in the population of *Bemisia tabaci* (vector of cassava mosaic disease) was secured following spraying of 0.03% dimethoate at monthly intervals for the first 6 months. Likewise, in Coleus, infestation of root-knot nematodes was reduced by soil application of Nemagon of 0.5 ml| ft^2 of Terracur P at 1.5 gm| ft^2. (Author's summary) G01 E00 D00

0931-0101 REA, J. **Establecimiento del banco de germoplasma de yuca,** ***Manihot esculenta.*** *(Establishment of a cassava, Manihot esculenta Crantz, germplasm bank).* Lima, Peru. Instituto Interamericano de Ciencias Agrícolas. Carta Informativa no. 1. 1969. 9p. Span.

Cassava. ***Manihot esculenta.*** **Germplasm. Cultivars. Genetics. Clones. Bolivia. Paraguay.**

This article presents the characteristics, vernacular names and locations of 72 clones of cassava (*Manihot esculenta* Crantz) collected in Bolivia, Paraguay, Brazil and Peru as part of a FAO-IICA project to establish a cassava germplasm bank. *(Summary by P.A.C.)* G01

0932-0675 MAGOON, M. L., KRISHNAN, R., and VIJAYA BAI, K. **Chromosomal differentiation between cassava and ceara rubber.** Tropical Root and Tuber Crops Newsletter no. 4:23-25. 1971. Engl.

Cassava. ***Manihot glaziovii. Manihot esculenta.*** **Genetics. Backcrossing. Hybridizing. Plant breeding.**

A comparative description of the karyotypes of *Manihot glaziovii* and *M. esculenta* is presented. Differences were confirmed by pachytene analysis of the F1 hybrids. In addition, pachytene analyses of 3 backcross plants provided evidence for random transmission of at least some of the parental chromosomal types through the male gametes of the F1 hybrid. *(Summary by F.M.)* G01

0933-0698 ARRAUDEAU, M. **Cassava in the Malagasy Republic; research and results.** *In* International Symposium on Tropical Root Crops, Ist., St. Agustine, Trinidad 1967. Proceedings. St. Agustine, University of West Indies, 1969. v.1., pp. 180-184. Engl.

Cassava. Hybrids. Plant breeding. Clones. Productivity. Cultivation. Genetics. Selection. Malagasy Republic.

Experiments in Malagasy showed that local cassava varieties and hybrids yielded in dry, low-lying areas 7-8 and 12-35 tons| ha; in humid, low-lying areas 9-25 and 28-66 tons| ha; in areas of medium altitude (300-900 m) 4-20 and 30-80 tons| ha; and in areas of high altitude (900-1,300 m) 4-12 and 12-25 tons| ha, respectively. *(Summary by Tropical Abstracts)* G01 D03

0934-2150 ZIMMERMANN, A. **Die Deutsch-Ostafrikanischen Maniok-Varietaten.** *(The German East African cassava varieties).* Pflanzer 3(17-18):258-265. 1907. Germ., 1 Ref.

Cassava. Leaves. Resistance. Identification. Flowers. Cultivars. Diseases and pathogens. Pests.

Cassava varieties were introduced to find resistance to a "leaf curl" disease. To properly describe the material, a classification of clones is given, using stem and leaf characteristics. The varieties are briefly discussed. *(Summary by A. van S.)* G01

0935-0720 DOUGHTY, L. R. **Cassava breeding for resistance to mosaic and brown streak viruses.** *In* East African Agricultural and Forestry Research Organization. Annual Report 1958. pp. 48-55. Engl.

Cassava. Diseases and pathogens. Pests. ***Manihot glaziovii. Manihot dichotoma. Manihot saxicola. Manihot melanobasis.*** **Cassava mosaic virus. Viroses. Plant breeding. Crossbreeding. Resistance. Cassava brown streak virus. Kenya.**

A review is made of 21 years work on interclonal crosses of cassava and interspecific crosses between cassava, ceara rubber, *M. dichotoma, M. saxicola, M. catingae* and *M. melanobasis.* Resistance to mosaic disease was tested with fairly good results. Programs for 1959 and 1960 are given. *(Summary by H.J.S.)* G01 E04

0936-0685 MONTOYA, L. A. *et al.* **Preliminary work on the problem of classifying manioc varieties.** *In* International Symposium on Tropical Root Crops, lst, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 1. pp. 89-99. Engl., Sum. Engl., 8 Refs.

Cassava. Cultivars. Identification. Plant anatomy. Productivity. HCN content. Composition. Mexico.

Working with vegetative material from the cassava collection at Campo Cotaxtla near Veracruz, (Mexico), an exploratory classification was made on the basis of certain morphological characteristics. The HCN content of the roots was analyzed, and a number of varieties selected as outstanding in this collection are described. *(Author's summary)* G01 B00 C03

0937-0188 **INDIA PLANS increased tapioca production.** Foreign Commerce Weekly 49(12):14. 1953. Engl.

Cassava. Crossbreeding. Productivity. Plant breeding. India.

Improved varieties of cassava are being developed at Trivandrum, (Travancore-Cochin), research station under the Indian Council of Agricultural Research. About 250 varieties are being tested and crossed to produce superior varieties. *(Summary by Tropical Abstracts)* G01

0938-0310 LEON, J. ESTEVES, L.,and REA, J. **Normas para el estudio de la variabilidad clonal en yuca,** *Manihot esculenta. (Norms for the study of clonal variability in cassava, Manihot esculenta).* Fitotecnia Latinoamericana 4(2):125-138. 1967. Span., Sum. Engl., 21 Refs.

Cassava. Clones. Plant anatomy. Stems. Leaves. Flowers. Fruits. Seed. Branching. Plant development. Developmental stages. HCN content. Composition. Plant physiology. Shoots. ***Manihot esculenta.*** **Plant height. Starch content. Tubers.**

There is a great deal of variability in cassava; in this study only a very narrow section was considered: 28 clones, the most common in the coastal area of Peru. Among the characters studied were habit; stem characteristics, particularly internode pattern, diameter and color; nodes, including base of leaves, particularly of the central segment; coloration, position and shape of the petiole; color of the new growth; pigmentation of the sepals and disk, etc. The vegetative characters are stressed since many clones do not flower or set seed in certain localities. Root characters, particularly the color of the peel, permit dividing the clones into two large groups: dark brown roots associated with pigmented stems and gray roots with green stems. Other important characters are the HCN content and the percentage of starch; these two characters are strongly influenced by soil and climatic conditions. Several techniques of study, recording and interpretation are discussed. *(Author's summary)* G01

0939-0822 NICHOLS, R. F. W. **Breeding cassava for virus resistance.** East African Agricultural Journal 12(3):184-194. 1947. Engl., Sum. Engl., 7 Refs.

Cassava *Manihot glaziovii. Manihot dichotoma. Manihot saxicola. Manihot melanobasis.* **Plant breeding. Resistance. Clones. Hybrids. Grafting. Pollination. Pests. Diseases and pathogens. Cultivars.** *Manihot esculenta.* **Cassava mosaic virus. Seed. Viroses. Cassava brown streak virus. Productivity. Field experiments.**

An interim account is given of the materials and methods being used at Amani in an attempt to improve cassava (*Manihot utilissima* Pohl) by selection and hybridization, with particular reference to resistance to the 2 virus diseases, mosaic and brown streak, which are the cause of heavy yield losses in East Africa. The first stage is the production of seed of both cassava and interspecific hybrids by controlled pollination and multiplication of the seedlings by vegetative propagation, followed by preliminary and replicated field trials for disease resistance and cropping qualities. A method of classifying clones on the basis of their resistance to natural infection as reflected by statistical analyses of the results is described. Successful interspecific hybridization is reported between cassava and "tree" cassava (which is probably itself a natural hybrjd between *M. glaziovii* Muell.- Arg. and cassava), *M. glaziovii* (ceara rubber), *M. dichotoma* Ule, and *M. saxicola* Lanj. Backcrossing to cassava was successful, and the third generation has been reached by this means. The fertility, morphology and disease resistance of these hybrids is discussed. Field trials show that there is a wide range betwèen the resistance of different clones to the two diseases. Highly resistant forms of true cassava and of interspecific hybrids have been produced; results indicate that complete immunity in all but the *M. dichotoma* hybrids is unlikely to be obtained. In some of these hybrids, immunity to particular virus strains is demonstrated; it is not yet known whether this immunity will be retained through continued backcrossing, which must be carried on until normal tuberous root systems are restored. It is stressed that the efficacy of the grafting test to prove immunity is conditioned by the particular virus strain used; immunity to one strain does not automatically imply immunity to other strains. *(Author's summary)* G01 E04

0940-0684 BOLHUIS, G.G. **Intra and interspecific crosses in the genus Manihot.** *In* International Symposium on Tropical Root Crops, 1st, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of the West Indies, 1969. v.1, pp.81-88. Engl., Sum. Engl., 9 Refs.

Cassava. Manihot. *Manihot glaziovii. Manihot saxicola.* **Hybridizing. Crossbreeding. Backcrossing. Plant breeding. Genetics.**

Crosses of cassava cultivars show largely different results. At Buitenzorg only a few cultivars proved to give fairly good results when used as parents in hybridization work. When based on the right cultivars, at least 20% success may be expected. Some cultivars proved to be very bad parents; in crosses few or no seeds were harvested. How far this is due to incompatibility has yet to be proved. Cassava can be crossed with several other species of **Manihot.** The percentage of successful pollinations, however, is generally very low. Moderate success of these interspecific hybridizations is to be expected only if cassava is used as the female parent. F1 hybrids between cassava and *M. glaziovii* show a high rate of sterility when intercrossed. Backcrossing of the hybrids with the cassava parent gave fairly good results provided a good cassava cultivar which had also given success in cassava crosses, was used. Crosses of cassava with *M. saxicola* gave a high percentage of successful pollinations, which makes it doubtful whether *M. saxicola* should be considered as a separate species. Backcrossing of the hybrids with a cassava parent gave exceptionally good results when *M. saxicola* is used as the female parent in the original interspecific cross. Two authors have proved that hybrids containing the "blood" of 3 species can be obtained. In the majority of crosses, the mean number of seeds per fruit was rather small. Further investigation as to the nature of this phenomenon is recommended. *(Author's summary)* G01

0941-0567 SILVA, J. R. DA and SCHMIDT, N. C. **Cultivar de mandioca com provável resistencia ao tombamento ou acamamento.** *(Cassava cultivars likely to resist lodging).* Bragantia 26:63-65. 1967. Port., Sum. Engl.

Cassava. Resistance. Clones. Cultivation. Climatic requirements. Cultivars. Brazil.

A report is given of the results of a study carried out in the district of Pindamonhangaba, state of São Paulo, with regard to the variation of resistance shown by plants of different cassava clones to lodging caused by the wind. *(Author's summary)* G01

0942-0583 OSORES, A. and DELGADO, M. **Cuarentena del germoplasma internacional de yuca en el Perú.** *(Quarantine for international cassava germplasm in Peru).* Lima, Peru, IICA, 1970. 18p. Span., 9 Refs.

Cassava. Entomology. Germplasm. Pests. Diseases and pathogens. Disease control. Development. Clones. Selection. Viroses. Injurious insects. Insect control. Pest control. Cassava mosaic virus. Peru.

The status of cassava material introduced into Peru is presented. Results obtained on sanitary control of infected plants arriving from abroad are given, as well as control regulations adopted for the future. *(Summary by H.J.S.)* G01 E00

0943-0660 MAGOON, M. L., JOS, J. S. and NAIR, S. G. **A morphological, embryological and cytological study of male sterility in *Manihot esculenta* Crantz.** Tropical Root and Tuber Crops Newsletter no. 2:10-12. 1969. Engl. 2 Refs.

Cassava. Cytology. Selfing. Plant breeding. Genetics. Plant fertility. Plant anatomy. Morphogenesis.

In Kerala (India) a study was made of the lower, microsporogenesis, and the development of male gametophyte in 4 male-fertile and 12 male-sterile lines of cassava. It was found that in the male-sterile lines, pollen abortion was due to the persistant nature, abnormal behavior and development of tapetum. In addition, a study was made of the cytology of the male-sterile lines, indicating that the meiotic abnormality is not the cause of male sterility in these lines. *(Summary by Tropical Abstracts))* G01 B00

0944-0400 PANDEYA, R. S. **Cassava genetics and breeding, a review.** International Development Research Center. Working Note. no. 4. 1972. 13p. Engl., 38 Refs.

Cassava. Manihot. Genetics. Backcrossing. Hybridizing. Cytology. Plant breeding. Resistance. Productivity.

Comparatively little attention has been paid to the study of fundamental aspects of genetics, cytology and breeding of cassava. Based on a review of literature, discussions are presented on the following aspects: cytology, barriers of crossability, nature of qualitative and quantitative morphological variability, breeding for yield improvement, resistance, quality, early maturity and induced polyploidy. A few long- and short-term objectives in a cassava breeding program are suggested by various researchers in this area. *(Summary by H.J.S.)* G01

0945-0650 ABRAHAM, A. **Breeding work on tapioca (cassava) and a few other tropical tuber crops.** *In* International Symposium on Tropical Root Crops, 2nd, Honolulu and Kapaa, Hawaii, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v. 1, pp.76-78. Engl., Sum. Engl., 7 Refs.

Cassava. Plant breeding. Hybridizing. Polyploidy. Chromosomes. Mutation. Seed. Sweet-potatoes. Amorphophallus. Taro. Dioscorea.

The tuber crops constitute a very important subsidiary source of human and animal food. There is scope for great improvement in these crops, both by traditional plant breeding methods and by induction of new chromosomal races and production of artificial mutants. These crops deserve greater scientific attention than they have received so far. *(Author's summary)* G01

0946-3480 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Cultures autres que céréals; le manioc.** *(Crops other than cereals; cassava). In* Rapport annuel d'activité 1963. Paris, 1966. v. 2, pp.367-379. Fr.

Cassava. Cultivars. Plant breeding. Genetics. Hybridizing. Hybrids. Selection. Fertilizers. Cultivation. Senegal. Dahomey. Gabon. Niger. Malagasy Republic.

In Madagascar the most advanced studies on varietal improvement have been undertaken. The principal aim is to obtain mosaic resistant and high-yielding varieties. Selection and hybridizing trials are carried out at the experimental station of Lake Alaotra. Resistance trials in Senegal, Dahomey, Gabon, Niger, French, Guiana and the French Caribbean are outlined, as well as some remarks on fertilization, chip production and drying. *(Summary by J.L.S.)* G01

0947-1545 CONCEICÃO, A. J. DA., CUNHA, H. M. P. DA. and SAMPAIO, C. V. **Programa de melhoramento.** *(Plant breeding program).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):9-20. 1973. Port., Sum. Port., Engl., 6 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Plant breeding. Genetics. Cassava programs. Development. Germplasm. Crossbreeding. Propagation. Plant reproduction. Brazil.**

The author comments on the breeding of cassava (*Manihot esculenta* Crantz) being developed at the Escola de Agronomia da Universidade Federal de Bahia in Cruz das Almas, Bahia (Brazil). This program was initiated in 1969. It consists of studies on the germplasm bank, polycross, controlled crossbreeding, development of plants by sexual and asexual means and fields for clonal multiplication. *(Author's summary)* G01

0948-0668 DOUGHTY. L. R., JENNINGS, D. L. and GOURLAY, D. W. **Plant improvement and protection; Cassava breeding.** *In* East African Agriculture and Forestry Research Organization. Annual report 1955. pp. 36-39. Engl.

Cassava. Genetics. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Field experiments. Cassava brown streak virus. Backcrossing. Plant breeding. Resistance. Kenya.

The purpose of the cassava breeding program is to concentrate the factors controlling resistance to the virus diseases of mosaic and brown streak and at the same time to maintain the ability to produce a high yield of palatable roots. To this end the most resistant lines derived from backcrosses to cassava (of ceara cassava derivatives) were intercrossed; backcrossed with their parents; crossed with hybrids of *M. dichtoma* cassava origin, resistant to disease but poor yielders with woody roots; and inbred. Breeding was also continued with *M. Catingae* cassava and *M. melanobasis* cassava hybrids. Field trials, greenhouse experiments and quarantine for improved cassava clones are dealt with. *(Summary by H.J.S.)* G01 E04.

0949-0763 MONTALDO, A. *et al.* **Banco de germoplasma de yuca** *(Manihot esculenta)* **en Venezuela.** *(Cassava (Manihot esculenta) germplasm bank in Venezuela).* Maracay, Universidad Central de Venezuela, Instituto de Agronomía, 1972. 12p. Span., Sum. Span.

Cassava. Growth. Tuber productivity. Flowering. ***Manihot esculenta.*** **Tuber development. Cultivars. Plant development. Productivity. Branching. Developmental stages. Germplasm. Plant height. Venezuela.**

In the cassava (*Manihot esculenta* Crantz) germplasm bank at the Estación Experimental Saman Mocho, Carabobo (Venezuela), a reverse of national cultivated material and some introduced valuable strains (Branca de Santa Catarina, etc.) is maintained. In this location, types with valuable agronomic characteristics are selected, increased and then transferred for regional yield trials. A total of 380 clones are under cultivation: 91 from the total collections made up through 1970; 103 clones of Collection Occidente 1971, 118 clones of the Collection Oriente 1971, 22 clones of the Collection Maracay 1971, 5 clones of the Collection Aragua 1971, 25 clones of the Collection Guayana 1972 and 10 clones of the Collection Occidente 1972. The cooperation of the botanist V.M. Patiño, Director of the Botanical Garden, Cali (Colombia) and commissioned by the Centro Internacional de Agricultura Tropical, Cali, Colombia, was relied or for the 1971-1972 collection. In the period 1970-71 cultivation observations were made on the clones; and at harvest time, the total dry matter and yield of roots were determined. As a result, 22 clones were selected and are now under intensive multiplication. In the Collection Maracay made among 125 strains maintained in this region, 28 were selected. Apart from the regular cultivation observations, stem branching, crop penetration and plant height were added, keeping in mind that there will soon be a need for cassava suited for mechanized harvest and cultivation. In the plans for the 1972 harvest, observations on wind damage (lodging resistance), type and shape or root development were included. *(Author's summary)* G01

0950-2277 **TAPIOCA.** *In* Indian Council of Agricultural Research. Annual Report 1953-54, p.52. Engl.

Cassava. Germplasm. Cultivars. Starch content. Maturation. India.

In Madras State, varietal collections were made at Coimbatore and 7 more varieties were added to the previous collection of 36 varieties. At Mangalore 4 more varieties were collected, bringing the total to 20. The morphological characters of these varieties were recorded. In Bombay, at the Agricultural Research Station, Phondaghat, 6 promising varieties of cassava were studied. Two varieties *(Annanna ravamma* and *Kayal Chiddi)* gave the highest yield while *Sunderville* and *Vellamaddamma* were the next in order. A feeler trial was conducted to determine the nitrogen, phosphate and potash requirements of cassava. There was good response to nitrogen and potash. In Travancore-Cochin, 300 varieties were collected from different parts of Travancore-Cochin, Malabar, Mysore, Malaya and Brazil. Two varieties introduced from Malaya were found to be very high yielders and suitable for this area. A detailed study regarding the chemical composition of tubers was made of Hybrid 105. It was found that maturity in tapioca should be decided on the basis of maximum starch content. *(Full text)* G01

0951-2044 PYNAERT, L. **Au sujet du manioc.** *(Talking about cassava).* Revue Internationale des Produits Coloniaux 27:219-224. 1952. Fr.

Cassava. Rice. Human nutrition. Proteins. Development. Cassava programs. Economics. Cultivation. Genetics. Plant breeding. Indonesia.

The significance of cassava as a product for the world market and as a foodstuff in the areas where it is produced is discussed. The results of scientific research into the question of breeding are reviewed; special mention is made of the research work carried out at the "Algemeen Proefstation voor de Landbouw" at Bogor (Indonesia). Selection research is directed not only towards increased production but also towards raising the protein content (it is hoped to reach 3% protein) and the necessary factors for extensive cultivation in Central Africa, including a fallow period and cattle breeding (as practiced in the Congo) and the economic necessity of trying to achieve a more intensive system of cultivation are also dealt with briefly. *(Summary by tropical Abstracts)* G01 D00

0952-0380 CHANDRARATNA, M. F. and NANAYAKKARA, K. D. S. S. **Studies in cassava. II. The production of hybrids.** Tropical Agriculturist 104:59-74. 1948. Engl., Sum. Engl., 4 Refs.

Cassava. Hybrids. Flowering. Cultivars. Developmental stages. Genetics. Hybridizing. Inflorescences. Plant anatomy. Plant breeding. Sri Lanka.

The floral biology of cassava was studied as a preliminary to the execution of a breeding program. In some races, the male flowers were abortive, rarely opened and never produced functional pollen. In several races, abnormal female flowers possessing varying numbers of staminodesoccurred with appreciable frequency. The inflorescences were markedly protogynous. The blooming of both male and female flowers was concentrated into a relatively short period immediately following midday 91% of the male flowers bloomed between 12:30 p.m. and 1:30., and 96% of the female flowers bloomed between 12 noon and 1 p.m. The size of buds on the day previous to blooming provided a useful index of maturity. The stigma was receptive at the time of blooming but lost its receptivity in 24 h. Anthers dehisced before blooming. Pollen stored under desiccation remained functional for at least 6 days. Both wind and insects appeared to function as pollinating agencies. The interval between pollination and the passage of male nuclei past the style was over 8 hours and under 19 h. Parthenocarpy appeared appreciably frequent. The technique of crossing used is described. Hybrids produced as part of a program of combining high yield with a low content in HCN are described *(Author's summary)* G01-908

0953-0694 MAGOON, M. L. **Recent trends in cassava breeding in India.** *In* International Symposium on Tropical Root Crops, Ist., St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies. 1969. v. 1. pp. 100-117. Engl., Sum. Engl., 56 Refs.

Cassava. Plant breeding. Germplasm. Taxonomy. Hybrids. India.

The range of available genetic variability in the crop is presented. It seems that there are many opportunities of further improvement of cassava through efficient exploitation of the germplasm reserves available. The need for conducting a combined study of morphological, cytological and genetical aspects in arriving at a more natural, botanical classification based on ancestral relationships has been stressed since such knowledge is indispensable to the breeder and also has important applications is certain other fields. Problems and approaches of current interest in relation to production and resistance breeding are discussed. The chief characteristics of the selections and high-yielding hybrids recently developed at the Institute are briefly described. Work relating to interspecific hybridization, production of chromosomal races and mutation breeding and their implications in cassava improvement are briefly reviewed. The genome approach to cassava improvement has been discussed. It is suggested that the separation of the intragenomic and intergenomic phases of plant improvement offers the cassava breeder considerable scope for better genetic control than presently obtained. *(Author's summary)* G01

0954-3137 VASUDEVAN, K. N. *et al.* **Radiation-induced mutations in cassava.** Indian Journal of Horticulture 24(1-2):95-98. 1967. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. Plant breeding. Mutation. Cuttings. Composition. Starch content. HCN content. Chromosomes. Cytology.

The chief attributes are described of 2 mutants isolated in 2 strains of cassava as a result of irradiation of stem cuttings with gamma rays. The important traits characterizing one of the mutants related to increase in starch content and decrease in HCN content. It is suggested that such viable morphological mutants can be recovered within a dose range of 4,000 R and 7,500 R, and disruption of the chromosomal mechanism took place at 10,000 R and above. *(Author's summary)* G01 C03

0955-0737 SILVESTRE, P. **Les plantes a tubercules.** *(The tuber plants).* Agronomie Tropicale no. 10:990-992. 1965. Fr.

Cassava. Plant breeding. Cassava programs. Malagasy Republic. Senegal.

Comments are presented on cassava research carried out by IRAT in Madagascar and Senegal. Information deals with breeding of cassava varieties for industrial purposes (resistance to diseases, high yields response to fertilization and chip drying) and adaptation of cassava to different ecological conditions. *(Summary by H.J.S.)* G01

0956-1755 TRIVANDUM. CENTRAL TUBER CROPS RESEARCH INSTITUTE. Annual Report 1970. Trivandrum, 1971. 78p. Engl., Su. Engl.

Cassava. *Manihot esculenta.* **Genetics. Hybridizing. Plant breeding. Selection. Resistance. Tuber productivity. Productivity. Hybrids. Nutritional requirements. Manures. Dung. Fertilizers. N. P. K. Timing. Propagation materials. Cuttings. Planting. Spacing. Cultivation systems. Intercropping. Absorption. Analysis. Soil analysis. Minerals. Plant development. Tuber development. Plant-growth substances. Plant physiology. Harvesting. HCN content. Composition. Carbohydrate content. Dry matter. Protein content. Growth. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Injurious mites.** *Tetranychus telarius.***Noxious animals. Mycoses.** *Cercospora henningsii.* **Mite control. Pest control. Disease control. India.**

An exotic variety of cassava (*Manihot Columbiana* var.), which is supposed to contain high protein in tubers, is under multiplication. Among the exotic seedling selections, S-2407, S-2331 and S-2308 have yielded 45.3, 38.0 and 38.9 metric tons|ha, respectively at the level of 12.5 metric tons of farm yard manure (F y M) and 100 kg each of N.P.K. Among the recently evolved hybrids, hybrid 312 yielded 30.1 metric tons|ha while the control yielded only 16.7|ha. Similarly, hybrids 3473(2), 3562(1) and 1607(3) also recorded significantly higher yields than the control. The results of simple manurial trials with promising strains indicated that 15 metric tons FYM|ha and 75 kg N|ha or the N.P.K. combination of 100 kg each|ha were found to be the economic dose for cassava and 80 kg N along with 120 kg K O|ha for **Colocasia.** Split application of N.P.K. and a foliar spray of N were also found to be economical for cassava cultivation. The superiority of urea as a source of N and basic slag as a source of P was also confirmed. Liming at 2 metric tons|ha in laterite soil increased P availability, thereby increasing cassava yield significantly. It was found desirable in the case of cassava to keep the spacing of 90 x 90 cm for tall varieties, 75 x 75 cm for medium-tall varieties and 60 x 60 cm for the dwarf type. Boron and IAA were found helpful in inducing flowering in a nonflowering strain of cassava, S-1409; NAA and IAA at 20 ppm each and IBA and IPA at 50 ppm each produced a greater number of roots with a high concentration of starch. Out of 300 hybrids of cassava analyzed, the following variations were observed in their quality characters: HCN, 15-398 ug|g; dry matter 22-48%, carbohydrate (dry weight basis), 50-86%; crude protein (dry weight basis), 1.39-6.25%. Maturity index studies in cassava indicated that the crop can be harvested for consumption purposes from the 7th month onward; but for optimum yield, the harvest could be delayed up to the 10th month. Screening for field resistance to mosaic, supplemented by laboratory tests by means of graft transmission, showed that the strans S-1310, S-1315, S-2371 and S-2380 were highly resistant to cassava mosaic. Studies on metabolic changes evolved as a result of virus infection showed marked increases in the total P content of the leaves of mosaic-infected cassava plants. Spray trials to control **Cercospora** leaf spot of cassava showed that chemicals such as Bordeaux mixture, zineb, coppesan, etc. significantly reduced leaf spot incidence. Red spider mite infestation in cassava was effectively reduced by spraying dimethoate (0.03%). *(Author's summary)* G01

0957-1897 HAHN, S. K., HOWLAND, A. K. and TERRY, E. R. **Cassava breeeding at IITA.** Ibadan, Nigeria, IITA, 1973. 46p. Engl., Sum. Engl., Fr., 57 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Plant breeding. Plant physiology. Biochemistry. Cultivars. Resistance. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. *Xanthomonas manihotis.* **Bacterioses. HCN.** *Manihot esculenta.* **Pollination. Plant reproduction.** *Manihot glaziovii. Manihot melanobasis.* **Flowers. Seed. Germination. Plant development. Clones. Selection. Hybridizing. Crossbreeding. Inheritance. Plant fertility. Hybrids. Nigeria.**

The importance of cassava as a food crop in Africa is stated, and major problems involved in production in the area are briefly discussed. The cassava breeding objectives in the Root and Tuber Improvement Program of the International Institute of Tropical Agriculture (IITA) are laid down. Basic considerations in cassava breeding are reviewed and discussed. An attempt was made to produce a cassava breeding system applicable on a worldwide basis and to describe the present state and the future development of cassava breeding. *(Author's summary)* G01.

0958-2432 COURS - DARNE, G. J. M. **L'amelioration du manioc en Afrique.** *(Cassava breeding in Africa).* *In* Colloque sur les Priorités de la Recherche Agricole dans le Developpement Economique d l'Afrique, Abidjan, 1968. Washington, Academie Nationale des Sciences, 1968. pp.360-369. Fr., Sum. Fr., 5 Refs.

Cassava. Plant breeding. Hybridizing. Cultivars. Selection. Hybrids. Resistance. Cassava mosaic virus. Starch productivity. Tuber development. HCN. Harvesting. Productivity. Malagasy Republic.

Plant breeding is the best economic solution to low cassava yields. In Africa, varietal improvement of cassava has been undertaken on a large scale only at the Station Agronomique de l'Alaotra (Madagascar). The creation of an African Research Centre on cassava is proposed. Any breeding program should take into account the following factors: harvest index (weight of roots:weight of stems and leaves), long-range resistance to soil humidity, resistance to mosaic virus, resistance to accidents to roots (necrosis, darkening, liquefaction of starch) and growth characteristics such as ease of regrowth upon transplanting these factors are discussed at length. *(Summary by T.M.)* G01

0959-3132 KOCH, L. **Cassaveselectie.** *(Cassava breeding).* Wageningen, H. Veenman and Zonen, 1954. 71p. Dutch., Sum. Dutch., 76 Refs., Illus.

Cassava. Genetics. Plant breeding. Selection. Seed. Plant anatomy. Productivity. Tuber productivity. Starch productivity. Flowering. Developmental stages. Plant fertility. Manihot. ***Manihot esculenta. Manihot glaziovii.***

A general history is given of the origin of cassava and its introduction to Java. Selection of true seed has been done in various countries; however, positive results were obtained only in Indochina and Indonesia. Extensive research on flowering and fertilization showed how to obtain seed from the desired parents, how to germinate these seeds and how to evaluate the plants. This increased the effectiveness of the breeding procedures. A description is given of the desirable characteristics (for food and for industrial purposes). Environmental effects were also investigated. Selection of the parents influenced the behavior of the seedlings; however, this does not mean that characteristics of the parents are transferred to the offspring. Via a great number of correlations, it was proved that a combination of certain characteristics are not limited by genetic factors. Hybridization of cassava and *Manihot glaziovii* produced about 30 plants that grew very rapidly. These plants could be intercrossed or backcrossed with both parents. Some guidelines are given for future breeding and it is recommended that material from South America should be crossed with local material. *(Author's summary)* G01

0960-3183 STOREY, H. H. and DOUGHTY, L. R. **Virus diseases of cassava.** *In* East African Agriculture and Forestry Research Organization. Annual report 1951. pp. 26-28. Engl.

Cassava. ***Manihot glaziovii. Manihot dichotoma.*** **Viroses. Plant breeding. Resistance. Productivity. Diseases and pathogens. Pests. Cassava mosaic virus.**

A brief report is given on cassava hybridization, field and yield trials conducted in 1951 as part of the program of breeding for resistance to mosaic. *(Summary by H.J.S.)* G01 E04

0961-4782 KOCH, L. **Zaailingselectie bij cassave.** *(Seedling selection in cassava).* Algemeen Landbouwweekblad voor Nederlandsch-Indie 11(20):485-488. 1926. Dutch., Sum. Engl.

Cassava. Selection. Productivity. Clones. Roots. Starch productivity. Indonesia.

By sowing 10,000 seeds of the cassava variety Mandioca São Pedro Preto, 4577 seedlings were produced. After 7 months, 3901 seedlings were still alive. These were tested 6 times during the years 1918-26, discarding the low yielders. In January, 1926, only 8 seedlings were left. These seedlings proved to be heavy yielders, every one of them producing more starch/ha than the mother variety. *(Author's summary)* G01 D03

0962-2335 GUILLOTEAU, S. **Travaux sur manioc a la station agronomique du Lac Ala''tra. Campagnes 1965 et 1966.** *(Cassava trials at the experimental station of Lac Alaotra; 1965 and 1''56).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1967. 76p. Fr., Illus.

Cassava. Genetics. Plant breeding. Crossbreeding. Selection. Hybrids. Hybridizing. Resistance. Cultivation. Spacing. Productivity. Tuber productivity. Field experiments. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Harvesting.

A report is given of selection work done in 1965-66 at the experimental station of Lac Alaotra. Results, as well as recommended varieties, are given from trials in different ecological zones. Efforts were made to develop new clones equal to or superior to the best local hybrids (H 54 and H56) suitable for the starch industry and animal nutrition. A botanical description of varieties is included. *(Summary by J. L. S.)* G01 E00

0963-3208 OPSOMER, J. E. **Technique et premiers resultats de l'amelioration du manioc a Yangambi, Congo Belge.** *(Techniques and first results of cassava breeding in Yangambi, the Belgian Congo). In* Congress International de Agriculture Tropicale, 3o., 1937. pp.107-114. Fr., Sum. Fr., 6 Refs.

Cassava. Resistance. Cultivars. Cuttings. Clones. Diseases and pathogens. Pests. Viroses. Cassava mosaic virus. Seed.

High-yielding varieties (30-40 tons without fertilizers) were obtained in the first selection of cuttings. After 5 years of continuous planting, these varieties have shown to be highly resistant to diseases. For the collection of varieties obtained from vegetative origin, 80.9% have been attacked by mosaic; this percentage tends to increase. The selection of material obtained by seeds is not very advanced. Observations on this material indicate a fast diminution of the quantity of mosaic-free clones; after the 3rd-4th generation, 87.1% of the cuttings have been infected. The resistance to mosaic seems to be the natural condition of a small quantity of clones, though this resistance is not complete. Therefore it is necessary to maintain these clones for consistant selection. *(Author's summary)* G01 E04

0964-3157 **VIRUS DISEASES of crops in East Africa.** World Crops 3:385-386. 1951. Engl., 8 Refs.

Cassava. Viroses. Resistance. Diseases and pathogens. Pests. Cassava mosaic virus. Cassava brown streak virus. Hybrids. Backcrossing. Plant breeding. ***Manihot glaziovii.*** **Kenya.**

This is an account of work on virus diseases in maize, tobacco, groundnut and cassava; it was taken from a short memoir by H.H. Storey on accomplishments at EAARI in Amani (Kenya). As regards cassava, work done at Amani proved that mosaic is caused by a virus and transmitted by the whitefly when it feeds on young leaves. The spread of the disease was much more rapid during some months; therefore, it was possible to select an "ideal" planting date that would permit cassava to remain healthy for the longest period of growth. A second virus disease, brown streak, was found at low altitudes. Resistant varieties were developed and distributed to farmers. A program of interspecific hybrids, developed from resistant cassava varieties and other **Manihot** spp. including *M. glaziovii,* was begun. Results have shown that high resistance can be conferred to the progeny of interspecific crosses, but several generations have to be backcrossed to cassava to restore the ability to produce satisfactory tuberous roots. *(Summary by T.M.)* G01

0965-0518 ROGERS, D. J. **Dwarf, short-stemmed cassava?.** Tropical Root and Tuber Crops Newsletter no. 5:36. 1972. Engl.

Cassava. Plant breeding. Cultivars. Propagation. Manihot. Stems. Development. ***Manihot esculenta.***

Dwarf or short-stemmed varieties could be useful for developing modern cultivars of *Manihot esculenta,* as it is for wheat and rice. Suggestions are made about some cassava cultivars and **Manihot species which could** serve this purpose. *(Summary by H.J.S.)* G01

0966-0605 ARRAUDEAU, M. **Considerations sur des methodes d'obtention de nouveaux clones de manioc.** *(Methods of obtaining new cassava clones).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaostra. 1962. 22p. Fr.

Also available in Spanish, translated by T.E. Delgado.

Cassava. Pollination. Plant reproduction. Clones. Hybrids. Plant fertility.

The goal of any plant selection program is to achieve positive results in a minimum amount of time. In reference to cassava (a heterozygote plant), the creation of new varieties is based on hybridization between generators, of which the whole generic constitution is ignored. The identification of the parents of a significant hybrid clone seems to be of little importance since the probability of appearance of another significant recombining factor obtained by an identical cross is slight. Although manual crosses between 2 interesting phenotypes are valuable the polyclone method gives us a simple, practical solution to any problem. *(Author's summary)* G01

0967-0601 KANNEGIETER, A. **Die züchtung von nahrungspflanzen im tropishen Afrika.** *(Breeding of food plants in tropical Africa). In* Deutschen Afrika-Gesellschaft. Afrika-heute. Jahrbuch 1963. pp. 283-290. Germ., Illus.

Cassava. Sorghums. Millets. Maize. Rice. Groundnut. Plant breeding. Cassava mosaic virus. Viroses. Diseases and pathogens. Pests. Resistance. Africa.

Some economic and social aspects of plant breeding in tropical Africa are briefly discussed. Information is provided on results obtained with the improvement of sorghum, millets, cassava, maize, rice and groundnut. *(Summary by Tropical Abstracts)* G01

0968-3497 CONCEIÇAO, A. J., CUNHA, H. M. P. AND SAMAPIO, C. B. **Programa de melhoramento da mandioca.** *(Cassava breeding program).* Cruz das Almas, Bahia, Brasil, Universidade Federal da Bahia, Escola de Agronomia, 1973. 19p. Port., Sum. Port., Engl., 6 Refs.

Cassava. *Manihot esculenta.* **Plant breeding. Germplasm. Crossbreeding. Clones. Genetics. Pollination. Flowering. Developmental stages. Selection. Field experiments. Growth-chamber experiments. Research. Brazil.**

A report is given on the breeding of cassava (*Manihot esculenta* Crantz) being done at the Escola de Agronomia da Universidade Federal da Bahia in Cruz das Almas, Bahia (Brazil). This program was initiated in 1969. It consists of studies on the germplasm bank, polycrosses, controlled crossbreeding, development of plants by sexual and asexual means, and fields for clonal multiplication. *(Author's summary)* G01

0969-0455 UMANAH, E. E. **Identification and cultivation of currently recommended improved cassava varieties.** Federal Department of Agricultural Research. Memorandum no. 93. 1970. 18 p. Engl., 20 Refs.

Cassava. Plant breeding. Taxonomy. Propagation. Starch productivity. Bemisia. Gari. Uses. Cultivars. Cultivation. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. *Cercospora henningsii.* **Mycoses. Productivity. Food products. Nigeria.**

This memorandum summarizes work carried out at the Federal Department of Agricultural Research, Ibadan (Nigeria) and covers the following topics: botany; national cassava production; cassava breeding for varietal improvement (objectives are high yield, high dry matter content, high starch content, low HCN content, good food quality and resistance to cassava mosaic virus); useful characteristics for varietal identification; improved and recommended cassava varieties; multiplication and distribution schemes; cultural practices; pests and diseases; and uses of cassava. *(Summary by P. A. C.)* G01

)970-0509 HERNANDEZ X., E. and PATIÑO, V. M. **Exploración etnobotánica de Manihot en México.** *(Ethnobotanical exploration of Manihot in Mexico).* Tropical Root and Tuber Crops Newsletter no. 5:14-22. 1972. Span., 2 Refs.

Cassava. History. Taxonomy. Cassava programs. Development. Germplasm. Cultivars. Manihot. Mexico.

Based on the international germplasm bank at the Centro Internacional de Agricultura Tropical (CIAT), an ethnobotanical study on **Manihot** was carried out in Mexico in collaboration with CIAT, CIMMYT and the Instituto Nacional de Investigaciones Agrícolas (INIA). Brief notes are given on the agronomic characteristics of 71 cassava varieties and 8 wild species collected by the second author in the southern and southeastern regions of Mexico. Plant material is maintained at INIA's Experiment Station at Cotaxtla, Veracruz. *(Summary by T.M.)* G01

)971-0278 JENNINGS, D. L. **Further studies in breeding cassava for virus resistance.** East African Agricultural Journal 22(4):213-219. 1957. Engl., Sum. Engl., 6 Refs.

Cassava. Plant breeding. Pests. Diseases and pathogens. Cassava mosaic virus. Cassava brown streak virus. Viroses. Field experiments. Research. Hybrids.

Further studies in breeding cassava resistant to virus diseases have shown that cassava possessing a high degree of resistance to mosaic and brown streak viruses can be obtained but that the manifestation of resistance is influenced by environmental conditions. It is not known whether complete resistance under all conditions can be obtained. The most successful hybrids are those derived from *M. glaziovii*, and in this series improved resistance to mosaic virus was obtained when third backcross hybrids were intercrossed. Improvements in the method of field experimentation and the estimation of resistance are reported. *(Author's summary)* G01 E04

0972-0512 APPAN, S. G. and ROGERS, D. J. **The closed gene pools of Manihot delimited by computeraided taximetric methods, to aid utilization of the wild genetic wealth in cassava improvement programs.** Tropical Root and Tuber Crops Newsletter no. 3:16-18. 1970. Engl., 7 Refs.

Cassava. Taxonomy. Genetics. Plant breeding. Manihot. *Manihot glaziovii. Manihot dichotoma. Manihot melanobasis. Manihot saxicola.*

This paper is a summary of a monograph by the authors: The wild species of **Manihot** (about 200) represent practically unexplored and unexploited reservoirs of potentially valuable genetic variability. Five species *(M. glaziovii, M. dichotoma, M. catingae, M. melanobasis* and *M. saxicola)* are utilized in interspecific improvement of cassava. Intensive biological studies of the entire genus **Manihot** are being carried out, employing computer-aided procedures. Over 5,000 specimens representing wild species of **Manihot** were assembled for this study. The 18 closed gene pools of the North American segment and the single gene pool of the newly described monotypic genus **Manihotides** have been delimited. Three of the 18 are newly discovered gene pools. The results support the hypothesis advanced by Rogers that the cassava gene pool constitutes genetic material drawn from wild species of **Manihot** occurring in Mexico, thus Mexico is one of the geographical centers of speciation of *M. esculenta. (Summary by J.L.S.)* G01.

0973-0451 ADDOH, P. G. **Cassava; selection of varieties of resistance to mosaic disease.** *In* Ghana. Crops Research Institute. Annual Report 1965. Accra. 1969. pp.40-43. Engl.

Cassava. Cultivars. Cassava mosaic virus. Resistance. Productivity. Palatability. Clones. Selection. Ghana.

Results are presented as tables. One table deals with yield and mosaic resistance, yield per plant, suitability for color, texture and taste, and suitability of making "fufu" and "ampesi." Another table deals with the results of experiments on clones (obtained from crosses in 1963-64) have high mosaic resistance and desirable food qualities. *(Summary by H.J.S.)* G01 E04

0974-3343 CENOZ, H. M., HENAIN, A. E. and PERUCCA B., B. D. **Mandioca "Taragui Cafpta" F.A.V.C. Un nuevo cultivar (clon) para el nordeste argentino** [*Taragui Cafpta F.A.V.C.(clone),a new cassava cultivar for the northeastern region of Argentina*]. Corrientes, Argentina. Universidad Nacional de Nordeste. Facultad de Agronomía. Publicación no. 15. 1972. 14p. Span., Sum. Span. Engl., Illus.

Cassava. Hybridizing. Plant breeding. Cultivars. Starch content. Composition. HCN content. Protein content. Crossbreeding. Clones. Dry matter. Argentina.

In this work, the new cultivar (clone) of a foodstuff cassava named TARAGUI CAFPTA—F.A.V.C. is described; it was obtained by the natural crossbreeding of the cultivars, Carapé and Pombero Blanco at the School of Agronomy and Veterinary Medicine of the Universidad Nacional de Nordeste, Corrientes (Argentina). The results obtained comparative test on root yield from 1969-70 to 1971-72 are given; and besides the values obtained from the analysis of their roots as far as total dry stuff, P.S. starch, P.F. starch, proteins and HCN content are concerned. The diffusion of this new cultivar (clone) is recommended for the Argentine northeast region. *(Author's summary)* G01 C03

0975-2045 TARDIEU, N. **Note sur le manioc.** *(Note on cassava).* Bulletin du Centre des Recherches Agronomiques de Bambey no. 10-11:62-72. 1953. Fr., Illus.

Cassava. *Manihot glaziovii. Manihot saxicola.* **Manihot. Germplasm. Productivity. Nutritive value. Human nutrition. Food energy. Genetics. Plant breeding. Toxicity. Clones. Hybrids. Bemisia. Africa. Nigeria. Senegal. Sudan.**

A survey was made of the importance of cassava in French African territories. A global estimate places production at an average of 4.25 tons of tubers| ha. Yields are estimated at 1.8 tons| ha in Senegal, 10 tons| ha in the Sudan and 4.2 tons| ha in Niger. The author considers that any large-scale increase in the production and quality of cassava is out of the question in these areas. Genetic data and suggested lines along which future research might be conducted are also given. *(Summary by Tropical Abstracts)* G01 H00.

0976-0531 ABRAHAM, A. **Tuber and root crops germ plasm collection.** Tropical Root and Tuber crops Newsletter no. 5:40-41. 1972. Engl.

Cassava. Manihot. Germplasm. India.

The experimental form of the University of Kerala (Trivandrum) has collected 640 accessions of **Manihot, Ipomoea, Dioscorea, Colocasia, Xanthosoma, Amorphophalus, Coleus, Maranta, Zingiber and Curcuma.** Planting material is available; of these, 620 are cultivated plants and the rest are wild species. A careful study of the tuber crops already collected has shown that there is a wide genetic variability in the varieties. A full list of material in the germplasm collection is being prepared for publication. *(Summary by H.J.S.)* G01

0977-0600 DELGADO, T. E. and ROSAS, J. S. **Germoplasma internacional de yuca: su evaluación botánica agronómica preliminar en el Perú.** *(International cassava germplasm: preliminary botanical and agronomic evaluation in Peru).* Lima, Perú, Instituto Interamericano de Ciencias Agricolas, 1970. 14p. Span., 3 Refs.

Cassava. Germplasm. Leaves. Petioles. Clones. Developmental stages. Plant development. Shoots. Flowers. Fuits. Plant anatomy. Identification. Peru.

Seventy-eight clones were evaluated. The following characteristics were studied: growth habits, shape of the leaf central lobe, color of the upper surface of the leaf presence and color of umbilical spot, petiole color and length, angle of petiole attachment, bud color, number of stipule teeth, color of stem epiderm and periderm, length of internodes, flowering and fructification periods. *(Summary by H.J.S.)* G01 B00

0978-3014 NICHOLS, R. F. W. **Virus diseases of cassava.** *In* East African Agriculture and Forestry Research Organization. Annual report 1949. pp. 13-15. Engl.

Cassava. Hybridizing. ***Manihot melanobasis.*** **Manihot. Resistance. Backcrossing. Diseases and pathogens. Cassava mosaic virus. Cassava brown streak virus. Viroses. Pests. Plant breeding.**

Research is in progress on control of 2 cassava virus diseases: mosaic and brown streak. Improvement is sought by interspecific hybridization of woody-rooted wild species of **Manihot** with the tuberous-rooted cultivated cassavas; subsequent backcrossing would restore fully tuberous roots while retaining the disease resistance of the wild species. A very high resistance to brown streak was shown by a group of F1 *Manihot melanobasis* hybrids. It appears that one backcross will probably suffice to restore fully tuberous roots in this material. *(Summary by H.J.S.)* G01 E04.

0979-0287 BOLHUIS, G. G. **A survey of some attempts to breed cassava-varieties with a high content of proteins in the roots.** Euphytica 2:107-112. 1953. Engl., Sum. Dutch., 11 Refs.

Cassava. Plant breeding. Roots. ***Manihot saxicola. Manihot glaziovii.*** **HCN. Cultivars. Proteins. Hybridizing. Hybrids. Crossbreeding. Genetics. Research.**

The results are given of several experiments concerning the breeding of cassava (**Manihot** spp.) varieties with roots containing a higher than normal percentage of protein. Results indicate that little success may be expected. The hybrids from the cross *M. utilissima x M. saxicola* seem to offer the greatest possibilities although they are adversly affected by a high degree of toxicity and unfavorable growing habits. Further studies on the variability of *M. saxicola* must disclose whether within this species a combination of a high protein content occurs in roots with a low degree of toxicity. *(Summary by P.A.C.)* G01

0980-3294 ACCRA, GHANA ACADEMY OF SCIENCE. **Cassava.** *In*______ Crop Research Institute, Annual Report 1965. pp.39-43. Engl.

Cassava. Cultivars. Clones Hybrids. Cassava mosaic virus. Diseases and pathogens. Pests. Resistance. Human nutrition. Productivity. Ghana.

Several experiment stations carried out experiments to compare the Ankra variety with 31 clones, varieties and hybrids as regards yield and mosaic resistance. The crossbreeding program to combine high yield with high resistance and desirable food qualities continues to progress. *(Summary by J.L.S.)* G01 E04.

0981-0606 IRVINE, F. R. *Manihot glaziovii, Manihot utilissima.* *In*______. Plants of the Gold Coast. London, Oxford University Press, 1930. v.2., pp. 274-276. Engl.

Cassava. ***Manihot glaziovii. Manihot esculenta.*** **Cultivars. Identification. Ghana.**

Brief descriptions are given of *Manihot glaziovii* and *M. utilissima.* Miscellaneous characteristics of 16 cassava varieties from the Twi and Ga districts (Gold Coast) are listed. *(Summary by H.J.S.)* G01

0982-0510 JENNINGS, D. L. **Recognizing good parents in root crop breeding.** Tropical Root and Tuber Crops Newsletter no. 5:11-13. 1972. Engl., 4 Refs.

Cassava. Plant breeding. Genetics. Backcrossing. Resistance.

Since systemic crossing is often impracticable because of prohibitive labor costs, etc., it is suggested that performance of a progeny can be assessed by studying the additive or "parental values" and interaction effects. An illustration is given from Tanzania where the method was used successfully to study the inheritance of disease resistance in instances where variation in resistance is continuous. *(Summary by T.M.)* G01

0983-0515 ALVAREZ-LUNA, E. **Colección de yucas del CIAT.** *(Collection of cassava at CIAT).* Tropical Root and Tuber Crops Newsletter no. 3:29. 1970. Span., Sum. Engl.

Cassava. Germplasm. Cultivars. Colombia.

As part of a multidisciplinary approach to the development and breeding of cassava, 1260 accessions have been obtained in Colombia. This germplasm bank will be expanded, and should serve as a major source of materials of this crop plant. *(Author's summary)* G01

0984-2430 ARRAUDEAU, M. and LAVIGNE, R. **Travaux sur manioc a la Station Agronomique du Lac Alaotra; campagnes 1961 et 1962.** *(Work on cassava at the Agronomy Station in Lake Alaotra; campaigns of 1961 and 1962).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1962. 46p. Fr., Illus.

Cassava. Pollen. Pollination. Productivity. Genetics. Resistance. Cultivars. Hybridizing. Pests. Diseases and pathogens. Viroses. Cassava mosaic virus. Plant breeding. Malagasy Republic.

Work on developing high-yielding cassava hybrids that also have high resistance to mosaic disease is discussed. The main subjects dealt with are the collection of cassava clones (infected by mosaic and healthy) and some of their characteristics. Hybridizations and research concerning random and controlled pollinization are described. Four types of hybrid cassava seeds, classified according to their size, were found. Several field observations suggested that the 4 sizes correspond to tetra-, tri-, di- and haploid seeds. Cassava pollen grains were very heterogeneous in size. Yields are given for several hybrids. *(Summary by H.J.S.)* G01 G01.

0985-4627 GRANT, W.F. **Chemosystematics in the classification of cultivars.** *In* Nobel Symposium, 25, London, 1973 Chemistry in Botanical Classification. London, 1973. pp.293-302. Engl., Sum. Engl., 51 Refs., Illus.

Cassava. Cultivars. Leaves. Analysis. Chromosomes. ***Manihot esculenta.***

Morphological descriptions of cultivars present problems in identification as clear-cut distinguishable differences between cultivars are often lacking. With the development of breeder's rights in various countries, the unequivocal identification of cultivars and the establishment of parental origins is increasingly important. Biochemical techniques such as paper and thin-layer chromatography, electrophoresis and serology offer ways to identify cultivars completely due to limited intercultivar genetic variability, more than one biochemical system (different enzymes) or the use of different plant parts (leaves, roots) may be necessary to distinguish all cultivars of a species. Infracultivar genetic heterozygosity may also be diagnosed through such methods. Secondary phenolic compounds from leaf samples of over 900 cultivars of *Manihot esculenta* Crantz were used for cultivar classification by means of 2-dimensional thin-layer chromatography. Intercultivar differences for 55 fluorescent spots were compared by a cluster analysis computer program, in which the cultivars were grouped at different S value. By means of chromatography and spectrophotometry, flavonoids were identified as the glucosides of quercetin and luteolin. The cinnamic acids were identified as chlorogenic acid, esters of p-coumaric, caffeic, ferulic, and sinapic acids, and the glucosides of caffeic and ferulic acids. *(Author's summary)* G01 C03

0986-2337 SAPIN, P. **Sélection du manioc a Yangambi.** *(Cassava selection at Yangambi)* Bulletin d'Information de l'INEAC 7(3):181-195. 1958. Fr., 1 Ref., Illus.

Cassava. Cultivation. Diseases and pathogens. Pests. Toxicity. Selection. Cultivars. Clones. Plant breeding. Resistance. Tubers. Zaire.

After describing the cultural methods, diseases and toxicity of the tubers of cassava, the selection of cassava varieties at the Research Station of Yangambi (Congo) is discussed. Agricultural and technological criteria and selection plans are given. The various characteristics of the selected elite clones are summarized in tables. *(Summary by Tropical Abstracts)* G01

See also 0169 0281 0296 0526 0527 0528 0536 0718 0755

0987-0659 MAGOON, M. L., KRISHNAN, R. and VIJAYA B., K. **The pachytene karyology of *Manihot esculenta* Crantz.** Tropical Root and Tuber Crops Newsletter no. 1:9. 1969. Engl.

Cassava. *Manihot esculenta.* Chromosomes. Cytology. Cytogenetics.

This paper gives the results of the analysis of the entire pachytene complement of a cultivar leading to the identification of all the 18 bivalents based on suitable morphological markers. *(Summary by J.L.S.)* G02

0988-0338 GRANNER, E.A. **Polyploid cassava; induced by colchicine treatment.** Journal of Heredity 32:281-288. 1941. Engl., 4 Refs., Illus.

Cassava. Polyploidy. Cytogenetics. Colchicine. Cuttings. Flowers. Stomata. Roots. Plant tissues. Chromosomes. Leaves. Genetics. Plant anatomy. *Manihot esculenta.*

Cuttings of *Manihot utilissima* Pohl were raised in pots, and after 30 days all shoots but the strongest were removed. The apical bud of this shoot was kept in contact with cotton soaked in 0.5 or 1.0% colchicine for 8 days. Using this treatment, several plants were produced with larger stomata and broader, thicker leaf lobes than the controls. These plants were found to be polyploids, one of them being octoploid (2n= 144) and the rest tetraploid (2n=72). In the plants raised by cuttings from these polyploids, it will be possible to study the effects of polyploidy on such economically important characters as root size and starch content. *(Summary by Plant Breeding Abstracts)* G02

0989-2170 BOITEAU, P. **Caryologie du manioc cultivé.** *(Karyology of cultivated cassava).* Bulletin de l'Academie Malgache 20:117-118. 1937. Fr., 3 Refs., Illus.

Cassava. Cytology. Chromosomes. Tubers. Genetics. Malagasy Republic.

Young tuber cells were studied to determine the number of chromosomes in high and low-yielding varieties. The 7 cultivated varieties studied showed 4 chromosomes (2n=4). Cassava has the simplest chromosomic arrangement of all plants. One pair of chromosomes is 5µm long and V-shaped; the other pair is 1.5µm long and rod-bacterium shaped. The chromosomes come from the nucleole and not from chromatine as in most plants. Suggestions are made for further studies. *(Summary by H.J.S.)* G02

0990-2659 GRANER, E.A. **Uma forma tetraplóide de mandioca Vassourinha de provável valor hortícola.** *(A tetraploid form of cassava (variety Vassourinha) of probable horticultural value).* Revista de Agricultura (Brazil) 19(9-10| 11-12):380-391 1944. Port., Sum. Port., Engl., 15 Refs., Illus.

Cassava. *Manihot esculenta.* Cytogenetics. Polyploidy. Clones. Chromosomes. Roots. Productivity. Stems. Growth. Brazil.

Two tetraploid clones of cassava (*Manihot utilissima* Pohl) obtained experimentally by colchicine were compared to the diploid one. Tetraploid clone no. 6 is different from tetraploid clone no. 2, and both are different from diploid clone no. 8. The 4n clone (no. 6) produced plants that did not grow well in field conditions; and judging by the small size of the plants, it is suggested that this clone could be good for horticultural conditions. *(Author's summary)* G02

0991-2282 GRANER, E.A. **Contribuição para o estudo cytologico da mandioca.** *(Contribution to the cytological study of cassava).* Piracicaba, brasil, Escola Superior de Agricultura "Luiz de Queiroz", 1935. 28 p. Port., Sum. Engl., 23 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Cytology. Cultivars. Flowers. Chromosomes. Microsporogenesis. Pollen. Plant anatomy. Seed. Cytogenetics. Sweet cassava. Bitter cassava. Brazil.**

Results are based on a cytological study of 37 varieties of bitter and sweet cassava growing in Brazil. A short account of the floral morphology is given. Microsporogenesis is described; the diakinesis stage was not observed; normal pollen tetrads are formed. In macrosporogenesis, a typical 8-nucleate embryo sac is formed. The embryo sac is divided into 7 cells: 3 cells of the egg apparatus at the micropylar end, 3 cells of the antipodal group at the chalazal end and a binucleate primary endosperm cell. The obturating tissue characterist of Euphorbiaceae was observed. The haploid chromosome number in the sweet variety (Aipim preto) is 18. Somatic mitosis occurs normally and the 2n chromosome number of all varieties was found to be 36. Results seem to indicate that most of the varieties of sweet and bitter cassava cultivated in Brazil are forms of the species *M. utilissima* Pohl. *(Author's summary)* G02

0992-0410 MAGOON, M.L. *et al.* **Cytomorphological studies on induced polyploids of cassava.** Genética Ibérica 21:27-47. 1969. Engl., Sum. Engl., 30 Refs., Illus.

Cassava. Polyploidy. Cytology. Cytogenetics. Plant anatomy.

A comparative study of the morphological and cytological characters of three agronomically superior, cultivated diploid strains of cassava and their artificially induced tetraploids has been made. The induced tetraploids showed the usual "giga" characters associated with autotetraploidy for certain morphological characteristics. The extent to which induced tetraploidy has been responsible in bringing about morphological differences between the two chromosomal types is discussed. There was a significant reduction in pollen fertility and seed setting of induced tetraploids, as compared to their diploid progenitors. While the diploids showed normal meiosis, a breakdown of tetraploidy has been noticed as a result of the large number of irregularities in meiosis. Suitable explanations have been advanced to explain these abnormalities. The utility of induced tetraploids from a breeding point of view is also discussed. *(Author's summary)* G02

0993-0514 MAGOON, M. L., JOS, J. S. and NAIR, S. G. **Cytogenetics of induced polyploids of cassava.** Tropical Root and Tuber Crops Newsletter no. 3:18-20. 1970. Engl.

Cassava. Cytogenetics. Chromosomes. Polyploidy. Colchicine Plant anatomy. Plant breeding. Microsporogenesis.

This communication deals with the cytogenetical information on the pairing behavior of chromosomes in a few induced tetraploids ($4n = 72$) and triploids ($3n = 54$) of cassava. *(Summary by J.L.S.)* G02

0994-0556 MAGOON, M. L., KRISHNAN, R. and BAI, V. K. **Cytogenetics of the F1 hybrid between cassava and ceara rubber, and its backcross.** Genetica 41:425-436. 1970. Engl., Sum. Engl., 6 Refs.

Cassava. ***Manihot glaziovii.*** **Cytogenetics. Cytology. Hybrids.** ***Manihot esculenta.*** **Plant anatomy. Backcrossing. Plant breeding. Chromosomes. Plant fertility.**

Cytogenetical studies were made of the F1 hybrid between the commercially cultivated tuber crop, cassava (*Manihot esculenta* Crantz) and the closely related wild species *Manihot glaziovii* Muell. (Ceara rubber) used as donor species for cassava mosaic disease and drought resistant genes and backcrosses (to cassava parent). The contrasting parental characters showed partial to total dominance in the F1 hybrid, while the backcross plants were similar to cassava in most of their characters. Eleven of the 12 backcross plants exhibited resistance to cassava mosaic under field conditions. Karyological similarities and differences as resolved on the basis of a comparative study of the karyotypes of the cassava parent and ceara rubber were corroborated by the study of chromosomal pairing in the F1 at pachytene. Major chromosomal differentiation in the 2 species involved 3 chromosomes of their haplid complement, which were represented by 3 heteromorphic bivalent associations in F1, each consisting of a probably basic chromosomal type and a derived type. Pachytene analyses of 3 backcross plants provided direct proof for random transmission of marker chromosomes of both the parents through male gametes of the F1 hybrid. An increase in the chiasma frequency in the backcross plants over the F1 hybrid at metaphase I stage was also observed. Pollen fertility of the backcross plants showed considerable variation. *(Author's summary)* G02

0995-0561 MAGOON, M. L., KRISHNAN, R. and BAI, K. V. **Morphology of the pachytene chromosomes and meiosis in *Manihot esculenta* Crantz.** Cytologia 34:612-625. 1969. Engl., Sum. Engl., 33 Refs., Illus.

Cassava. *Manihot esculenta.* **Chromosomes. Cytogenetics. Cytology. Plant anatomy. Microsporogenesis.**

Detailed analyses of chromosomes at pachytene and later stages of meiosis were made in a cultivated type of cassava. Pachytene chromosomes are depicted on the basis of total length, relative length, arm ratio, amount and distribution of heterochromatin and number and position of chromomeres. Idiograms showing details of all the 18 pachytene bivalents in the haploid complement are presented and based on the average values of lengths obtained by accurate measurements of the bivalents in a minimum of 15 completely analyzable nuclei. The 18 pachytene bivalents have been arranged and numbered in order of their decreasing length as chromosome I to chromosome XVIII. The haploid chromosomal complement, *inter alia,* has 3 functional nucleolar chromosomes and 6 chromosomal types represented in duplicate. Based on the data of the pachytene karyology obtained, a segmental allopolyploid origin of the present-day cultivars of cassava has been suggested. Based on cytological data, it has been suggested that meiotic abnormality is not the cause of pollen degeneration in the material studied. *(Author's summary)* G02.

0996-0582 CRUZ, N. D. DA. **Citologia no genero Manihot Adans. I. Determinacao do numero de cromossomos em algumas especies.** *(Cytology in the genus Manihot Adans. I. Chromosome counts in some species).* Anais da Academia Brasileira de Ciencias 40(1):91-95. 1968. Port., Sum. Port., Engl., 6 Refs., Illus.

Cassava. Manihot. Cytology. Chromosomes. Cytogenetics. Brazil.

In Brazil this genus is represented by a large number of species and varieties. Chromosome counts have been made in 15 plants from several Brazilian regions; 36 somatic chromosomes were found in all of them. Karyotype analysis was difficult because there were no significant differences in chromosome size, either betwen species or within the same species. Although this is a handicap in phylogenetic studies, it may bring greater possibilities to a breeding program. The plants, together with a herbarium specimen of each one, are kept at the Jardim Botanico in Sao Paulo and at the Instituto Agronomico do Estado de São Paulo in Campinas. *(Author's summary)* G02

0997-3499 UMANAH, E. E. and HARTMANN, R. W. **Chromosome numbers and karyotypes of some Manihot species.** Journal of the American Society for Horticultural Science 98(3):272-274. 1973. Engl., Sum. Engl., 21 Refs., Illus.

Cassava. Cytogenetics. *Manihot esculenta. Manihot glaziovii.*

The chromosome numbers of both *Manihot esculenta* Crantz and *M. glaziovii* Muell.-Arg. were found to be 2n = 36. The karyotypes of the two species are similar. Two pairs of satellited chromosomes for both species are reported for the first time. Meiosis was normal in pollen mother cells; the 18 bivalents at Metaphase I disjoined regularly at Anaphase I. We suggest that these **Manihot** species are allopolypoids with a basic chromosome number of x = 9. *(Author's summary)* G02.

0998-2454 JOS, J. S. *et al.* **Studies on sterility in cassava. I. Mechanism of pollen abortion in some male sterile lines.** Indian Journal of Horticulture 23:177-184. 1966. Engl., Sum. Engl., 13 Refs.

Cassava. Pollen. Cytology. Anthers. Plant anatomy.

The external morphology, microsporogenesis and development of male gametophyte have been studied in detail in both the male fertile as well as male sterile lines of *Manihot utilissima.* The similarities and differences between the 2 types of plants have been critically discussed. In the 2 male sterile lines (C.T.C.R.I. 131 and 270), degeneration of individual microspores is probably due to the failure of the separation of microspores from the tetrad which leads to the formation of empty anthers. However, in the third male sterile line (C.T.C.R.I. 1416) the pollen abortion appears to be due to the persistent nature, abnormal behavior and development of the tapetum. The nutritive relationship between the developing microspores and the tapetum has also been discussed. Based on cytological data, it has been suggested that meiotic abnormality is not the cause of pollen degeneration in the present material. *(Author's summary)* G02.

0999-1674 GRANER, E. A. **Chimera chromosomica na mandioca.** *(Chromosomal chimera in cassava).* Piracicaba, Brasil, Escola Superior de Agricultura "Luiz de Queiroz". 1935. 10p. Port., Sum. Engl., 18 Refs., Illus.

Cassava. *Manihot esculenta.* **Polyploidy. Cytology. Chromosomes. Cytogenetics. Roots.**

Studying somatic mitosis in cassava (*Manihot utilissima* Pohl) root tips,tetraploid cells were detected in their plerome. A preliminary description is made by the author on this chromosomal chimera, identical to that reported by others in **Euphorbia, Mercurialis** and other genera. *(Author's summary)* G02.

1000-3357 SINGH, A.P. and NAIR, R. G. **Pollen abnormalities in cassava (*Manihot esculenta* Crantz).** Current Science 37(16):476-477. 1968. Engl., 7 Refs., Illus.

Cassava. Pollen. Cytology. Genetics.

Irregular meiosis resulting in the formation of monad, dyad, trial and pentad pollen, in addition to the normal tetrad associations, was observed during cytological studies of local and introduced material. *(Summary by Plant Breeding Abstracts)* G02

1001-0579 SOHMER, S. H. **Microsporogenesis in** *Manihot esculenta.* Cytologia 33:97-99. 1968. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Microsporogenesis. Cytogenetics. Plant reproduction. *Manihot esculenta.*

Microsporogenesis was investigated in selected cultivars of *Manihot esculenta* being cultivated at the Instituto Interamericano de Ciencias Agricolas in Turrialba(Costa Rica).The course of microsporogenesis was found to be "normal" in these cultivars, and various stages of the process were recorded. *(Author's summary)* G02

See also 0019

H00 NUTRITION

1002-3351 JACQUOT, R. and NATAF, B. **Le manioc et son utilisation alimentaire.** *(Cassava and its utilization as a foodstuff).* Paris, Hermann, 1936. v. 1, 56p. (Actualites Scientifiques et Industrielles no. 364). Fr., 65 Refs. Illus.

Cassava. Cultivation. Uses. Animal nutrition. Cattle. Swine. Composition. Food products. Nutritive value. Human nutrition. Economics.

The following aspects are dealt with: botanical description, cultivation, varieties, chemical composition, digestibility, caloric value, starch value, cassava as a complete foodstuff, supplementation, swine fattening, calf nursing and fattening, uses, milling and wastes, bread making, cassava economics, conclusions and bibliography. *(Summary by H.J.S.)* H00.

1003-2238 LES PRODUCTIONS **alimentaires vegetales.** *(Production of plant foodstuffs).* *In* Cote d'Ivoire. Ministre d'Agriculture. Dix ans de development agricole 1960-1969. Abidjan, 1970. pp. 57-60. Fr.

Cassava. Taro. Potatoes. Banana-plantains. Yams. Human nutrition. Development. Production. Consumption. Ivory Coast.

Root crops and plantain production in the Ivory Coast showed a 2.9% growth rate, and population increased at a rate of 3% from 1960 to 1969. However, crop production was enough to satisfy the internal demand. The future production and demand of foodstuffs and the migration of farmers to the cities are briefly discussed in relation to the foodstuff requirements. *(Summary by H J.S.)* H00

1004 2318 LINARES, F. A. *et al.* **Analytical studies of a wild, high-yielding variety of yuca** *(Manihot esculenta).* Cali, Colombia, Universidad del Valle, 1970. 7p. Engl.

Paper presented at the International Food Science Technology Congress, Washington, 1970.

Cassava. Animal nutrition. N. Proteins. Amino acids. Composition. Analysis. Colombia.

The search continues for new sources of protein-rich foods to satisfy the needs of the world-wide shortage. Cassava is a basic staple in the diets of low socioeconomic groups in Colombia and Ecuador. Analysis of the protein content and amino acid composition of the different nitrogen fractions are mentioned. A qualitative evaluation of this high protein-yielding variety in diets for rats, is presented, and the nutritional implications are discussed. *(Author's summary)* H00 C03

1005-0654 ROGERS, D. J. and APPAN, S. G. **Cassava-based nourishment generating system capable of functioning in ecologically and economically improverished areas.** Tropical Root and Tuber Crops Newsletter no. 4:13-17. 1971. Engl., 16 Refs., Illus.

Cassava. Manihot. Ecology. Research. Human nutrition. Cassava programs.

Systems with the potential of generating nourishment from deteriorated environmental pockets or under economically impoverished conditions are necessary to supply man's growing need for food. Preliminary evaluation of such a cassava system is presented. A research project is outlined for an intensive computer-aided system with analytical studies and models to elucidate the problems, feasibility, scope, efficiency and values of the system. *(Summary by J.L.S.)* H00

1006-0688 MOLINYAWE, C. D. **Status of root crop research in the Philippines.** *In* International Symposium on Tropical Root Crops, 1st, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 1. pp. 69-83. Engl., 44 Refs.

Cassava. Harvesting. Storage. Processing. Sweet potatoes. Arracacia. Yams. Swine. Chicks. Cultivars. Cultivation. Consumption. Inter-cropping. Composition. Animal nutrition. Poultry. Domestic animals. Philippines.

A review is presented of research work on propagation,intercropping,fertilizing, storage and processing cassava and sweet potatoes, in addition to their value as food material for pigs and chickens. Taro, yams, sweet potatoes and arrowroot are mentioned briefly. *(Summary by Soils and Fertilizer Abstracts)* H00 D00

1007-0646 NORMANHA, E. S. **General aspects of cassava root production in Brazil.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd., Honolulu and Kapaa, Kauai, Hawaii, 1970. Tropical Root and Tuber Crops Tomorrow. Honolulu, University of Hawaii, 1970. v. 1., pp. 61-63. Engl.

Cassava. Production. Human nutrition. Animal nutrition. Feeds and feeding. Uses. Industrialization. Cultivation. Mechanization. Pests. Diseases and pathogens. Brazil.

Brief notes are given on cassava in Brazil: acreage and production of tubers for human food and animal feed, industrial products, main agricultural problems (diseases and pests), crop mechanization, uses and research work. *(Summary by H.J.S.)* H00 I02.

1008-2304 NORMAN, J.C. **Tropical leafy vegetables in Ghana.** World Crops 24(4):217-219. 1972. Engl., Sum. Engl., 15 Refs.

Cassava. Consumption. Vegetable crops. Human nutrition. Nutritive value. Starch crops. Research. Ghana.

The review has attempted to stress the nutritional importance of tropical leafy vegetables. The nutritive values of these vegetables compare favorably with exotic types like cabbage and lettuce. The cooperation of the Ministries of Agriculture, Health, and Rural Development and Social Welfare is of prime necessity if promotion of consumption and production of the crops is to be successful. The introduction of the concept of home gardens has been recommended. Agronomic, postharvest physiologicial and breeding studies have been suggested as possible areas to begin research. There is, undoubtedly, a wide range for improving and increasing tropical leafy vegetable production in Ghana. *(Author's summary)* H00

1009-2020 SUBRAHMANYAN, V. and SWAMINATHAN, M. **Utilization of tuber crops for meeting food shortage.** Food Science 8(5):177-181. 1959. Engl., 10 Refs.

Cassava. Groundnut. Sweet-potatoes. Rice. Metabolism. Cassava flour. Digestibility. Consumption. Cereals. Diets. Potatoes. Human nutrition. Energy productivity. Productivity. Dietary value. Food energy. Flours. India.

India must continuously import food grains to supplement its domestic shortage. Roots and tubers appear to be the most promising sources as they yield 2-3 times as many calories| ha as cereals. An added advantage is that they are apt for both small- and large-scale farming. Their nutritive value is discussed. Blends of a tuber flour and low-fat oilseed flours can be used successfully as partial substitutes for cereals. Results are given of large-scale feeding experiments with a blend of cassava and groundnut flour (Mysore). *(Summary by Tropical Abstracts)* H00

1010-0103 VAN VEEN, M. S. **Some ecological considerations of nutrition problems of Java.** Ecology of Food and Nutrition 1:25-38. 1971. Engl., Sum. Engl., 30 Refs.

Cassava. Human nutrition. Malnutrition. Hunger oedema. Deficiency diseases. Deficiencies. Vitamin deficiencies. Protein deficiencies. Diets. Human health. Developmental research. Research. Java.

Indonesia is the world's fifth largest country. In 1968, the Workshop on Food, convened by the Indonesian National Institute of Sciences and the National Academy of Sciences of the United States, called attention to the critical nature of the country's food situation. Within Indonesia, Java occupies a unique position, comprising approximately 7% of the country's total land area and containing almost two-thirds of its population. Food production dominates the agricultural economy of Java. The main foods are rice, corn, cassava, sweet potatoes, peanuts and soybeans. Cassava has become the main staple in areas where food production has seriously deteriorated over the years due to deforestation and soil erosion. Cassava provides a reasonable amount of calories but very little protein. Fish is the main source of animal protein and supplies are low. A number of factors influencing the food and nutrition problems are discussed, including demographic, economic, cultural and institutional factors. An understanding of the ecology of the food and nutrition problems is needed to facilitate the establishment of priorities and the development of programs that can lead to better levels of nutrition and health for the population. *(Author's summary)* H00

1011-0996 BELL, J. M. K. and COURSEY, D. G. **Tropical vegetables in Britain.** Tropical Science 13(4):251-263. 1971. Engl. 17 Refs., Illus.

Cassava. Yams. Sweet-potatoes. ***Manihot esculenta.*** **Banana-plantains. Vegetable crops. Human nutrition. Trade. Economics. Distribution. Africa. India.**

In the U.K., 2% of the total population are estimated to be people of non-European origin. This population has food needs that are substantially different from those of the indigenous population. This paper discusses technical problems and future prospects. Among the vegetables discussed are: yams (**Dioscorea** spp.), sweet potatoes *(Ipomoea batatas)*, cassava *(Manihot esculenta)*, aroid root crops (**Colocasia** and **Xanthosoma** spp.), plantains (**Musa** spp.), breadfruit *(Artocarpus altilis)*, squash *(Cucurbita maxima)*, eggplant *(Solanum melongena)*, chillies *(Capsicum annuum* and *C. frutescens)* and okra *(Hibiscus esculentus)*. *(Summary by Tropical Abstracts)* H00 J00

1012-2026 PARPIA, H.A.B. and SUBRAHMANYAN, V. **Some aspects of the utilization of food research in India.** Food Science 8(5):149-160. 1959. Engl., Sum. Engl.

Cassava. Food products. Mysore flour. Production. Human nutrition. Tapioca macaroni. Composition. Composite flours. Cassava programs. India.

The Institute has developed a number of processes which are being utilized commercially. The development of tapioca macaroni, nutro flour, the Mysore flour, the Indian multipurpose food, grain storage techniques, an improved method for parboiling rice, and infant foods made from surplus buffalo milk in certain regions are some of the most important processes which can make valuable contributions towards solving the food problem of this country. A concerted effort has been made to develop these processes and to make the products acceptable to the people in the rural and urban areas of the country. All aspects of food including production, distribution and consumption require technological assistance, which the Institute is endeavoring to provide through its extension services and development programs. *(Author's summary)* H00 J00

1013-0773 PATIÑO, V. M. **Plantas alimenticias,** *Manihot esculenta* **Crantz.** *(Food crops: Manihot esculenta Crantz). In*________. Plantas cultivadas y animales domésticos en América Equinoccial. Cali, Colombia, Imprenta Departamental, 1964. v. 2., pp.43-57. Span.

Cassava. ***Manihot esculenta.*** **History. Human nutrition. Uses. Panama. Colombia. Peru. Central America.**

A history is given of cassava in equinoctial America, which comprises the linguistic group anthropologists call macro-Chibcha and other cultures, such as Mexican and Central American. The study has been organized according to geographical groups: Panama, Colombia, the Caribbean, the Amazonas, Peru and Central America. *(Summary by J.L.S.)* H00

1014-2313 RAYMOND, W. D., JOJO, and NICODEMUS, Z. **The nutritive value of some Tanganyika foods. II. Cassava.** East African Agricultural Journal 6:154-159. 1941. Engl., Sum. Engl., 12 refs.

Cassava. Composition. Ascorbic acid. Mineral content. Cooking. Sweet-potatoes. Leaves. Nutritive value. Human nutrition. Cyanogenic glycosides. Vitamin content. Kenya.

In its fresh state, the cassava root is a source of arcorbic acid comparable to that of the sweet potato. Its cyanogenetic glycoside content varies according to variety and cultivation, but most Tanganyika varieties do not contain much. The HCN is destroyed by roasting or boiling. The protein and mineral content of the root is low, and it contains a negligible amount of digestible fat. The leaf also contains cyanogenetic glycosides, but these are destroyed by African methods of cooking. It is one of the richest sources of vitamin C, while it also contains appreciable amounts of carotene, losing little of either of these substances upon cooking. It is also rich in calcium but contains oxalic acid. The inclusion of both the fresh root and the leaf makes a most valuable addition to African diets, and every encouragement should be given to the use of cassava as a supplement to the main staple. The dried ground root is not valuable as a staple but no doubt has its place as a famine food. Extracting' and vacuum concentrating the juice from cooked leaves yields a storable product containing more than 2,000 mg of ascorbic acid| 100g. The cooked leaf may also be preserved by home canning methods. *(Author's summary)* H01

1015-2346 MARAVALHAS, N. **O panorama alimentar da Amazonia.** *(The nutritional status in Amazonas). In* ________. Cinco estudos sobre a farinha de mandioca. Brasil. Instituto Nacional de Pesquisas da Amazonia. Publicação no. 6. 1964. pp.23-34. Port.

Cassava. Human nutrition. Diets. Malnutrition. Deficiencies. Soybeans. Economics. Brazil.

The deficiencies of the diet in the Amazonas region result from the fact that cassava meal is the main ingredient. Local cultivation of soybeans and incorporation of soybean products into the diet is proposed to improve the situation. *(Summary by Tropical Abstracts)* H00

1016-0248 SUBRAHMANYAN, V. and SWAMINATHAN, M. **Utilization of tapioca flour and low-fat groundnut flour in meeting the food shortage.** Food Science 7(10):287-292. 1958. Engl., 14 Refs.

Cassava. Cassava flour. Groundnut flour. Oilseed flours. Flours. Feed mixtures. Composition. Cereals. Feeds and feeding. Diets. Human nutrition. Tapioca macaroni. Composite flours. Processed products. Wheat flour. Nutritive value. Substitutes. India.

Blends of a tuber flour and low-fat oilseed flours can be used with advantage as partial substitutes for cereals. Successful efforts to meet the cereal shortage by increasing the production and consumption of root crops have already been made in Japan, China, Indonesia and Ceylon. This line of approach has great possibilities for the future since the production of cereals in several Asian countries has not been able to cope with the increasing demands of the growing population. *(Summary by Tropical Abstracts)* H00

1017-0633 UFER, M. **Manihot and Dolichos.** Tropical Root and Tuber Crops Newsletter no. 4:45-50. 1971. Engl., Sum. Engl., 6 Refs.

Cassava. Dolichos. Human nutrition. Productivity. Composition. Protein content. Fat content. Ca. Iron. Mineral content. Diets. Brazil. Africa.

The nutritional consequences of increasing cassava cultivation in Africa and South America are discussed. The unbalanced cassava diet can be enriched by the introduction of Dolichos lablab (hyacinth bean), a legume that is better adapted to cassava-growing regions and that yields much more than the traditionally cultivated pulses. Its foliage can also be eaten by animals. *(Summary by T.M.)* H00.

T-1311

1018-0508 ALBUQUERQUE, M. De. **Estado atual da mandioca na Amazonia.** *(The present state of cassava in Amazonas).* Tropical Root and Tuber Crops Newsletter no. 5:23-27. 1972. Port.

Cassava. Farinha. Tubers. Protein deficiencies. ***Manihot esculenta.*** **Human nutrition. Cultivation systems. Soil impoverishment. Brazil.**

In Brazil, there are various problems related to cassava *(Manihot esculenta)* production that require immediate solution. The problems discussed are the low protein content, geographical localization, exploration methods, management and processing. *(Summary by Tropical Abstracts)* H00 D00

1019-1942 BANGHAM, W. N. **La yuca reemplaza la alfalfa.** *(Cassava replaces alfalfa).* Hacienda 45(8):31-33. 1950. Span., Illus.

Cassava. Cassava leaves (vegetable). Nutritive value. Processing. Drying. Composition. Protein content. Industrial machinery. Cassava meal. Animal nutrition. Human nutrition. Costa Rica.

This article describes various uses of cassava in relation to the preparation of feedstuffs for livestock and poultry; it is a valuable element in these feeds because it contains 82% carbohydrates. Cattle ate leaves from the tender cassava stalks without harmful effects; therefore, leaves can possibly be used as a good by-product. The flour extracted from cassava leaves was analyzed, and its carotene and protein contents were superior to those of alfalfa leaves. The protein content of flour extracted from debyfrated, mature, whole plants was 15.7%, equivalent to that of alfalfa. The fiber content was lower. Six pounds of green leaves were required to produce 1 lb of leaf flour; it should be remembered that leaves from cassava grown in rich soil contain much more vitamin A and protein. *(Summary by L.C. Trans. by T.M.)* H00

1020-3803 MUKHERJEE, S. **Tapioca as a solution of the food problem.** Science and Culture 13(3):118-119. 1947. Engl.

Cassava. Productivity. Cassava programs. Human nutrition. India.

Cassava is a possible solution of the food problem in Bengala. There are only two varieties: bitter and sweet. The roots of the former are rich in starch (30%) and contain a glucoside (phaseolunatin), which upon hydrolysis produces HCN; therefore, roots are unsuitable for human consumption. These roots are mainly used for producing starch. Sweet cassava roots contain about 20% starch, and glucoside is found in the peel only. Cassava has become an important staple in native diets in the coastal regions of southern India, Malaya, eastern India and tropical South America. A comparison between the yield of cassava and other cereals should be made on the basis of starch content. Domestic and industrial uses of cassava starch are also described. *(Summary by L.C. Trans. by T.M.)* H00.

1021-0421 PEREIRA C., O. **La yuca** *(Cassava).* Agrotecnia de Cuba 4(2):22-42. 1966. Span.

Cassava. Composition. Cassava meal. Fat content. N. Protein content. Fibre content. Ash content. Productivity. Stems. Drying. Storage. Processing. Economics. Roots. Leaves. Dry matter. Feeds and feeding. Tubers. Costs. Production. Animal nutrition. Cuba.

Results are given of work carried out on cassava (*Manihot esculenta* Crantz) to show its possibilities for animal and human consumption and as a source of starch. The following topics are covered: chemical analysis and uses of the aerial part of the plant as a feed; the dehydration and storage of cassava roots as a feed; feed rations using cassava flour made from leaves or roots; the production of starch for use in feeds; the consumption of vegetables (including cassava) in the feeding of cattle; and the composition of cassava bread compared to wheat bread. *(Summary by P.A.C.)* H00

See also 0010 0036 0245 0247 0262 0347 0553 0558 0975 1236 1672 1818 1827 1847 1849 1858 1911 H00

H01 Cassava Foods and Nutritive Value

1022-0169 TASKER, P. K. *et al.* **Supplementary value of high protein food based on groundnut protein isolate to a maize-tapioca diet.** Food Science 11(7):205-210. 1962. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Diets. Groundnut. Deficiencies. Feeds and feeding. Proteins. Maize. Animal physiology. Animal nutrition. Nutritive value. Protein deficiencies. Composition. Supp'ements.

(1) A diet based on a 1:2 blend of maize and cassava, containing only 5% protein, did not promote any growth in albino rats. Supplementation of the diet with a high-protein food based on a blend of groundnut protein isolate (85 parts) and Bengalgram flour (15 parts) fortified with vitamins and minerals so as to provide 15% extra protein in the diet made up for the deficiencies in the diet and promoted a highly significant ($P < 0.001$) increase in the growth of rats. (2) The serum of rats receiving the maize-cassava diet had a lower albumin content and a higher gamma globulin content than those of rats receiving the protein foods. (3) The mean fat content of the livers of rats fed on the maize-cassava diet was significantly higher ($P < 0.001$) and protein content significantly lower ($P < 0.001$) than that of rats receiving the protein foods. The mean xanthine oxidase activities of the livers of rats receiving the protein supplements were significantly higher ($P < 0.001$) than those of rats fed on the control maize-cassava diet. (4) The mean protein content of the carcass of rats fed on the maize-cassava diet was significantly lower than that of rats receiving the protein supplements. (5) The livers of rats fed on the maize-tapioca diet showed a moderate degree of parenchymal damage of the protein-deficiency type and severe periportal fatty infiltration. On the other hand, the livers of rats receiving the supplements of different protein foods were quite normal, indicating that a high-protein food (based on groundnut protein and Indian multipurpose food when providing 15% extra proteins) was as effective as powdered skim milk in correcting the protein deficiency in the diets and in preventing liver damage *(Author's summary)* H01 H03

1023-0754 DOVLO F. F. **Cassava as food in Ghana.** Seera, Ghana, Food Research Institute, 1972. 12p. Engl., 3 Refs.

Paper presented at Cassava and Cassava Products Conference, Segon, Ghana, 1972.

Cassava. Human nutrition. Processed products. Analysis. Processing. Bakery products. Fermented products. Agbeli kaklo. Dried tubers. Cassava flour. Cassava starch. Tapiocas. Industrial microbiology. Ghana.

Cassava is eaten in varying forms in the coastal grassland and forest areas of the country. It is eaten mostly in the fresh form and to some extent in the form of gari. A description of the various forms in which cassava and cassava products are used in the Ghanaian diet is given. Methods for the preparation of these foodstuffs and the extraction of starch and tapioca are discussed in detail. Nutrients in raw cassava are compared to other starchy crops, and nutrients in selected cassava products are compared to other products. Traditional fermentation methods employed in the manufacture of cassava products (e.g., kokonte) provide the basis for the use of microorganisms in the enrichment of cassava. Attempts are being made to isolate the right type of organism from moldy cassava for enrichment purposes. *(Summary by J.L.S.)* H01 I02.

1024-0197 NETO, J. S. A. **Food staples as vehicles for protein concentrates.** Nutrition Reports International 9(1):85-90. 1974. Engl., Sum. Engl., 11 Refs.

Cassava. Cassava meal. Processed products. Food enrichment. Proteins. Composition. Water content. Fibre content. Fat content. Ash content. Amino acids. Palatability.

The enrichment of corn and cassava meals was studied by using dried skimmed milk, soy protein isolate, food yeast and DL-methionine. The crude protein content of corn meal increased from 8 to 21%, and cassava meal reached a crude protein content of 12.2%. Enriched food staples have not shown any loss of palatability. *(Author's summary).* H01

1025-2317 SUBRAHMANYAN, V. *et al.* **Investigations on grain substitutes. I. Production of round grain from blends of tapioca and groundnut.** Bulletin of the Mysore Central Food Technological Research Institute 3:180-183. 1954. Engl., 2 Refs., Illus.

Cassava. Substitutes. Processing. Economics. Palatability. Development. Uses. Cassava products. Composite flours. Nutritive value. Cassava flour. Groundnut flour. Gelatinization. Drying. India.

This paper gives a description of the industrial process of preparing synthetic grains. Economic aspects about production of the grains and their potentiality as rice substitutes are discussed. Data about the cooking properties and palatability of the products are given as well. *(Summary by H.J.S.)* H01 I02

1026-2351 SPICKETT, R.G.W., SQUIRES, J.A. and WARD, J.B. **Gari from Nigeria.** Colonial Plant and Animal Products 5(3):230-238. 1955. Engl., Illus.

Cassava. Gari. Nutritive value. Proteins. Fat content. Starch content. Mechanization. Production. Composition. Food products. Nigeria.

Gari, prepared from the roots of *Manihot utilissima* is a basic foodstuff in West Africa. However, it has little nutritional value because of its low protein and fat content, but does contain about a quarter of its starch in a gelatinized form. Mechanization of gari manufacture will not present any major difficulties, but the product will not have a nutritional value superior to that now produced by the household method. *(Summary by Tropical Abstracts)* H01 I02

1027-2364 LUYKEN, R., GROOT, A. P.DE and STRATUM, P.G.C. VAN. **Nutritional value of foods from New Guinea. II. Net protein utilization, digestibility and biological value of sweet potatoes, sweet potato leaves and cassava leaves from New Guinea.** Utrecht, Central institute for Nutrition and Food Research, 1961. 18p. Engl., 4 Refs.

Cassava. Amino acids. Leaves. Nutritive value. Methionine. Proteins. Tubers. Rats. Digestibility. Animal nutrition. Diets. Sweet potatoes. Papua and New Guinea.

Feeding experiments using rats showed that the tubers and leaves of the sweet potato and the leaves of cassava have a low nutritional value. The low net protein utilization could be improved by the addition of methionine. Since the material used was insufficient or not altogether representative, the absolute values obtained may be questionable. *(Summary by Tropical Abstracts)* H01

1028-0194 COMHAIRE-SYLVAIN, S. and COMHAIRE-SYLVAIN, J. **La alimentación en la región de Kenscoff, Haití.** *(Nutritional aspects in the region of Kenscoff, Haiti).* América Indígena 12(3):177-203. 1952. Span., Sum. Engl.

Cassava. Human nutrition. Cassava products. Uses. Haiti. Casave. Processing.

This is an anthropological study of the food habits of the inhabitants of the Kenscoff region, located about 20 km SE of the Haitian capital, Port-au-Prince. In addition to a description of the physical environment and the manner in which the people carry out functions such as harvesting, hunting and fishing, the major part of this work is devoted to the enumeration and preparation of various foods. Cassava is used in the preparation of "cassave," a thin, round, grayish white "cracker" that becomes very hard; it can be stored for a long time. In this form it can be eaten instead of bread, but more often it is soaked in water to make it soft. Two other foods prepared from cassava are "couche-couche" or cassava grits and "panisik," similar to a tamale. *(Summary by T.M.)* H01

1029-2358 REYNVAAN, J. **Cassave producten.** *(Cassava products).* Landbouw Nieuws 1954:4-7. July 1954. Dutch., Illus.

Cassava. Cassava beer. Cassava bread. HCN content. Human nutrition. Surinam. Detoxification.

Aspects regarding the conservation of cassava and its by-products derived from the whole, peeled tuber or its starch are studied. A distinction is made between the sweet and bitter varieties. (As a rule, products of Javanese origin are made from sweet cassava, the native Indian population preferring to use the bitter variety. Bitter cassava products, cassava bread, "kwak" or "koek," "kokeri," "kasiripo" and two alcoholic drinks, "kasiri" and "kapana" are described. Methods of removing HCN in the preparation of cassava bread are also discussed. *(Summary by T.M.)* H01

1030-2223 ARNAL-PEYROT, F. and ADRIAN, J. **Role nutritionnel de certaines feuilles alimentaires tropicales (manioc, igname, baobab et fromager).** *(Nutritional role of some edible tropical leaves: cassava, yam, baobab and ceiba).* Annales de la Nutrition et de l'Alimentation 24(6):137-153. 1970. Fr., 38 Refs.

Cassava. Cassava leaves (vegetable). Nutritive value. Human nutrition. Amino acids. Analysis. Protein content. Human physiology. Digestibility. Sorghums. Yams. Diets. Groundnut. Animal physiology. Lysine. Methionine. Tryptophane. Dietary value. Mozambique. Senegal. Malagasy Republic.

Research was designed to combine local resources with tropical leaves currently used as food in an attempt to provide the nutritional requirements of the people's diet. Leaves studied were cassava from Mozambique and Madagascar; yam (**Dioscorea**) from Mozambique; and baobab *(Adansonia digitata)* and ceiba *(Ceiba pentandra)* from Senegal. Basal diets for weanling rats were made from cassava flour, groundnut oil meal and sucrose, minerals and vitamins; or whole sorghum replaced the first two ingredients. With the sorghum diet, cassava and ceiba leaves improved weight gain, even though they are poor in lysine. *(Summary by J.L.S.)* H01

1031-2324 LIRA, M.B. and FERNANDES, E. **Bromatologia das farinhas de mandioca produzidas no Amazonas.** *(Bromatology of cassava flours produced in the state of Amazonas).* Brasil. Instituto Nacional de Pesquisas da Amazonia. Publicação no. 7. 1964. pp. 3-9. Port., Sum. Port.,Engl., 5 Refs.

Reprinted from Arquivos Brasileiros de Nutrição 18(1-2):87-94. 1962.

Cassava. human nutrition. Cassava flour. Protein deficiencies. Consumption. Marketing. Analysis. Mineral content. Economics. Composition. Vegetable crops. Brazil.

Cassava flour is an important staple in the diet of the "caboclo" tribes in this region. Although its protein content is low, cassava flour has a high starch content, which highly favors proper tryptic digestion, since diets are already high in protein obtained from fish and game. The two types of cassava flour produced ("farinha d'agua," which is of better quality and "farinha seca") vary in demand and consumption, but the former is preferred. These two types may be distinguished according to their moisture, acid, fixed mineral residue and starch content. A more accurate method is the measurement of the raw fiber content: farinha seca, above 2.0% and farinha d'agua, less than 2.0%. It should be noted that under chemical analysis it was found that both types contain a considerable amount of Ca (up to 100 mg| 100 g), P (up to 71 mg| 100 g) and Fe (up to 6.5 mg| 100 g). *(Summary by T.M.)* H01

1032-0892 SUBRAHMANYAN, V. and SWAMINATHAN, M. **Adverse weather conditions and seasonal food shortages; a practical approach to the problem.** Food Science 6(7):159-162. 1957. Engl.

Cassava. Human nutrition. Cassava programs. Development. India.

Because of its high tuber yields and its special agronomic characteristics, cassava is presented as the very crop which could help in periods of foodstuff shortage in India. Policies to increase cassava production are discussed. *(Summary by H.J.S.)* H01 J00

1033-0728 BRASIL. CENTRO DE TECNOLOGIA AGRICOLA E ALIMENTAR. **Enriquecimiento nutricional da farinha de mandioca com proteina isolada de soja.** *(Nutritional enrichment of cassava flour with isolated soybean protein).* Rio de Janeiro, Brazil, 1972. 15p. Port., 16 Refs.

Cassava. Human nutrition. Supplements. Cassava flour. Soybeans. Composition. Methionine. Food enrichment. Processed products. Amino acids. Proteins. Developmental research. Brazil.

The enrichment of cassava food products could improve the amount of protein intake of poor people in both rural and urban areas. Discussions are presented on the possibilities of enriching cassava flour, on international programs for enrichment of foodstuffs, and on characteristics of isolated soybean protein. A description is made of the process to enrich cassava flour with an isolated soybean protein, called proteinmax in Brazil. The main disadvantage of the enriched product is its low methionine content. Research will continue to work on this problem. *(Summary by H.J.S.)* H01

1034-0955 SUR, G. *et al.* **Partial replacement of cereals by Mysore flour.** Bulletin. Central Food Technological Research Institute 3(4):85-87. 1954. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Cereals. Rice. Wheat. Milk. Vitamins. Ca. P. Human nutrition. Proteins. Composite flours. Flours. Mysore flour. Composition. Food energy. Water content. Fibre content. Vitamin content. Mineral content. Iron. Nutritive value. India.

An institution feeding experiment using 48 girls (age 5-11 years) was carried out for a period of 6 months in Mysore to evaluate the effect of replacing 50% of the cereals in their diet by an equal quantity of Mysore flour. Data ragarding weight, height, nutritional status, hemoglobin level and R.B.C. count in the control and experimental groups were obtained at the beginning and end of the experiment. The results showed that there was no significant difference between the 2 groups except for hemoglobin,which showed a significant increase ($P<0.05$) in favor of the Mysore flour diet. It is concluded that 50% of the cereals in poor, vegetarian diets could be replaced by an equal quantity of Mysore flour without adversely affecting the general health and nutritional status of children. *(Author's summary)* H01

1035-0335 OKE, O. L. **Chemical studies on some Nigerian foodstuffs-"gari."** Nature 212(5066):1055-1056. 1966. Engl., 7 Refs.

Cassava. Gari. Human nutrition. Composition. Food products. Food energy. Dietary value. Mineral content. HCN content. Food enrichment. Detoxification. Detoxification processes. Nigeria.

Cassava *(Manihot utilissima)* can either be boiled and eaten as a vegetable or grated, fermented and fried to produce "gari," the staple foodstuff of Nigeria. Gari and cassava are compared in terms of results of chemical analyses. In the production of gari, about 20-40% of the protein is lost. A decrease of 10-20% in the carbohydrate content also occurs, and gari is about 18% less calorific than cassava. Other important differences in ash content, calcium:phosphorus ration, and iron content are also discussed. The oxalate content in gari is decreased by about 20%. The total amount of oxalate in cassava and gari is, however, too small to be toxic. The only disadvantage in this respect is that if oxalate content exceeds that of calcium, the excess may combine with calcium from other sources, thus making the latter unavailable in the diet. The chief advantage of gari over raw cassava is the decreased HCN content. The addition of glucose to unprocessed cassava roots causes the HCN to disappear. It is suggested that glucose be added when foods are prepared from cassava. The Federal Institute of Industrial Research has a plan for mechanizing gari production, adding about 5% groundnut or soybeans to raise the protein content. In this manner, gari would serve not only as the main source of starch and calories but also as an effective protein supplement. *(Summary by P.A.C.)* H01 H04

1036-0889 **LEGUMES EXOTIQUES.** *(Exotic vegetables).* *In* Randoin, L. *et al.* Calorific value and chemical composition of tapioca. Paris, Jacques Langre, 1961. pp.76-77. Fr.

Cassava. Yams. Nutritive value. Cocoyams. Food energy. Composition. Mineral content. Vitamin content. Chickwangue. Leaves. Tapiocas.

A table is given, dealing with the food constituents rendered by some vegetables and root crops including cassava, yams and **Xanthosoma.** Data refer to caloric value, cellulose, minerals and vitamins. *(Summary by H.J.S.)* H01

1037-0885 SUBRAHMANYAN, V. *et al.* **Investigations on grain substitutes. IV. The biological value of the proteins of round grains from blends of tapioca and groundnut flours.** Bulletin. Central Food Technological Research Institute (India) 3(7):190-193. 1954. Engl., Sum. Engl., 13 Refs.

Cassava. Substitutes. Rice. Wheat. Cereals. Proteins. Animal physiology. Feed Constituents. Cakes. Laboratory experiments. N. Rats. Digestibility. Laboratory animals. Groundnut flours. Cassava flour. Composite flours. India.

The biological value of the proteins of round grains prepared from cassava flour (80 %) and groundnut cake flour (20 %) was determined by 4 different methods: (a) The nitrogen balance method, (b) The rat growth method, (c) The liver-protein regeneration method and (d) The hemopoiesis method. Nitrogen balance experiments showed that at a 5 % level of intake, the biological value of the synthetic grain proteins was inferior to that of rice proteins, while at a 10 % level of intake, the biological values of the synthetic grain and wheat proteins were nearly the same. Rat growth experiments confirmed the above findings and showed that the protein efficiency ratios of synthetic grain and wheat (both at 7.5 and 10 % levels of protein intake) were nearly equal. Synthetic grain and wheat proteins were found to be almost equally effective for the regeneration of liver-proteins in fasted rats. The biological value of synthetic grain protein at 5 % level of intake for hemopoiesis was slightly less than that of rice proteins, while at a 10 % level of intake, synthetic grain proteins were nearly as efficient as wheat proteins in promoting hemopoiesis in anemic rats. *(Author's summary)* H01

1038-0884 SUBRAHMANYAN, V. *et al.* **Investigations on grain substitutes. III. The nutritive value of round grains from blends of tapioca and groundnut flours.** Bulletin. Central Food Technological Research Institute. (India) 2(7):187-189. 1954. Engl., Sum. Engl., 5 Refs.

Cassava. Substitutes. Cereals. Rice. Rats. Diets. Human nutrition. Nutritive value. Sorghums. Composite flours. Flours. Composition. Cassava flour. Laboratory animals. Proteins. Laboratory experiments. Groundnut flours. India.

The nutritive value of round grains prepared from 4 different blends of cassava and groundnut cake flours was determined by the rat growth method. The nutritive value of a poor, vegetarian diet based on grain A (90 % cassava flour and 10 % groundnut flour) was found to be of the same order as that of the rice diet. The nutritive value of the diet based on grain B(87.5 % cassava flour and 12.5 % groundnut flour) was slightly higher than that of the rice diet and almost equal to that of the poor *jowar* diet. The nutritive values of diets based on grain C (85 % cassava and groundnut flour 15 %) and grain D (80 % cassava flour and 20 % groundnut flour) were significantly higher than that of rice and *jowar* diets and were of the same order as that of wheat and *ragi* diets. When 25 % of the cereals or millets in a poor vegetarian diet was replaced by grain A, there was no deterioration in the overall growth-promoting value of the diets. Grains C and D were found to possess a definite supplementary value to diets based on rice, wheat, *jowar* and *ragi*. *(Author's summary)* H01

1039-0958 MARAVALHAS, N. **Estudos sôbre a farinha de mandioca.** *(Studies on cassava flour).* Revista de Quimica Industrial 30(153):13-18. 1961. Port., Sum. Port., 1 Ref.

Cassava. Human nutrition. Palatability. Cassava flour. Water content. Composition. Fibre content. Brazil.

A revision was made of an analytical study on the composition of cassava flours in the Amazon region. "Dry" and "moist" flours were compared because of popular preference for the latter. No chemical difference was found, except for a slightly higher fiber content in the dry type. The preference for the moist type is due to its slightly aromatic taste. *(Author's summary)* H01

1040-3793 NARAYANA RAO, D. and SREERAMAMURTHY, V. V. **The supplementary effect of pulses and rice on tapioca diet.** Indian Journal of Medical Research 39(3):329-336. 1951. Engl., Sum. Engl., 15 Refs.

Cassava. Tubers. Analysis. Composition. Water content. Ash content. Mineral content. N. Amino acids. Arginine. Histidine. Tyrosine. Cystine. Methionine. Diets. Laboratory animals. Nutritive value. Food enrichment. Proteins. Supplements. India.

Experiments were carried out to purify tapioca protein by electrodialysis. It was possible to obtain a sample whose ash content was 1.03%. The nitrogen content of the protein was conspicuously low, (10.5%). An analysis of tapioca protein showed that it contained no methionine. The histidine content was 3.5% (calculated to 16 g of N). *(Author's summary)* H01

1041-0964 ALBERTO, J. **A mandioca. III. Seus derivados, preparos e usos.** *(Cassava. III. Its derivatives, preparation and uses).* Gaceta Agrícola de Angola 3(3):128-131. (Cont.). 1958. Port., Illus.

Cassava. Cassava products. Cassava meal. Tapiocas. Human nutrition. Animal nutrition. Uses. Processed products. Processing. Angola.

In Angola, raw cassava is used to prepare various food products consumed by both natives and Europeans. Methods of preparing the following products are described: fuba, a fermented staple food; farinha de crueira, an unfermented variant of fuba; farinha de pau, a coarse, toasted meal; tapioca; funge or lúku, a cake made from preboiled flour; matsá, maióeu or mucamba ocuó, roasted tubers; mavulo, malambo or mucamba clamba, boiled fresh roots; kuanga, a cake mixed with peanuts, sweet potatoes, pepper and salt; supó or muamba; banvy or uála, a fermented beverage; animal feeds and alcohol. *(Summary by J.L.S.)* H01 I02

1042-0959 SUBRAHMANYAN, V. *et al.* **Effect of storage on the chemical composition and nutritive value of groundnut flour, tapioca flour and their blends.** Bulletin. Central Food Technological Research Institute. 4(2):31-33. 1955. Engl., Sum. Engl., 14 Refs.

Cassava. Storage. Proteins. Temperature. Vitamins. Groundnut flour. Cassava flour. Nutritive value. Human nutrition. Vitamin content. Composition. Composite flours. Organoleptic examination. India.

Cassava flour, expeller-pressed groundnut cake flour (with and without cuticle) and a blend of cassava and groundnut flours (ratio of 4:1) were stored in gunny sacks at room temperature (72º-91ºF) and 98.6ºF for a period of 5 months. All the samples were free from insect infestation. The changes brought about in the flours during storage have been studied. In all the samples, a slight loss of thiamine (from 15-25%) was observed. An increase in the free fatty acid and peroxide value of the fat present in the groundnut flour samples and their blends with cassava flour was noticed. The groundnut flours samples had developed slight rancidity, but the blends of cassava and groundnut flours remained in good condition and was organoleptically acceptable. No appreciable difference was noticed between the samples stored at room temperature and those at 37ºC. No appreciable lowering in the overall nutritive value of the flour blends and in the biological value of the proteins of groundnut flour as judged by the rat growth method was observed as a result of storage for 5 months. *(Author's summary)* H01 I02 C02

1043-1857 ADRIANO, F. T., RAMOS, H. T. and YNALVEZ, L. A. **The proximate chemical analysis of Philippine foods and feedingstuffs. III.** Philippine Agriculturist 20(8):530-534. 1932. Engl., 6 Refs.

Cassava. Cultivars. Composition. Ash content. Protein content. Fat content. Fibre content. Starch content. Carbohydrate content. Food energy. Philippines.

The data in this paper cover the analysis of 50 samples of root crops and 45 samples of vegetables. The proximate chemical composition of 7 cassava varieties is given. *(Summary by J.L.S.)* H01

1044-3431 **BAKING BREAD from beans, nuts and cassava.** New Scientist 42:185. 1969. Engl.

Cassava. Human nutrition. Cassava bread. Cassava flour. Protein content. Flours. Bakery products. Soybean flour. Netherlands.

A bread was prepared (FAO, Institute of Cereals, Flour and Bread at Wageningen), using starch isolated from cassava, cassava flour and soybean flour. The protein content is superior to that of wheat flour bread and is more digestible. Even when peanut flour is substituted for soybean flour, the protein content is still equal to that of wheat flour bread. Rats fed the new bread gained more rapidly than rats fed the wheat bread. *(Summary by H.J.S.)* H01

1045-2161 MOSHA, A. C. **Cassava production, utilization and potential fortification in Tanzania.** Dar es Salaam, Tanzania, 1972. 11p. Engl., Sum. Engl., 20 Refs.

Paper presented at Mandioca Fortification Conference, Rio de Janeiro, 1972.

Cassava. Production. Productivity. Cassava products. Cassava flour. Bitter cassava. Nutritive value. Cassava leaves (vegetable). Cassava tubers (vegetable). Fresh products. Composition. Processed products. Food enrichment. Cassava programs. Development. Proteins. Tanzania.

The paper briefly reviews the nutritional status of cassava, with particular reference to protein calorie deficiency. Production figures for cassava and main methods of preparation as a food are given. The use of the leaf as a food is described, and local potential fortificants and preliminary trials are outlined. *(Author's summary)* H01 I02

1046-1581 JOACHIM, A. W. R. and PANDITTESEKERE, D. G. **The analysis of Ceylon foodstuffs. II. Some important pulses, oilseeds and roots.** Tropical Agriculturist 94(1):7-10. 1938. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava flour. Processed products. Tubers. Composition. Water content. Protein content. Carbohydrate content. Fibre content. Mineral content. Food energy. Sri Lanka.

In an analysis of 30 locally cultivated cereals, pulses, oilseeds and roots, it was found that cassava, sweet potatoes, arrowroot and king yams were rich in charbohydrates but low in protein. Diets using these foods should be supplemented with protein foods. The dried flours are of high calorific value. *(Summary by T.M.)* H01

1047-1636 KIGER, J. **Emplois de farines de manioc dans les industries de la biscuiterie et de pâtes alimentaires.** *(Use of cassava flour in the bakery industry).* *In* Congrès du Manioc et de Plantes Féculentes Tropicales, Marseille, 1949. Marseille, Institut Colonial, 1949. pp. 79-81. Fr.

Cassava. Cassava flour. Processed products. Breads. Biscuits. Composition. Mineral content. Water content. Ash content. Fat content. Protein content. Carbohydrate content. Cellulose. HCN content.

The cassava flour analyzed had the following composition (%): moisture 10.4; ash 1.74; fat 0.64; protein 1.75; cellulose 1.46; and digestible carbohydrates 84.01. *(Summary by Chemical Abstracts)* H01 I02

1048-3927 KURIEN, P.P. *et al.* **The effect of replacing wheat in a poor Indian diet by a blend of whole wheat flour, tapioca flour and low-fat groundnut flour (paushtic atta) on the metabolism of nitrogen, calcium and phosphorus in children.** Annals of Biochemistry and Experimental Medicine 21(1):13-16. 1961. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava flour. Composite flours. Human nutrition. Diets. Digestibility. Dietary value. Proteins. Analysis. Minerals. Metabolism. Human physiology. N. P. Ca. India.

The effects of replacing whole wheat flour which formed 50% of the cereals in a poor Indian diet by paushtic atta (a 75:17:8 blend of whole wheat, tapioca and groundnut flours) on the metabolism of nitrogen, calcium and phosphorus was studied in 8 pairs of boys, age 11-12. The mean daily N intake on the wheat and paushtic atta diets was 9.78 g and 9.97 g and the apparent digestibility coefficient of the proteins was 74.5 and 75.8%, respectively. All the children were in positive N balance. The daily retention of N on the wheat and paushtic atta diets was 1.61 g and 1.90 g. The mean daily intake of Ca on the wheat flour and paushtic atta diets was 694 mg and 702 mg. All the children were in positive Ca balance. The mean daily retention of Ca was 102 mg and 113 mg, respectively on the two diets. The mean daily intake of P on the wheat and paushtic atta diet was 1.41 g and 1.35 g while the mean retention of P was 395 mg and 404 mg, respectively. *(Author's summary)* H01

1049-1776 JOSEPH, K. *et al.* **The supplementary value of certain processed protein foods based on blends of groundnut, soybean, sesame, chickpea *(Cicer arietinum)* flour and skim milk powder to a maize-tapioca diet.** British Journal of Nutrition 16(1):49-57. 1962. Engl., Sum., Engl., 26 Refs.

Cassava. Composite flours. Protein deficiencies. Food enrichment. Supplements. Laboratory animals. Proteins. Amino acids. Nutritive value. Animal physiology. Diets. Human nutrition. Maize.

The supplementary value for a maize-tapioca diet for 4 processed protein foods was studied by growth experiments using albino rats. The foods were blends of 2 or more of the following: low-fat groundnut flour, soybean flour, sesame flour, chickpea flour and powdered skim-milk. They were fortified with vitamins A and D, thiamine and riboflavin and calcium phosphate. When incorporated in the diet at a 30% level (providing about 7-11% extra protein), the different protein foods were as effective as an equivalent amount of powdered skim milk in promoting weight gain of rats. No significant differences were observed in the mean protein content of the carcasses or livers of rats receiving the protein foods or powdered skim milk. The protein efficiency ratios of the proteins of the different blends (at a 10% level of protein intake) determined on groups of 8 male rats, ranged from 2.25 to 2.36 in a 4-week test and from 1.81 to 1.84 in an 8-week test, as compared to values of 2.98 and 2.19, respectively, for powdered skim milk. The livers of animals receiving the maize-cassava diet showed a moderate degree of parenchymal damage of the protein-deficiency type and severe periportal fatty infiltration. On the other hand, the livers of animals receiving the different protein foods of powdered skim milk were normal, indicating thereby that the different protein foods were as effective as powdered skim milk in correcting the protein deficiency in the diet and in preventing liver damage. *(Author's summary)* H01

1050-0977 OYENUGA, V.A. **Notes on the feedingstuffs analysed. A. Roots, tubers and green leaves,** *Manihot utilissima* **Pohl.** *In* ______. Nigeria's feedingstuffs: their composition and nutritive value. 2 ed. Ibadan, University Press, 1959. pp.15,24-27. Engl.

Cassava. Human nutrition. Animal nutrition. Yams. Taro. Starch crops. Composition. Analysis. Dry matter. Proteins. Cortex. Cassava tubers (vegetable). Cassava leaves (vegetable). Gari. HCN content. Nigeria.

A table is presented on chemical and nutritional characteristics of several starch crops including roots (peeled and unpeeled), peels and leaves of cassava, *Xanthosoma sagittifolium* and *Colocasia esculentum;* leaves of sugar cane; tubers (peeled and unpeeled) and young sweet potato; leaves of *Talinum triangulare* and *Telfairia occidentalis.* Data given in this table deal with average chemical composition and calculated digestible nutrients for human and animal nutrition. *(Summary by H.J.S.)* H01

1051-0956 SUBRAHAMAYAN, V. *et al.* **Utilization of tapioca flour and low fat groundnut flour admixed with wheat flour for the preparation of chappati and poori.** Food Science 7(1):4-6. 1958. Engl., Sum. Engl., 8 Refs. Illus.

Cassava. Groundnut flour. Wheat flour. Cassava flour. Human nutrition. Composition. Protein content. Water content. Fat content. Ash content. Fibre content. Carbohydrate content. Mineral content. Ca. P. Nutritive value. Composite flour. India.

Research was carried out on the preparation of chappati and poori from the following blends of whole wheat, cassava, and groundnut flours: (a) whole wheat flour, 75% + cassava flour, 25% (b) whole wheat flour, 70% + cassava flour, 25% + groundnut flour, 5% and (c) whole wheat flour, 85% + groundnut flour, 15%. Organoleptic evaluation revealed that the chappati and poori prepared from the above flour blends were equally acceptable as those prepared from wheat flour. It was concluded that a mixture of cassava flour and groundnut flour could be used to the extent of 25-30% admixed with wheat flour to meet the grains shortage. *(Author's summary)* H01

1052-3802 JOWETT, D. **Use of rank correlation methods to determine food preferences.** Experimental Agriculture 2(3):201-209. 1966. Engl., Sum. Engl., 9 Refs.

Cassava. Palatability. Dietary value. Statistical analysis. Human nutrition. Uganda.

Certain statistical techniques useful in collecting and interpreting ordinal data are described and their applicability in plant breeding explained. It is suggested that these statistical techniques may be particularly valuable to plant breeders in determining taste preferences. A series of experiments are described, investigating the taste preferences of the Iteso of Uganda, who show a strong preference for a mixture of cassava, sorghum and finger millet for food. They do not seem to prefer white sorghum grains to food nor colored grains for beer although such preferences have been recorded elsewhere. They dislike maize and *Pennisetum millet.* It is suggested that an experimental approach to quality in the breeding of tropical food crops is both desirable and possible, using rank correlation techniques. *(Author's summary)* H01

1053-0997 RICE, H. L. and PETTIFOR, A. H. **The Probyte: A new protein unit system.** Journal of Agricultural and Food Chemistry 20(3):509-518. 1972. Engl., Sum. Engl., 30 Refs.

Cassava. Analysis. Human nutrition. Proteins. Amino acids. Eggs. Food energy.

A fundamental unit for protein (a Probyte) is proposed and its use described. The unit is defined as one calorie composed of the 8 essential amino acids required by the adult human in the gram pattern of the protein of whole eggs. A second term (Probit) accounts for the essential amino acids left over as fractional Probytes. A mathematical procedure is given for deriving the Probyte content of foods and diets, permitting simple addition of the Probytes and Probits from all sources. The use of the Probyte in terms of human requirements is described, as are the corrections for biological value, corrections for losses due to processing, and methods for setting a single protein standard in crop genetics research and pricing of commodities. It is estimated that 48 Probytes|day is the recommended dietary allowance, approximately the same as recommended in grams of high-quality protein by the Food and Nutrition Board of the National Research Council. Because the Probyte has a calorie of essential amino acids as its only dimension, it is proposed for use in systems analysis, pricing policies, nutrition economics, and design of least-cost diets. Its use in systems models is illustrated. *(Author's summary)* H01 C03

1054-2340 OBIOHA, F. C. **Utilization of cassava as a human food.** *In* Hendershott, C. H. *et al.* A literature review and research recommendations on cassava. Athens, Ga., University of Georgia, 1972. pp.130-156. Engl., 45 Refs.

Cassava. Productivity. HCN content. Food products. Cassava starch. Food enrichment. Industrial microbiology. Fermentation. ***Geotrichum candidum.*** **Corynebacterium. Water content. N. Fibre content.**

Protein content. Ash content. Mineral content. Tapioca macaroni. Carbohydrate content. Vitamin content. Human nutrition. Food products. Nutritive value. Development. Composition. Tubers. Leaves. HCN. Detoxification. Toxicity. Tapiocas. Gaplek. Cassava bread. Cassareep. Cassava products. Energy productivity.

A review is made of the utilization of cassava for human consumption. Data given refer to caloric production and consumption, chemical composition and HCN content of cassava tubers and leaves, nutritive value of roots, and characteristics of edible products made from cassava. Research recommendations are: (1) A rapid detoxification of HCN in cassava would shorten the process time. (2) Some information is needed on the biological value and nutritional ratio where cassava is the predominant or subsidiary diet. (3) Check the strong possibility that residual poison can accumulate in the body through continued consumption of cassava products. (4) Develop new menus in which cassava products can exist in adequate proportions to ensure balanced rations. (5) Study the possible use of cassava as a substrate in fermentation processes to produce microbial protein. *(Summary by H.J.S.)* H01 H04 I03

1055-2180 BORASIO, L. **La farina di manioca nella panificazione.** *(Cassava flour in bread making).* Giornale di Risicoltura 28(7):132-134. 1938. Ital.

Cassava. Human nutrition. Processed products. Uses. Breads. Composition. Cassava flour. Flours. Food products. Bakery products.

Cassava flour proved to be adequate for bread making. Wheat flour was substituted by cassava flour in progressive mixtures of 5% to 30%. *(Summary by H.J.S.)* H01

1056-0396 OKE, O. L. **Cassava as food in Nigeria.** World Review of Nutrition and Dietetics. 9:227-250. 1968. Engl., 93 Refs. Illus.

Cassava. Production. Harvesting. Roots. *Manihot esculenta.* **Cultivars. Human nutrition. Cultivation. Composition. HCN content. Productivity. Nutritive value. Cassava products. Deterioration. Storage. Water content. Ash content. Starch content. Carbohydrate content. Fat content. Protein content. Fibre content. Corynebacterium.** *Geotrichum candidum.* **Industrial microbiology. Gari. Fermented products. Fermentation. FooFoo. KpoKpo gari. Food products. Mineral content. N. P. K. Ca. Magnesium. Dry matter. Toxicity. Food enrichment. Nigeria.**

Results are given of work carried out on cassava *(Manihot utilissima* and *Manihot palmata)* in Nigeria. Included are descriptions of local varieties; review of planting, cultivation and harvesting practices; a chemical analysis of cassava roots and cassava products; an analysis of the nutritive value of gari and foofoo, two local foods prepared from cassava; and an analysis of the HCN content in local varieties. *(Summary by P.A.C.)* H01 I03.

1057-3794 REDDY, S. K. *et al.* **Effects on the general health and nutritional status of children of partial replacement of rice in a poor vegetation diet by tapioca flour.** British Journal of Nutrition 8(1):17-21. 1954. Engl., Sum. Engl.

Cassava. Cassava flour. Processed products. Nutritive value. Human nutrition. Human health. Diets. India.

A 6-month feeding experiment was carried out in a girls' orphanage in Mysore to evaluate the effect of replacing 25% of the rice in a poor vegetarian rice diet by cassava flour on the growth and nutritional status of children between 4 and 12 years of age. Data on the weight, height, hip width, nutritional status, hemoglobin, red blood cell count and serum proteins were taken at the beginning and at the end of the experiment for those receiving the rice-tapioca diet and for a control group receiving the rice diet. The results showed that there was no significant difference between the two groups except for the hemoglobin content, which decreased in both groups, however, the decrease was significantly less ($P < 0.05$) in the experimental group than in the control group. *(Author's summary)* H01

1058-2181 PEYROT, F. **Rôle nutritional de certaines feuilles alimentaires tropicales (manioc, igname, baobab et fromager).** *(Nutritional role of some edible tropical leaves: cassava, yam, baobab and kapok tree).* Thésis. Paris, Université, Faculté des Sciences, 1969. 61p. Fr., Sum. Fr., 73 Refs., Illus.

Cassava. Animal nutrition. Leaves. Yams. Digestibility. Amino acids. Methionine. Dietary value. Protein content. Composition.

A study was carried out on the nutritive value of leaves of cassava, yam *(Dioscorea alata),* baobab *(Adansonia digitata)* and kapok *(Ceiba pentandra).* Biochemical characteristics of the leaves were analyzed. All leaves were deficient in methionine. In vitro experiments were conducted to study the possibilities of feeding animals with the leaves. It is stated that only cassava might be useful for preparing supplemented rations for animal feeding. *(Summary by H.J.S.)* H01

1059-0265 CONCEPCION, I. and CRUZ, I. S. **Amino acid composition of some Philippine plant foods.** Philippine Journal of Science 90:497-516. 1961. Engl., Sum. Engl., 44 Refs., Illus.

Cassava. Amino acids. Biochemistry. Cereals. Tubers. Arginine. Histidine. Threonine. Cystine. Methionine. Tryptophane. Tryosine. Lysine. Human nutrition. Protein content. Philippines.

Eight essential and 4 semiessential amino acids for man were determined microbiologically in 18 cereals, 7 tubers, 20 beans and seeds, 5 nuts and food yeast. Moisture, ether extract and ash were also analyzed in these foods before hydrolysis for amino acid analysis. The ranges of protein content are as follows: cereals 5.4 to 10.71%; tubers, 1.01 to 6.25%; beans and seeds, 12.19 to 31.75%; nuts, 5.62 to 39.07%; and food yeast, 43.83%. The egg ratio and essential amino acid index (EAA index) of the plant foods reported in this study were used for evaluating their protein quality. With the exception of tubers, coconut meal, flour and copra cake, the EAA indices obtained were above 70. Most of the foods had egg ratios of over 100% for arginine, histidine and threonine. The lowest egg ratios were obtained for cystine + methionine and tryptophan, which are reported in the literature to be the limiting amino acids in legumes, cereals and other vegetables. With the exception of cystine, tryptophan and tyrosine, the amino acid values reported in this study are comparable with those of other authors in spite of differences in variety of samples and climatic conditions. Arginine, lysine and methionine values for beans and seeds (except for lysine in cowpea) are higher in this study than those obtained by Bendaña-Brown *et al. (Author's summary)* H01

1060-1901 MARTIIS, P. DE. **Efecto de las adiciones de almidón de yuca, harina y harina precocida de maíz sobre la panificación de harinas comerciales de trigo.** *(The effect of partial substitution of wheat flour by cassava starch, corn flour or precooked corn flour on the baking properties of commercial wheat flour).* Tecnología (Colombia) 11(58):9-18. 1959. Span., Sum. Engl.

Cassava. Cassava starch: Wheat flour. Maize flour. Bakery products. Analysis. Substitutes. Human nutrition. Composite flours. Colombia.

In order to determine the effect of partial substitution of wheat flour by cassava starch, corn flour or precooked corn flour on its baking behavior, baking tests were carried out with 10 commercial flours: 5 milled from imported wheats and 5 from domestic wheats, using levels of substitution of 0.3, 6.5 and 10%; that is, 10 treatments per flour and a total of more than 200 tests. For the evaluation of the results, volume and quality (score) of the bread were considered. Results indicated the following: (1) All the domestic wheat flours and 3 of the imported wheat flours produced bread of reduced volume with partial substitution. (2) Each flour behaves differently as to volume of bread with the various treatments. (3) Only the domestic flours, presented some unacceptable partial score of the bread containing substitutes, but only 2 gave unacceptable total scores. (4) The volume of the bread obtained in the control was significantly greater than that of any of the other 9 treatments. (5) Regarding the quality of the bread, the score of the control was significantly greater than that of the other treatments, with the exception of the 3% corn flour treatment. (6) Due to their better quality, imported wheat flours gave better results than domestic products. (7) Cassava starch and corn flour are better substitutes than the precooked corn flour. *(Author's summary)* H01

1061-1879 CHAMBERLIN, J. C. and STICKNEY, R. E. **Improvement of children's diets in developing countries: an analytical approach to evaluation of alternative strategies.** Nutrition Reports International 7(2):71-84. 1973. Engl., Sum. Engl., 7 Refs.

Cassava. *Manihot esculenta.* **Wheat. Rice. Maize. Yams. Millets. Sorghums. Human nutrition. Developmental research. Research.**

An analytical approach based on linear programming is examined as a potential aid in the planning and evaluation of nutritional programs for children in developing countries. The analysis determines which combinations of foods will provide children's diets that satisfy the following constraints: (1) adequate content of nutrients (calories, protein, and essential amino acids); (2) sufficiently low bulk (volume) to be consistent with the limited consumption capacity of children: (3) low cost. The analysis also determines the competitive prices of various potential products, mixtures, concentrates and supplements. The approach is illustrated by obtaining results for 5 regions representing different staples: northern Nigeria (millet and sorghum),southern Nigeria (yams and cassava); México (maize); India (rice); Turkey (wheat). Although these results are based on a number of simplifications and on input data of limited accuracy, they do provide consistent evidence in support of several general statements regarding children's diets: (1) The influence of the bulk constraint is often comparable to that of the nutritional constraints; (2) the nutritional constraints that are most difficult to meet are calories, lysine, sulfur amino acids and tryptophan, with calories being the dominant constraint; (3) foods having high concentrations of calories (e.g., oil and sugar) and of protein (e.g., legumes) are mandatory because of the stringent bulk constraint; (4) the difficulty of formulating adequate diets for children depends strongly on the regional staple; and (5) the economic advantages of different nutritional strategies vary markedly with the regional cereals and legumes. *(Author's summary)* H01

T-446

1062-3261 SREERAMAMURTHY, V. V. **Investigations on the nutritive value of tapioca** *(Manihot utilissima).* Indian Journal of Medical Research 33(2):229-238. 1945. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Nutritive value. N. Proteins. Tubers. Amino acids. Tyrosine. Cystine. Trytophane. Digestibility. Enzymes. Carbohydrate content. Composition. Laboratory experiments. Research. Starch content. Analysis. *Manihot esculenta.*

The nitrogen complex of cassava *(Manihot utilissima)* was investigated. A major portion of the N exists in the form of simple nitrogenous compounds. An attempt was made to isolate the proteins of the root in pure form. Both the protein and nonprotein fractions contain the amino acids tyrosine, tryptophane and cystine in fair amounts and have a high arginine content. In vitro digestibility experiments showed that digestibility of cassava proteins was not inferior to that of rice protein. The chief defect of cassava as a source of protein appears to be its low total protein content rather than the quality of the protein present. The digestibility of the carbohydrates of cassava by 2 enzymes has been studied and found to be 48.3% in raw state and 77.9% after cooking. The starch is digested to a greater extent by taka diastase than by pabcreatic amylase. *(Author's summary)* H01

1063-2266 OOMEN, H. A. P. C. **Vegetable greens, a tropical undevelopment.** Chronica Horticulturae 4(1):3-5. 1964. Engl., Illus.

Cassava. Composition. amino acids. Vitamin content. Mineral content. Protein content. Human nutrition. Cassava leaves (vegetable).

Adequate consumption of green vegetables among the indigenous people of tropical regions is almost exclusively found in a few areas here acute food shortage prevails. On the whole, vegetables are consumed in insignificant quantities only, although a multitude of wild-growing plants have edible green parts, and many of them can easily be grown around homes or in small plots. Among several species enumerated special attention is drawn to the semiequatic weed, *Ipomoea reptans,* which is highly valued in Indonesia. The unfavorable consequences of the substitution of cassava for nutritionally more valuable crops, which is taking place in s ·al countries, may partly be counteracted by consuming its leaves as well. More research on edible leaves and their preparation, and more information on their use are urgently needed since increased consumption of vegetables will prevent many cases of blindness which are the result of vitamin A deficiency. *(Summary by Tropical Abstracts)* H01

T-560

1064-3186 DAME, C., STINSON, W. S. and CAPOSSELA, A. C. **Snack food product and process.** United States Patent 3, 647, 474. 1972. 3p. Engl., Sum. Engl.

Cassava. Cassava flour. Uses. Human nutrition. Breads. Processed products. Food products.

This snack food product is made of popped popcorn in a dough matrix containing cassava flour, corn flour and potato starch and is deep-fat fried. The product also contains sucrose and an alkali metal bicarbonate, which serves to improve the stability of the deep-fat fried snack food product, as well as to enhance its flavor. The process for preparing the snack food is also described. *(Au.hor's summary)* H01

T-743

1065-0223 BAINS, G. S., RAO, N. G. and RAO, S. V. **Studies on enriched tapioca macaroni products.** Food Scienoe 11(11):342-344. 1962. Engl.

Cassava. Cassava products. Processed products. Tapioca macaroni. Composite flours. Nutritive value. Cassava flour. Flours. India.

This is a summary of a discussion held in Mysore, India, on the local production and the nutritive value of "tapioca macaroni," formerly called "synthetic rice." A variety of foods containing 10-20% protein have been prepared from tapioca blended with 2 or more of the following products: groundnut flour, chickpea *(Cicer arietinum)* flour, semolina, nonfat milk solids, and casein fortified with several vitamins. *(Summary by Tropical Abstracts)* H01
T-782

1066-2441 PERISSE, J., ADRIAN, J. and JACQUOT, R. **Etude in vivo et in vitro de la digestibilité du manioc sous differentes formes: Farine entiére, farine blutée, fécule et gari; Applications aux régimes Africains.** *(In vivo and in vitro study of cassava digestibility in different forms; whole meal, bolted meal, starch and gari; applications to African diets).* Annales de la Nutrition et de l'Alimentation 10(2):13-21. 1956. Fr., 16 Refs., Illus.

Cassava. Cassava meal, Cassava starch. Processed products. Cassava products. Digestibility. Human nutrition. Gari. Fermented products. Diets. Uses.

This study gives the characteristics of the forms in which cassava is consumed, the coefficients of digestive utilization, and the results of in vitro digestibility. In vivo experiments with rats are described in detail. Compared to the other three forms tested, gari seems to be the best form of consuming cassava. *(Summary by S.S. de S.)* H01

T-723

1067-3380 CUADRADO, G. A. **El pan de yuca.** *(Cassava bread).* .Sanidad y Beneficencia (Cuba) 27:145-146. 1922. Span.

Cassava. Human nutrition. Cassava bread. Cassava flour. Organoleptic examination. Composition. Cultivation. Uses. Cuba.

Cassava grows wild in Cuba, where it resists the most severe drought. Cassava bread (externally) looks very much like that made from wheat; on account of the lack of gluten, it is not so soft. It is slightly bitter, but the taste is pleasant. The following analyses are given for cassava bread and wheat bread, respectively: moisture 26.00, 29.31; protein (N x 6.25) 11.25, 13.45; starch and reducing sugars 49.11, 54.42; fats 8.60, 1.18; cellulose 4.00, 0.63; ash 1.04, 1.00; P_2O_5 in the ash 0.074, -; acidity calculated as AcOH 0.40, 1.40%; calories per kg of dry matter calculates according to the metabolic formula 4666, 4081. The figures given for wheat bread represent the average of 5 years of analyses. *(Summary by Chemical Abstracts)* H01
T-891

1068-2436 KORULA, S. *et al.* **Studies on a spray-dried infant food based on peanut protein isolate and full-fat soy flour and fortified with DL-methionine and certain vitamins and minerals. III. Supplementary value to a maize-tapioca diet.** Food Technology 18(6):113-116. 1964. Engl., Sum. Engl., 11 Refs., Illus.

Cassava, Human nutrition. Diets. Dietary value. Groundnut. Maize. Soybeans. Rats. Milk. Proteins. Hepatic disorders. Food enrichment.

The supplementary value of a spray-dried infant food (based on peanut protein isolate, full-fat soy flour, dextrimaltose and hydrogenated peanut oil and fortified with DL-methionine and certain vitamins and minerals) to a maize-tapioca diet was studied by growth experiments on albino rats. When incorporated at the 20% level (providing about 5% extra protein), the food was as effective as an equivalent amount of milk food in promoting growth. No significant differences were observed in the mean protein contents of carcasses or livers of rats receiving the fortified infant food or milk food. The livers of animals receiving the maize-tapioca diet showed a moderate degree of parenchymal damage of the protein-deficiency type and severe periportal fatty infiltration. In contrast, the livers of rats receiving the supplement of infant food and milk supplement were normal, indicating that both supplements were effective in correcting the protein deficiency in the maize-tapioca diet and in preventing liver damage. *(Author's summary)* H01

T-720

1069-2445 **LES PROPRIETES peu connues du manioc, tubercule des tropiques, sous sa forme la plus elaborée, le tapioca. Données actuelles sur la digestibilité et les particularités nutritionnelles du tapioca.** *(The little known properties of cassava, a tropical tuber, in the form of tapioca; present data about the digestibility and nutritional properties of tapioca).* Cahiers de Nutrition et de Dietetique 3(Suppl.): 1-32. 1968. Fr., Sum. Fr., 10 Refs., Illus.

Cassava. Tapiocas. Composition. Digestibility. Nutritive value. Human nutrition. Human physiology. Viscosity. Proteins. Enzymes.

Tapioca is a source of glucosides with physicochemical characteristics that allow the plant to be distinguished from other amylaceous plants in regard to its digestible properties. Its salivary saccharification of sugar is faster than that of maize and potato starches, producing large chains instead of producing maltose directly, as occurs in rice starch. The long polysaccharide chains interfere with the coagulation of casein in the stomach, producing a coagulum with very fine grains. Contrary to tapioca, flours (wheat, rice, maize) have more or less stable antitrypsical factors and demand more abundant pancreatic secretion. The weak buffering capacity of tapioca, together with its low capacity for fixing cations and amino acids, makes it a food that economizes gastric functions. Without including proteins of the gluten type, it is indicated for intolerance to gluten and for allergies to cereal products. These properties are based on physicochemical characteristics, individualizing tapioca among other amylaceous products. These properties assess the stability of viscosity and hydration in frozen preparations or in pastries. Significant results have been obtained with infants and adults without presenting colic digestion. An appendix is given dealing with the physicochemical characteristics of cassava. *(Author's summary)* H01
T-589

1070-3177 PAPE, G. **Estudo sobre o comportamento do estearoil-lactil-lactato de calcio (CSL) e do estearoil-lactil-lactato do sodio (NSL) em panificacão.** *(Research on the behavior of calcium stearyl-2-lactylate and sodium stearyl-2-lactylate in bread making).* Boletim Técnico da Divisão de Tecnologia Agricola e Alimentar no. 5:1-46. 1971. Port., Sum. Port., Engl., 2 Refs., Illus.

Cassava. Human nutrition. Breads. Eggs. Milk. Cassava flour. Bakery products. Calcium stearyl lactylate. Sodium stearyl lactylate. Bread improvers. Wheat flour. Brazil.

The behavior of calcium-stearyl-2-lactylate (CSL) and sodium-stearyl-2-lactylate (NSL) in the manufacture of french bread, milk bread, sweet bread and buns was studied. Results were evaluated and compared. Various processes and formulas were used as follows: (a) bread making the basic formula, with and without the addition of CSL or NSL; (b) bread making with a substitution in the basic formula of a portion (5%) of the wheat flour by cassava flour, with and without the addition of CSL or NSL; (c) formulas with different contents of sugar, salt, eggs and yeast, with and without additions of CSL or NSL, and with and without the partial substitution (5%) of the wheat flour by cassava flour; (d) formulas with and without fat, and with and without the CSL or NSL, and with a partial substitution (5%) of the wheat flour by cassava flour; and (e) variations in times of fermentation. Better results were obtained when using CSL or NSL. The volume of the bread was increased. The characteristics of the crust, break and shred, and the texture of the crumb, as well as the organoleptic qualities, were improved. It was also concluded that CSL is easier to manipulate by flour mills and bakers due to its lower hygroscopicity. It was further concluded that by using the 2 additives, the shortening in the formulas used in the experiments could be reduced or eliminated. The use of the 2 additives permits the use of an increased percentage of cassava flour in proportion to wheat flour. The addition of CSL or NSL kept bread fresh longer and permitted a higher water content in the formula. *(Author's summary)* H01 102

T-740

1071-0918 SUBRAHMANYAN, V. *et al.* **Processing of tuber foods with special reference to cassava (tapioca) into enriched macaroni-type products.** *In* International Congress of Food Science and Technology, Ist, London, 1962. Proceedings. New York, Gordon and Breach, 1966. pp. 653-678. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. Sweet-potatoes. Yams. Production. Cassava flour. Composition. Tapioca macaroni. Nutritive value. Composite flours. Factories. Processing. Deterioration. Supplements. Rice. Feed mixtures. Diets. Human nutrition. Rats. Storage. Food enrichment. India.

Tuber crops are important sources of starchy foods; and in the present world food situation, they assume special significance in densely populated areas as they are much heavier yielders than food grains. Among the tuber crops, cassava is of special significance since it can grow under a variety of soil and climatic conditions. Intensive studies have been directed at this Institute and elsewhere towards the processing of cassava tubers. Methods have been worked out for the preparation of edible flour having a satisfactory shelf life. Several problems arose during the processing of cassava flour into composite grains. Like other root starches and unlike cereal starches, cassava starch tends to cook to a translucent, sticky mass. A suitable blend (60% cassava flour, 25% wheat semolina and 15% groundnut flour) was ultimately evolved for processing into different shapes including that of rice grains. These products were designated as "tapioca macaroni." Method of production and data on the storage properties, nutritive value and consumer acceptance are presented. A flow diagram of the process, together with a description of the pilot plant set up at the Institute, is given. The use of sweet potato and potato flours in such compositions is indicated. Commercial plants with capacities ranging from 7 to 48 tons| day have been designed and are available commercially. An extension program, conducted with a view to fostering these innovations is referred to. With a view to developing enriched formulations, some new blends have been processed into macaroni-type products. In addition to peanut flour, chickpea flour, casein and skim milk powder have been used for protein enrichment. The blends have also been fortified with thiamine, riboflavin, calcium pantothenate, vitamins A and D, calcium and phosphorus. The protein content of these formulations ranges between 18-20%. Results of investigations into the method of processing, the nutritive value as assessed with albino rats and supplementary value to the diet of weaned infants and children have been described. This mode of processing affords the possibility of incorporating suitable levels of enrichment of protein, vitamins and minerals into processed products. These products have a potential use in countries such as India, Indonesia, the Congo, Algeria, Ruanda-Urundi, Brazil, etc., where cassava is extensively grown and consumed. *(Author's summary)* H01 102

T-610

1072-0942 NIGERIA DEPARTMENT OF COMMERCE AND INDUSTRIES. **Gari and cassava products.** *In*_____. Annual Report 1957-58. pp. 30-31. Engl.

Cassava. Gari. Food enrichment. Fermentation. Industrialization. Processing. Food products. Nigeria.

Data given refer to the design of equipment to improve methods of making gari; research on the fundamental chemical and microbiological characteristics of the fermentation stage during which HCN is released and flavors are developed; and the nutritional fortification of gari. *(Summary by H.J.S.)* H01 102

T-615

1073-1850 SUBRAHMANYAN, V. *et al.* **The effect of replacement of rice in a poor vegetarian diet by tapioca macaroni on the general health and nutritional status of children.** British Journal of Nutrition 12(4):353-358. 1958. Engl., Sum. Engl., 18 Refs.

Cassava. Composite flours. Tapioca macaroni. Rice. Substitutes. Diets. Composition. Food value. Human health. Human nutrition. Cassava flour.

A 6-month feeding experiment was carried out on 32 girls (aged 4-11 years) in a boarding home in Mysore to assess the effect of replacing rice in a poor vegetarian diet by tapioca macaroni composed of cassava flour (60%), low-fat groundnut flour (15%) and wheat semolina (25%) on the growth, general health and nutritional status of children. The children were paired according to initial height and weight, and the members of each pair were allotted at random to the rice and tapioca-macaroni groups. Values for weight, height, nutritional status, hemoglobin level and red blood cell count were obtained at the beginning and end of the experiment for the subjects in the control and experimental groups. There was no significant difference in the increase in weight, height, and red-cell count between the two groups. Seven children in the tapioca-macaroni group improved in nutritional status as compared with 3 children in the rice group. Further more, 2 children in the rice group showed deterioration in the nutritonal status, but none in the tapioca-macaroni group showed any deterioration. *(Author's summary)* H01
T-876

1074-1619 OLIVEIRA, J. E. D. DE and SALATA, E. B. Z. M. **Methionine fortified manioc flour to combat protein malnutrition.** Nutrition Reports International 3(5):291-294. 1971. Engl., Sum. Engl., 4 Refs.

Cassava. Cassava flour. Food enrichment. Methionine. Protein deficiencies. Deficiencies. Malnutrition. Proteins. Human nutrition. Beans. Nutritive value.

Protein malnutrition is one of the main public health problems in developing countries. Several approaches should be utilized tocombat it.New protein foods of high nutritive value and low cost has been one of them; amino acid supplementation of specific foods, such as bread and rice, is another. The present study deals with another possibility: the utilization of a local food as a carrier of a nutrient to balance the protein of local diets. Cassava flour was used as a methionine carrier in a common bean-based diet, widely used in Brazil. A striking improvement in the nutritive value of the cassava flour-common beans mixture was found in rations given to rats when the cassava flour was supplemented with methionine. The advantages of this approach are discussed, showing the possibility of its utilization with different nutrients and in different countries. *(Author's summary)* H01

T-860

1075-0943 **GARI FROM Nigeria.** Colonial Plant and Animal Products 5(3):230-238. 1955. Engl., Sum. Engl., Illus.

Cassava. Gari. Nutritive value. Human nutrition. Gelatinization. Viscosity. Digestibility. Palatability. Food products. Proteins. Processing. Food enrichment. Nigeria.

Gari has little nutritional value because of its low protein and fat content; but it does contain about a quarter of its starch in gelatinized form, which is probably why it is much easier to digest than cassava flour or candi. It is not felt that the ratio of hydrolyzable sugars to water-soluble matter is a satisfactory criterion for distinguishing gari from other cassava products. The most useful identification test is probably its behavior in a Brabender or similar type of viscograph. Apart from reproducing fermentation conditions, the mechanization of gari manufacture should not present any insuperable difficulties, and the product should not have a nutritional value different from that now produced by the household method. The digestibility of the manufactured product may be improved by further study and control of the gelatinization process. Fermentation, a necessary part of the present household processing, does not appear to be essential, provided the absence of cyanogenetic glycosides in the product is assured. Whether the fermentation introduces flavors demanded by the consumers is a question which requires study in West Africa. *(Author's summary)* H01 I02

1076-2021 QUDRAT-I-KHUDA, M., DE, H. N. and DEBNATH, J.C. **Studies on indigenous starches of Pakistan. II. Starches from the rhizomes of *Curcuma zedoaria* (turmeric), tubers of *Manihot utilissima* (cassava) and *Ipomoea batata* (sweet potato) and their *in vitro* digestion by saliva and taka-diastase.** Pakistan Journal of Scientific and Industrial Research 5(1):30-34. 1962. Engl., Sum. Engl., 18 Refs.

Cassava. Curcuma. *Ipomoea batatas.* Cassava starch. Analysis. Composition. Enzymes. Digestibility. Pakistan.

The rhizomes of *Curcuma zedoaria* (turmeric), tubers of *Manihot utilissima* (cassava) and *Ipoemea batata* (sweet potato) yielded total starch amounting to 64.1, 68.4 and 69.4%, respectively, on a dry basis. Actual starch contents of the crude starches were found to be 93.8, 96.4 and 94.0%, respectively. Tubers of *Manihot utilissima* (cassava), thus appear to be economically a better source of starch compared to the other two. Investigation on *in vitro* digestion of the above starches in raw and cooked condition by saliva and taka-diastase shows that with cooked starch, 30-37% conversion to maltose occurs in 4 h depending on the nature of the starch and enzyme source. Although apparently cassava by saliva and shati (the starch prepared from turmeric) by taka-diastase showed maximum digestion, the true digestion by enzymes showed maximum effect on cassava by both saliva and taka-diastase. Digestibility is increased by cooking. *(Author's summary)* H01

1077-2023 BHATIA, D. S. and SUBRAHMANYAN, V. **Rice substitutes.** Food Science 8(5):161-167. 1959. Engl., 14 Refs., Illus.

Cassava. Human nutrition. Feed mixtures. Cassava flour. Tapioca macaroni. Composite flours. Vitamin content. Nutritive value. Productivity. Composition. Development. Industrialization. Groundnut flour. Rice. Food products. Processing. India.

The most practical approach to the production of rice substitutes in India is considered to be the development of composite grains from materials that are cheap and can be produced abundantly. The production of tapioca macaroni from cassava flour and groundnut flour is discussed extensively, including the processing of blends, pilot plant trials, the manufacturing process, nutritive value, etc. Composite grain production enables the conversion of low-grade, but high-yielding food materials into balanced cereal substitutes. It is stated that tapioca macaroni can be used in almost all preparations which are normally made from rice. *(Summary by Tropical Abstracts)* H01 I02

1078-2028 ADRIAENS, E. L. **Recherches sur la composition en acides aminés des protéines d' aliments végétaux du Congo Belge et du Ruanda-Urundi.** *(Research on the amino acid composition of the vegetable foodstuff proteins from the Belgian Congo and Ruanda-Urundi).* Mémoires de l'Académie Royale des Sciences Coloniales. Clase des Sciences Naturelles et Médicales. Collection 8 3(3):1-102. 1955. Fr., Sum. Dutch., 54 Refs., Illus.

Cassava. Human nutrition. Protein content. Composition. Analysis. Meals. Cassava flour. Cultivars. Proteins. Amino acids. Tubers. Zaire.

A study was made of the amino acid content of the proteins found in cassava roots, the main foodstuff of the natives in central Africa, in order to obtain some information as to the proteins that must be supplemented. The proteins in cottonseed can only partly make up the deficiency. *(Summary by Tropical Abstracts)* H01

1079-1703 ANKRAH, E. K. **Riboflavin content of some fermented foods of Ghana.** Ghana Journal of Agricultural Science 5(2):95-98. 1972. Engl., Sum. Engl., Fr., 6 Refs.

Cassava. *Manihot esculenta.* Maize. Fermentation. Riboflavin. Deficiencies. Fermented products. Analysis. Vitamin B. Ghana.

Levels of riboflavin were determined in maize *(Zea mays)* dough and cassava *(Manihot utilissima)* mash during various stages of fermentation. The effects of traditional methods of processing and preparing some foods from these products were also investigated. The level of riboflavin in both maize dough and cassava mash remained almost unchanged over 4 days of fermentation, being about 0.107 and 0.030 mg riboflavin per 100 g dry matter for maize| dough and cassava mash, respectively. Cooking maize dough into banku and Gakenkey resulted in a mean loss of 33% and 36% riboflavin, respectively. There was no significant change in the riboflavin level in gari made from cassava mash. Information is also given on the riboflaving content of pito and palm wine. *(Author's summary)* H01

1080-2027 ANCELOT, H. **Sur les plateaux stériles du Kwango. Un petit poisson devant un grand probleme.** *(On the barren kwango plateau; a little fish for a big problem).* Actualité Congolaise no. 221:1-2. 1955. Fr.

Cassava. Diets. Protein deficiency. Meals. Cassava flour. Human nutrition. Cassava leaves (vegetable). Congo.

In the Kwango highlands (Belgian Congo), the protein deficiency in the normal native's diet has been computed at 27 g| person| day. The diet contains excessive quantities of protein-deficient cassava *(Manihot utilissima)* flour. So far it has not been possible to change the people's diet habits so a fish breeding project was started. The fish are fed cassava leaves which are rich in protein. The addition of fish to the native diet will diminish their protein deficit. Some 4,500 fish ponds have already been stocked with *Tilapia melanopleura*, and a similar number are ready for stocking. A further 2,500 are under construction. The 4,500 stocked ponds cover a total area of 230 ha; the minimum yield is 1 ton of fish| ha| yr. *(Summary by T. M.)* H01

1081-1805 NOBRE, N. and ORLANDO, J.C. **Farinha de mandioca enriquecida con farinha de soja especial.** *(Cassava flour fortified with a special soybean flour).* Boletim Tecnico do Centro de Tecnologia Agricola e Alimentar no. 5:1-8. 1973. Port., Sum. Port., Engl., 17 Refs.

Cassava. Cassava flour. Soybean flour. Composite flours. Food enrichment. Proteins. Nutritive value. Organoleptic examination. Human nutrition. Brazil.

Several experiments with soybean protein were carried out to fortify cassava flour. Several mixtures were prepared with cassava flour and isolated soybean protein (powdered, insipid and odorless) containing 90.7% protein, 5.0% water, 0.8% fiber, and 6.0% ashes. Three techniques were used: (1) mixing isolated soybean protein (ISP) with cassava flour, powder to powder; (2) wetting the cassava flour before mixing with ISP. In these two cases it was difficult to homogenize the mixture due to the difference in density between the 2 ingredients. (3) At a small cassava flour factory, ISP was mixed with the wet, pressed cassava mass, in the course of the flour processing (mass containing 32-36% water). The mixture with 10% ISP gave a flour ready for consumption. The mixture with 40% ISP gave a premix to be added to pure flour. None of the mixtures gave satisfactory economic results. In another experiment, the characteristics of the edible cassava flour were studied, and a special soybean flour was prepared for the mixture. This preparation was made with whole, sound, clean and shelled soybeans, treated for inactivation of the antinutritional factors, and ground to the same granulation of cassava flour (20-40 meshed). This resulted in a neutral-flavored flour, with almost the same color as cassava flour. This special soybean flour presented the following composition: 47.3% protein, 10% water, 0.6% fat, 6.5% fiber. It could be mixed with cassava flour, powder to powder, did not impart any flavor to it and required no sophisticated mixing techniques or apparatus. *(Author's summary)* H01

1082-2043 MASSAL, E. and BARRAU, J. **Pacific subsistence crops; cassava.** South Pacific Commission Quarterly Bulletin 5(4):15-18. 1955. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Human nutrition.

The cultivation of cassava in the South Pacific, its dietary value and common ways of cooking it are discussed in this article. A note is also included on several other less widely grown, edible tuber-bearing plants. *(Author's summary)* H01

1083-0554 AKINRELE, I. A. **Nutrient enrichment of gari.** West African Journal of Biological and Applied Chemistry 10(1):19-23. 1967. Engl., Sum. Engl., 7 Refs.

Cassava. Gari. Amino acids. Human nutrition. Food products. Nutritive value. Food enrichment. Composition. Protein content.

The poor nutritive value of gari is quite incompatible with its role as a staple food of millions of people in Nigeria and elsewhere. Efforts have been made to enrich it with nutrients from other cheap vegetable sources. These are reported here with a critical appraisal of the targets required and the technological problems involved. *(Author's summary)* H01.

1084-2017 PARKINSON, S. **Problems of applied nutrition in the Pacific Islands.** South Pacific Commission. Technical Information Circular no. 52. 1962. 6p. Engl., 7 Refs.

Cassava. Diets. Human nutrition. Ecology. Food enrichment. Developmental research. Economics. Endemic goitre. Clinical manifestations. Human health. Deficiencies. Fiji.

In places where people have accepted more permanent cash crop farming, there has been an increasing tendency to raise cassava. Measures for diet improvement are discussed. *(Summary by Tropical Abstracts)* H01

1085-0761 PALAD, J. G. *et al.* **Nutritive value of some foodstuffs processed in the Philippines.** Philippine Journal of Science 93(3):355-384. 1964. Engl., Sum. Engl., 27 Refs.

Cassava. Food products. Cereals. Cassava flour. Vegetable crops. Nutritive value. Composition. Processed products. Vitamin content. Philippines.

The proximate, mineral and vitamin contents of 218 locally processed foods are presented. These foods included 96 cereal and grain products, 17 fruit and vegetable products, 55 meat fish and poultry products, 10 milk and milk products, 27 sugar products and 13 miscellaneous products. Peanut and soybean products, meat, fish and poultry products, milk and milk products are among the processed foods which can be considered as good or excellent sources of protein, minerals and vitamins. *(Author's summary)* H01

1086-2054 LEITAO, M. A. **A mandioca na culinaria Africanna; Algumas receitas.** *(Cassava in African cuisine; some recipes).* Gazeta do Agricultor 23(262):69-74. 1971. Port., 9 Refs.

Cassava. Tubers. Uses. Cassava leaves (vegetable). Food products. Human nutrition. Fresh products. Africa.

Forty recipes based on cassava are given. These recipes use fresh cassava roots and leaves. They include starch and tapioca for the preparation of bread and biscuits. Sweet cassava is preferred. *(Summary by J.L.S.)* H01

1087-0710 MEETING ON FORTIFICATION OF MANDIOCA PRODUCTS. 3rd, Rio de Janeiro, 1972. Agenda. Rio de Janeiro, Ministerio da Saude. 1972. 17p. Engl.

Cassava. Food products. Economics. Development. Toxicity. Cassava products. Food enrichment. Cassava programs. Gari. Foofoo. Uses. Brazil.

A summary and discussion is presented of international programs for the fortification of cassava products. The present status of cassava is discussed in addition to technological problems related to cassava, toxicity of cassava and its products, nutritional enrichment of cassava products, new products derived from cassava and economic problems. Differences among cassava by-products such as gari and foofoo are given, as well as their utilization. *(Summary by J.L.S.)* H01 J00.

1088-3347 TEJADA A., A. **La yuca agria y su gran utilidad comó alimento para el hombre.** *(The value of bitter cassava as food for humans).* Boletin de Agricultura y Caminos 6 (10):464-466. 1927. Span.

Cassava. Industrialization. Human nutrition. Tapiocas. Processing. Bitter cassava. Guatemala.

The author encourages the establishment of large-scale plantations of bitter cassava in Guatemala, stressing the economic importance of cassava in Brazil and Cuba. A description is made of the manufacturing of tapioca. *(Summary by H.J.S.)* H01.

1089-0686 JEFFERS, H. FK. HAEP. H. **A preliminary study of the nutritive value of some dehydrated tropical roots.** *In* International Symposium on Tropical Root Crops, Ist, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2. pp. 72-91. Engl., Sum. Engl., 32 Refs., Ilius.

Cassava. *Manihot esculenta.* **Wheat. Colocasia. Xanthosoma. Tubers. Feeds and feeding. Diets. Drying. Concentrates. Maize. Soybeans. Sweet-potatoes. Nutritive value. Cassava meal. Meals. Proteins. Ca. Composition. Wheat meal.**

Meals were prepared by grinding artificially dehydrated whole roots and tubers of cassava *(Manihot esculenta)*, dasheen *(Colocasia esculenta)*, sweet potatoes *(Ipomoea batatas)*, tania or cocoyams *(Xanthosoma sagittifolium)* and yams *(Dioscorea alata)*. Groups of weanling albino rats matched for initial weight were used to determine feeding values of dehydrated roots as a replacement for 10, 20 or 30% of a commercial feed or as basal ingredients in balanced rations. Dasheen meal was markedly inferior at all levels of substitution. Cassava. sweet potatoes and yams differed little from each other and produced satisfactory growth and performance at levels up to 20%. When dehydrated roots were supplemented with a commercial concentrate mix (36%), all were inferior to controls containing corn or wheat; dasheen being particularly poor. Dehydrated roots (48-50%) when mixed with wheat middilings (30%) and supplemented with fish meal (5%) and soybean meal (8-14%) produced generally better weight gains and efficiency of feed conversion than when supplemented with a commercial concentrate. In particular it was noted that weight gains and feed | gram gain with respect to the sweet potato diet (3.2 and 4.5) were superior to the control ration (2.9 and 5.3), with cassava (2.2 and 5.6) being slightly inferior. It was concluded that with high-quality protein supplementation, dehydrated cassava, sweet potatoes, cocoyams and yams could satisfactorily replace cereals as main carbohydrate components of balanced rations. The poor performance of dasheen meal may have been attributable to the presence of calcium oxalate and other irritants; this suggests that boiling or other treatment may be a prerequisite to dehydration. *(Autho's summary)* H01

1090-0809 VAN VEEN, A. G. **Over cassave-bladeren, een hoogwaardige bladgroente.** *(Cassava leaves, a green vegetable of high nutritional value).* Geneeskundig Tijdschrift voor Nederlandsch-Indie 78: 2548-2552. 1938. Dutch, Sum. Dutch, Engl.

Cassava. Cassava leaves (vegetable). Composition. Human nutrition. Vitamin content. Nutritive value. *Manihot esculenta.* **Fresh products. Protein content.**

Young cassava leaves are very often eaten as a cheap vegetable in Java, especially by the poor people. According to their chemical composition, they form a good complement—especially when steamed— to the mostly dried cassava roots *(Manihot utilissima)*, which are useful only as a source of carbohydrates that fill the stomach but have little nutritive value. The leaves have a high dry matter conte (23-28%) and a high total protein content (>8%), lipoids (1.2%) and calcium, phosphorus and iron. The provitamin A (B-carotene) and vitamin C content is high; viz., 130-160 IU of vitamin A and 1.5-1.8 mg of vitaming C| g of fresh matter. In contrast to other green vegetables, the leaves are very rich in vitamin B1 (± 1 IU| g of fresh material) and lactoflavin (4.3 r| g). The influence of boiling and steaming are also included in the tables. Through steaming, the vitamin B1 content does not decrease considerably; through boiling about half of it is extracted. Through steaming or boiling, the HCN disappears rapidly. Of the total protein, ± 75% is real protein. The total leaf protein has a good supplementary value as compared to rice protein, though it is less than soybean protein. *(Author's summary)* H01

1091-0563 PERISSE, J., ADRIAN, J. and JACQUOT, R. **Digestibilité du manioc sous différentes formes: farine entiére, farine blutée, fécule et gary étude in vivo et in vitro.** *(The digestibility of various preparations of cassava: whole meal, starch and gari; a study made in vivo and in vitro). In* Inter African Conference, 3d, Luanda, Angola, 1956. pp.759-768. Fr., Sum. Engl., Fr., Port., Illus.

Cassava. Human nutrition. Processed products. Cassava meal. Gari. Productivity. Vitamin content. Digestibility. Dietary value. Food products. Composition. Cassava starch. Togo. Africa.

It is evident that cassava is more digestible when freed as far as possible from cellulosic matter. However, in Africa, converting cassava into starch is not always advisable as some protein would thereby be wasted. Gari, in which the "formic insoluble matter" is low, seems to be a logical form of cassava to be used. Cassava may be eaten raw because unlike potato starch, it does not need to be cooked to make it easily digestible. Besides, vitamin synthesis may occur during the preparation of gari; Adrian has verified the synthesis of vitamin B12 in beers made from millet. From the point of view of digestion, it seems that raw gari is more easily hydrolyzed than cassava starch or meal. Perhaps this is an advantage when, as in Togo, cassava is eaten raw. Nevertheless, it should be remenbered that the sudden changes from a diet based on fermented foods to rations that have not undergone fermentation very often sets up serious intestinal disturbances in the African. This may be attributed to the establishment of a pathogenic flora in the gut. Now, we know that the flora changes with the sugars or starches available as substrates. In this respect gari may not have special significance since it has a different rate of hydrolysis from that of untreated cassava. The advantages of gari are as follows: Gari can be stored for a long time in contrast to the fresh root which deteriorates easily. It contains less indigestible carbohydrates than the freshly harvested roots and much less than whole cassava meal. In contrast to the starch, some of the protein in the cassava root is retained in gari; it can be eaten uncooked and is therefore suitable for the worker in the field. However, gari does not have the value of cassava itself and does not form a balanced diet. *(Author's summary)* H01

1092-0674 TERRA, G. J. A. **The significance of leaf vegetables, especially of cassava in tropical nutrition.** Tropical and Geographical Medicine 2:97-108. 1964. Engl., Sum. Engl., Span., 37 Refs.

Cassava. Amino acids. Food products. Cassava leaves (vegetable). Composition. Fresh products. Proteins. Productivity.

Although in various tropical regions young leaves of cassava are consumed in the manner of spinach, etc. in quantities up to 500 g| day, then is not a general practice. The leaves contain an average of 7% of the fresh weight in protein, and the relative portions of the usually limiting amino acids are fairly satisfying. Leaf yields are high, from 7,000 to 20,000 kg| ha| year, depending on the climate and method of cultivation. This corresponds to 500 - 1,400 kg protein| ha| year; hence cassava leaves are a good source of supplementary protein in regions or conditions where protein is at a premium. Moreover, they are rich in carotene and vitamins B and C. The leaves containing HCN should be boiled for about 5 minutes. The methods of preparing the leaves for consumption are described. A review is given of the leaves of many other tropical species of herbs, shrubs and trees that are eminently suitable for human consumption although they are often neglected. *(Author's summary)* H01

1093-3388 PAGES, A. **Sur la composition minerale des feuilles de certaines plantes entrant dans la ration alimentaire habituelle de la population des Hauts-Plateaux de Madagascar.** *(The mineral composition of leaves of certain plants forming part of the daily rations of the people of the high plateaus in Madagascar).* Naturaliste Malgache 7(2):215-218. 1955. Fr.

Cassava. ***Ipomoea batatas.*** **Ca. P. Iron. Manganese. Mineral content. Oxalic acid. Water content. Human nutrition. Human health. Leaves. Composition. Vegetable crops. Malagasy Republic.**

Leaves of 18 plants used as foodstuffs in Madagascar were analyzed. Data are given in the form of tables. Headings of the tables and data given for cassava are: common name (ravitoto), harvesting period (January), H_2O content(87.16%), Ca content (114.8 mg| 100g fresh, 891.2 mg| 100g dried), P content (47.8 mg| 100g fresh, 372.5 mg| 100g dried), Fe content (1.8 mg| 100g fresh, 14.1 mg| 100g dried), Mn content (1.97 mg| 100g fresh, 15.4 mg| 100g dried), Ca| P rate (2.40), and oxalic acid content (261.5 mg of anhydrous calcium oxalate, fresh; 2036.7 mg dried). Ca| P rate influences food utilization and assimilation. Oxalic acid content could play some role in the great number of cases of urinary lithiasis occurring in this area. *(Summary by H.J.S.)* H01.

1094-0944 PHILLIPS, P. G. and LADELL, W. S. S. **Nitrogen balance in Nigerians.** Journal of Tropical Medicine and Hygiene 62(8):181-194. 1959. Engl., Sum. Engl., 43 Refs., Illus.

Cassava. Food products. Digestibility. Composition. Diets. Proteins. Dietary value. Human nutrition. Yams. Foofoo. Soluble carbohydrates. Fibre content. Fat content. Food energy. Nigeria.

In the course of digestibility trials designed to compare the relative values in two cassava products, gari and cassava flour, a number of short-term N balance trials were conducted on a group of western Nigerian laborers. The digestibility of both products—particularly of the crude fiber—was high. Nitrogen equilibrium was established on a mixed diet with the cassava product as the staple on an intake of 44 g protein| day, of which only 6.4 g was vegetable in origin. Subjects fed more than 100 g protein daily for 10 days continued to retain N and in some cases lost weight. These results are compared to those reported from elsewhere, and it is concluded that the western Nigerian (Yoruba) peasant may be on the verge of protein deficiency. *(Author's summary)* H01

1095-0285 CLOSE, J. *et. al.* **Composition en acides aminés d'hydrolysats de farine de manioc roui variété amére.** *(Amino acid composition of hydrolysates of soaked flour, made from bitter cassava).* Bulletin de la Societé de Chimie Biologique 35(9):985-993. 1953. Fr., Sum. Fr., 12 Refs.

Cassava. Bitter cassava. Amino acids. Cassava flour. Processed products. N. Fat content. Fibre content. Composition. Analysis. Human nutrition. Protein content.

Chromatography on an ion-exchange column has been applied to soaked flour made from bitter cassava to determine its amino acid composition. Proportions of the majority of the amino acids were obtained from the hydrolysate of the whole meal, without interference from the carbohydrates, which attained levels of 97% in the sample. Chromatographic analyses of amino acids and ammonia in the cassava flour gave an overall yield of 86.7% of the total N content (0.323% N). The amino acid content in the hydrolysate from proteins, free amino acids and the root peptides corresponds to an overall protein ratio on the order of 1% of dry meal weight. Principal amino acids are glutamic acid, ornithine, alanine, aspartic acid, lysine and arginine. Ornithine comes from the arginine during soaking, a process used by natives to remove the cyanogen glucoside of the bitter cassava roots and to facilitate peeling. The amino acids of particular nutritional importance, such as cystine, methionine and tryptophane, are found only in small quantities. Flour from soaked cassava is of little value as a source of protein, because of the quality and quantity of amino acid content. *(Author's summary)* H01

1096-1854 MELO, M. S. **Teores de acidez em farinhas.** *(Acid contents of various meals).* Revista do Instituto Adolfo Lutz 1: 457-475. 1941. Port., Sum. Port., Engl., 12 Refs.

Cassava. Cassava flour. Wheat flour. Flours. pH. Analysis. Brazil.

Citing the multiplicity of methods for determining the acid content of meals and the consequent diversity of results, the author expresses the need to adopt a single method of analysis, thus permitting a more accurate comparison of results. The principal cause of acidity in meals is their oil content. Such acidity can only be represented by the degree of total acidity obtained by titration, thus eliminating the idea that this acidity can be completely represented by ionic acidity. In several hundred comparative determinations, great difference in results have been observed, proving the limited and unrepresentative value of the potential acidity of these products. Based on this analytical data, it is concluded that the degree of total acidity indicates product age and condition of conservation. *(Author's summary)* H01.

1097-0923 **NEW PROTEIN source found in Biafra.** Food Manufacture 44(8):56. 1969. Engl.

Cassava. Taro. Leaves. Proteins. Methionine. Costs. Yams. Human nutrition. Productivity. Nigeria.

Norwegian scientists E. Nordrum and B. Eggum have found that leaves of the cassava plant, abundant in Biafra, can yield up to 1,200 lb of protein per acre compared with 130 lb for rice and 260 lb for yams and taro. Biafrans eat only the cassava root, much poorer in protein; dried leaves contain up to 36 % protein lacking only methionine, which can be added at the rate of 2 g| kg of cassava leaves at a cost of only 15s. 6d. per ton, bringing protein quality up to that of meat and fish. *(Full text)* H01.

1098-2062 ALBERTO, J. **A mandioca. IV. Importancia económica da cultura.** *(Cassava. IV. Economic importance of the crop).* Gazeta Agricola de Angola 3(6):266-270. 1958. Port.

Also available in English, translated by Tropical Products Institute.

Cassava. Human nutrition. Economics. Trade. Cultivation. Angola.

Cassava, cultivated on a large scale by the natives of Angola, is used to produce fermented flour known commonly as "fuba." Cassava meals serve as a substitute for vegetables and legumes. Cultivation methods are described. *(Summary by J.L.S.)* H01 J00.

1099-0939 SUBRAHMANYAN, V. **Food-grains from tapioca.** Food Science 6(8):183-185. 1957. Engl.

Cassava. Cassava flour. Processed products. Human nutrition. Factories. Production. Proteins. Food enrichment. Dietary value. Research. India.

Research has shown that cassava flour can be suitably enriched and fortified with specially prepared oil-seed meals which are exceptionally rich in protein but that consumers preferred a product with a rice shape. These types of products have been prepared on a small scale in Kerala, and trials have been carried out to introduce them into the local diets with fairly good results. Descriptions are presented of the small factories and the methods of preparation. *(Summary by H.J.S.)* H01 I02.

1100-2403 PERERA, J. A. W. **Cassava in Ceylon.** Tropical Agriculturist 94(1):24-26. 1940. Engl.

Cassava. Human nutrition. Cassareep. Cassava bread. Bakery products. Processing. Sri Lanka.

A brief description is given of the introduction of cassava in Ceylon. Some food-stuffs prepared from cassava in Mauritius are also described. *(Summary by H.J.S.)* H01

1101-0259 MURTHY, H. B. N., SWAMINATHAN, M. and SUBRAHMANYAN, V. **Supplementary value of groundnut cake to tapioca and sweet potato.** Journal of Scientific and Industrial Research 9B:173-176. 1950. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Groundnut cake. Rice. Sweet-potatoes. Diets. Proteins. Cassava flour. Feeds and feeding. Rats. Animal nutrition. Dietary value. Supplements. India.

Young rats fed on a diet largely composed of cassava or sweet potato flour, in addition to pulses, vegetables, etc., in amounts corresponding to the usual consumption of poor rice eaters in South India, lost body weight. Some of the animals died within 8 weeks. Addition of groundnut cake flour to the above diet proved an effective supplement, promoting good growth; the average weekly increase in body weight was 10.3 g and 8.6 g, respectively, as compared with 3.9 g obtained with the poor rice diet. Animals fed on a poor rice diet in which 25% of the rice had been replaced by a mixture of 4 parts cassava of sweet potato flour and 1 part groundnut cake flour also grew well thus showing that the nutritive value of the poor rice diet was improved. *(Author's summary)* H01

1102-2130 BUSSY, M. **Analyses comparatives de qualques tubercules alimentaires de l'Indochine.** *(Comparative analysis of some food tubers from Indochina)*. Bulletin Agricole de Saigon no. 1:19-21. 1919. Fr.

Cassava. Yams. Potatoes. Taro. Nutritive value. N. Sugars. Minerals. Composition. Starch content. Fat content. Mineral content. Indochina.

Nutritive values are given of roots crops from Indochina; i.e., cassava, white potatoes, red potatoes, *Dioscorea esculenta* and taro. Data concern content of water, nitrogenous materials, fat, starch, sugars, cellulose and minerals. *(Summary by H.J.S.)* H01

1103-0209 SCHERRY, R. W. **Manioc - A tropical staff of life.** Economic Botany 1(1):20-25. 1947. Engl., 5 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Farinha. Processed products. Human nutrition. Uses.**

Cassava is a staple item of the diet in northern Brazil, Paraguay and the Andean countries. Of cassava products, farinha (meal) is the cheapest and frequently tne sole food in many regions of these countries. Description of the method for preparing farinha in northern Brazil is included. Cassava is also of importance as a tropical export item to Europe and the United States, where it is used for preparing foods, animal feedstuffs, laundry and sizing starches and as a source of simple sugars, alcohol, acetone. *(Summary by J.L.S.)* H01

1104-0210 DIAS, M. **Preparação da farinha de mandioca torrada (farinha dos musseques).** *(The preparation of toasted cassava or "musseque" flour)*. Garcia de Orta 10(1):59-76. 1962. Port., Sum. Port., Engl., Germ., 13 Refs., Illus.

Cassava. Cassava flour. Processed products. Fermented products. Flours. Uses. Pressing. Processing. Human nutrition. Fermentation. Angola.

A detailed study is made of the natives' preparation of toasted cassava flour in Angola. Their rudimentary implements are fully described and illustrated. The flour is marketed mainly in the "musseques" (native quarters) of Luanda. These methods are then compared to the Brazilian processes, from which they were originally adapted. *(Summary by T.M.)* H01 I02

1105-2348 MARAVALHAS, N. **Carotenoides nas farinhas de mandioca.** *(Carotenoids of cassava meal)*. *In* ________ Cinco estudos sobre a farinha de mandioca. Brasil. Instituto Nacional de Pesquisas da Amazonia. Publicação no. 6. 1964. pp.39-41. Port., Sum. Engl. 3 Refs.

Cassava. Analysis. Industrialization. Processing. Cassava meal.

In previous work, the author identified the yellow pigments occurring in certain varieties of cassava (*Manihot esculenta* Crantz) as carotenoids. Since cassava and cassava meal (farina) are basic staples in many peoples' diets in developing countries, it was interesting to determine to what extent the carotenoids were affected by the heat, light and aeration treatments required for preparing the meal. There were no appreciable losses in carotenoids as compared to those found in fresh roots. *(Author's summary)* H01 I02

1106-0290 SUBRAHMANYAN, V., SWAMINATHAN, M. and MURTHY, H. B. N. **Nutritive value of some subsidiary foods.** Journal of Scientific and Industrial Research 9B(5):135-136. 1950. Engl., 2 Refs.

Cassava. Sweet-potatoes. Groundnut. Cassava flour. Composition. Nutritive value. Development.

As a result of the cereal shortage, the use of tubers like cassava and sweet potatoes, which produce better yields than grain crops, appears possible. However, tubers are deficient in protein. Research carried out by the authors showed that groundnut cake flour has a remarkable supplement value in poor diets based on cassava and sweet potatoes. Nevertheless, in considering alternate food substitutes, not only their nutritive value but also their acceptability from the psychological standpoint must be considered. Food in the form of flour is not readily accepted by cereal eaters accustomed to grain. The possibility of preparing grain substitutes from cassava with or without the addition of groundnut cake flour, and also from millets was explored. Tuber flours and starches yield grains that tend to soften on cooking, resulting in a pasty product. However, such materials are suitable for preparing sago and sago-like products. The nutritive value of rice substitutes was studied by the rat growth method. The addition of groundnut cake flour to cassava or sweet potato diets produced a remarkable improvement in the nutritive value of the diet, making it much superior to the rice diet. *(Summary by J.L.S.)* H01

1107-MARTINO, G. **La panificazione mista con mandioca.** *(A bread-making mixture using cassava)* Quaderni della Nutrizione 1:149-152. 1934. Ital.

Cassava. Wheat flour. Soybean flour. Cassava flour. Composite flours. Nutritive value. Composition. Protein content. Human nutrition. Breads. Substitutes.

A bread prepared with a mixture of wheat flour (50%), cassava flour (35%) and defatted soybean flour (15%) was tested to determine the content of proteins and the nutrititional value and was fed to adult animals. White bread made solely with wheat flour had 7.1% protein while that made with the mixture had 7.5% protein. The author ate the mixed bread for 5 days without suffering any physiological disturbances. *(Summary by H.J.S.)* H01.

1108-2344 OKE, O.L. **Chemical studies on some Nigerian foodstuffs—kpokpogari (processed cassava).** Tropical Science 8(1):23-27. 1966. Engl., Sum. Engl., 6 Refs.

Cassava. Human nutrition. Gari. Nutritive value. Kopkpogari. Toxicity. HCN content. Processing. Composition. Nigeria.

The changes that occur when cassava is processed to kpokpogari are discussed in relation to food value, mineral composition and poisonous substances (HCN and oxalid acid). In the process most of the protein is lost, and the product contains a correspondingly larger proportion of crude fiber. About 20% of the carbohydrate is lost while the fat is reduced to nil. This leads to a lower calorific value. The ash content is doubled, corresponding to the high content of calcium. The oxalic contents of both cassava and kpokpogari are very small. From the point of view of its chemical composition, the major advantage of kpokpogari over cassava is the reduction of the HCN content from a lethal dose to a nontoxic level. *(Author's summary)* H01

1109-1718 PECHNIK, E. and GUIMARAES, L. R. **Sôbre o aproveitamento da folha de mandioca (Manihot sp.) na alimentação humana. III. Mandioca mansa.** *(Use of cassava (*Manihot *sp.) leaves in human nutrition. III. Sweet cassava).* Arquivos Brasileiros de Nutricão 18(1-2):25-36. 1962. Port., Sum. Port., Engl., Fr., 10 Refs.

Cassava. ***Manihot esculenta.*** **Leaves. Sweet cassava. Composition. Water content. Ash content. Protein content. HCN content. Nutritive value. Human nutrition. Laboratory animals. Drying. Amino acids. Brazil.**

This report presents data concerning the use of sweet cassava leaves (*Manihot aipi* Pohl) as a protein source in human nutrition. Because of the low HCN content, the meal did not require previous heat treatment and was obtained from leaves dried at room temperature. Two other types of meal were prepared from leaves dried at 70-80°C (24 h) and from leaves dried at 70-80°C (24 h) then cooked (3 h) and dried as before. All experiments used weanling Wistar rats. The untreated meal, when employed as the dietary protein source, promoted growth at a slow, subnormal rate. Supplementation of the diet with lysine and methionine resulted in a significant increase in protein efficiency. No growth response was obtained with the meal prepared from cassava leaves dried at 70-80°C during 24 h, however, supplementation of the ration with both methionine and lysine produced a marked improvement in protein efficiency. The meal obtained by drying, prolonged cooking and redrying did not stimulate growth, not even when supplemented with lysine, methionine and threonine. The protein efficiency ratio of sweet cassava leaves is similar to that of the alga *Chlorella pyrenoidosa*, superior to that of *Spongiococcum excentricum*, and inferior only to that of the mixture of the algae *Scenedesmus obliquus* + *Chlorella ellipsoida*. It may well be that, as in the case of the algae, the availability of the cassava leaf protein constitutes a problem closely related to the problem of digestibility, requiring further studies and adaptation of additional processes for the purpose of facilitating assimilation, thereby improving the nutritional adequacies of this material. *(Author's summary)* H01 C03.

1110-2135 COUSINS, H. H. **Cassava trials in 1907; native and Colombian varieties.** Bulletin of the Department of Agriculture, Jamaica 5:78-86. 1907. Engl.

Cassava. Cultivars. Starch content. Dietary value. HCN content. Palatability. Cooking. Productivity. Composition.

A report is given on experiments carried out at the Hope Experimental Station (Jamaica) on the starch value, dietetic quality and HCN content of cassava varieties collected in Colombia. The starch yields are presented for 22 selected native cassava varieties after 12 months of growth. Palatability tests were made by a voluntary committee. Culinary properties are also included. Of the Colombian varieties, only 2 could be considered as worthy of serious attention as starch producers in the plains: Miguela and Negrita 15. Luana Sweet, a native Jamaican variety of sweet cassava, gave the same tuber yield as Miguela under the same conditions, but its starch content was higher. *(Summary by J.L. S.)* H01

1111-0537 ADRIAENS, E. L. and HENSTERMANS-MEDARD, O. **Remarques à propos de la composition chimique du manioc roui, non roui ou cuit a l'eau.** *(Notes on the chemical composition of soaked, unsoaked and boiled cassava).* Bulletin Agricole du Congo Belge 45(1):1-26. 1954. Fr., Sum. Dutch., 5 Refs., Illus.

Cassava. HCN. Protein content. N. Drying. Processing. Composition. Cultivars. Analysis. Cassava flour. Fibre content. Industrialization. Boiling. Processed products. Mineral content. Fat content. Carbohydrate content. Bitter cassava. Sweet cassava. ***Manihot esculenta.*** **Fresh products. Tubers. Zaire.**

Cassava flour constitutes the staple food of the natives in Central Africa. In 1952, 730,000 ha were planted to cassava. A distinction is drawn between the sweet *(Manihot dulcis)* and bitter *(Manihot edulis, Manihot utilissima)* varieties. The latter are poisonous owing to the presence of the HCN-splitting enzyme, so that the flour has to be processed several times before it is fit for consumption. A description is given of the chemical composition of soaked, dried and boiled cassava roots. The authors consider that the Kjeldahl method is unsatisfactory for determining the protein content, as part of the total N content consists of free and combined ammonia salts. *(Summary by Tropical Abstracts)* H01 I02.

1112-1682 LEHMANN, G. **Lebensmittel-und ernahrungsprobleme in entwicklungsländern. I. Uber die brotversorgung.** *(Food and nutrition problems in developing countries. I. The bread situation).* Ernährungs-Umschau 18(12):505-510. 1971. Germ., 25 Refs.

Cassava. Cultivation. Composition. Linamarin. Cyanogenic glucosides. Breads. Bakery products. Bread improvers. Human nutrition. Food energy.

Cultivation, utilization, yield in tons|ha, nutritional value, and uses of cassava, yams, potatoes, sweet potatoes, maize, rice and bananas are discussed and reviewed with reference to factors of economic importance in developing countries and production of bread based on flour from plant sources other than wheat. Systemic testing of glycerol monostearate as an emulsifier in bread produced from flours of native plants in tropical and subtropical regions and in combination with wheat flour is advocated. The calorific value, in addition to the water, protein, fat and carbohydrate contents of cassava, yams, potatoes, sweet potatoes, maize, rice, quinoa, wheat and bananas, and the population of industrialized and nonindustrialized countries are tabulated. *(Summary by Food Sciences and Technology Abstracts)* H01.

1113-2071 SUBRAHMANYAN, V. *et al.* **Studies on the nutritive value of a blend of whole wheat flour, tapioca flour and low-fat groundnut flour ("aushtik atta").** Food Science 9(9):303-305. 1960. Engl., Sum. Engl.

Cassava. Cassava flour. Wheat flour. Groundnut flour. Flours. Processed products. Composition. Human nutrition. Nutritive value. Diets. Analysis. Amino acids. Composite flours. Dietary value. Proteins. India.

The overall nutritive value of a blend of whole wheat flour (75%), low-fat groundnut flour (8%) and cassava flour (17%), known as "paushtik atta," has been studied using albino rats. Complete replacement of whole wheat flour by *paushtik atta* in Indian diets significantly improved the overall nutritive value of the diet. Fortification of *paushtik atta* with calcium and riboflavin further increased its overall nutritive value. The protein efficiency ratio of the proteins in *paushtik atta* (1.20 and 0.98) in periods of 4 and 8 weeks, respectively, is significantly higher than that of the proteins of whole wheat flour (0.94 and 0.82). *(Author's summary)* H01.

1114-0930 CEDILLO, V. G. **Cassava rice, or landang.** Philippine Agriculturist 35(8):434-440. 1952. Engl., Sum. Engl., 2 Refs.

Cassava. Cassava meal. Cassava products. Nutritive value. Composition. Human nutrition. Protein content. Carbohydrate content. Processed products. Landang. Philippines.

The most important finding in this experiment is that landang compares favorably with corn and rice as to food constituents and calorific value for every 100-g sample. Although corn and rice contain more proteins, landang has a greater amount of carbohydrates. From the nutritive point of view landang can very well become a good substitute for corn or rice during hard times. The most striking difference between the landang prepared by the grating method and that by the soaking method lies in the protein content. The landang from the grating method contains 2.41% protein, whereas that from the soaking method is 1.22%. The discrepancy is perhaps due to the effect of soaking and washing in the latter method. The calorific value for every 100 g is also different; it is higher in the grating method. *(Author's summary)* H01

1115-3344 DESVERGNES, L. **Note sur une caracterisation chimique des farines de manioc et de riz.** *(Notes on the chemical characteristics of cassava and rice flours).* Annales de Chimie Analytique 3:205-206. 1921. Fr.

Cassava. Composition. Analysis. Cassava flour. Flours. Laboratory experiments. Rice.

Some merchants added cassava flour to wheat flour. These flours bear different contents of nitrogenous matter and ash when they are analyzed separately. When 10% - 20% cassava is added to wheat, it is not possible to establish the difference between pure wheat or a mixture by means of content chemical analysis. Thus the following colorimetric analysis was developed: 10% of the flour to be tested is mixed with 45 cm of alcohol 95° plus 5 cm HCl 22°. The solution is boiled for 5 min. After being cooled, the following results are obtained: oats gave a light yellow color; wheat, a light yellowish-pinkish tint; yellow corn, light yellow; cassava, cherry red barley, light straw yellow; rice, dark pink; rye, yellowish pink. Methodology for mixtures has not yet finished. *(Summary by H.J.S.)* H01.

1116-2359 COUTINHO, L. P. **A cultura da mandioca e o seu valor na alimentação humana.** *(The cultivation of cassava and its value for human nutrition).* Revista Agricola (Moçambique) 3(31):8-11, 52-54. 1961. Port., Illus.

Cassava. Cultivation. Human nutrition. Nutritive value. Composition. Leaves. Roots. Green manures. Fertilizers. N. P. K.

The chemical composition and nutritional value of tubers and leaves are analyzed. Methods of cultivation and application of fertilizers and green manures are also dealt with briefly. *(Summary by Tropical Abstracts).* H01 D00.

1117-3453 PEREIRA C., O. **La yuca: riqueza potencial inexplotada.** *(Cassava; unexploited potential wealth).* La Campiña de Ahora 2(18):5-6. 1968. Span.

Cassava. Cassava bread. Breads. Cassava flour. Composite flours. Composition. Analysis. Nutritive value. Flours.

Good-quality bread can be made with a mixture of 80% wheat flour and 20% cassava starch, provided fermentation of the dough is continued for no more than 4 h and enough salt (e.g. potassium phosphate) is added as a yeast nutrient. Weight loss during baking is only 10 to 11%, as compared to 13% for bread made from wheat flour alone. An analysis conducted in Puerto Rico showed that the nutritive value of the new type of bread compares favorably to that of bread made from wheat flour alone. *(Summary by Tropical Abstracts).* H01.

1118-3792 AYKROYD, W. R. and KRISHNAN, B. G. **The defects of tapioca as a staple food.** Indian Journal of Medical Research 27(1):139-145. 1939. Engl., Sum. Engl., 5 Refs.

Cassava. Diets. Laboratory animals. Deficiencies. Dietary value. Protein deficiencies. India.

Young rats fed on a diet largely composed of cassava and containing pulses, vegetables, etc., in amounts corresponding to the usual consumption of poor rice eaters in southern India, died within a few weeks. The addition of casein or skim milk to this diet permitted survival and an average weekly increase in body weight of about 6 g for 10 weeks. A supplement of soybeans given in such quantities that the addition of protein was equivalent to that supplied by a supplement of 1.5 oz casein, was less effective, the weekly increase in weight being only 1.5 g. Supplements of soybeans and other pulses containing about half this amount of protein produced little growth, and deaths occurred in these experimental groups. *(Author's summary)* H01

1119-3322 OLIVEIRA, J. E. D. DE, SALATA, E. B. Z. M. and CAMPOS, J. **Manioc flour as methionine carrier to balance common bean-based diets.** Journal of Food Science 38(1): 116-118. 1973. Engl., 8 Refs., Illus.

Cassava. Diets. Beans. Methionine. Human nutrition. Economics. Organoleptic examination. Cassava flour. Amino acids. Nutritive value. Food enrichments.

In diets for rats, the nutritive value of a cassava flour-common bean mixture was greatly improved by the addition of methionine. It was possible to calculate minimum amounts of methionine to fit the great majority of local food consumption patterns. By using minimum amounts, the price was kept low, and organoleptic characteristics of the flour were not changed. Up to 5.5% methionine in the flour had no harmful effects. Besides amino acids, cassava flour could also act as a carrier for minerals or vitamins or both. *(Summary by Chemical Abstracts)* H01

1120-3340 FULLER, A.B. *et al.* **The value of indigenous supplements to diets composed of West African staples: Preliminary studies.** Nutrition Reports International 5(4):293-299. 1972. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Rats. Palatability. Human nutrition. Groundnut. Diets. Dietary value. Animal physiology. Nutritive value. Africa.

The effects of adding various levels of black-eyed peas, peanuts and egusi seeds to diets composed of cassava and other West African staples were tested, using weanling albino rats. Weights of body, muscle and brain and physical endurance by the swim test were measured. Increased amounts of supplements improved all these parameters. Very acceptable results were obtained when 1|4 of the dry weight of the diet was from the supplements. The data suggest an association between development of the body and brain and physical endurance. These studies illustrate the practicability of supplementing cassava-based diets with locally available, inexpensive, palatable foods. *(Author's summary)* H01

1121-0843 COURSEY, D. G. and INGRAM, J. S. **Cassava as a tropical food plant.** London, Tropical Products Institute, 1969. 10p. Engl., 19 Refs.

Cassava. Cassava products. Human nutrition. Cultivation. HCN. History. Plant geography.

This article gives a brief history of the spread of cassava throughout the world, a summary of the preparation of cassava-based foods and the agricultural characteristics of the crop. *(Summary by A.P.)* H01.

1122-0925 LOPEZ, H. **Manihot shoots** *(Manihot esculenta). In*_____.Nutrient Composition of Cuban Foods. Journal of Food Science 28(5):602-610. 1965. Engl., 15 Refs.

Cassava. Human nutrition. Composition. Nutritive value. Shoots. Amino acids. Mineral content.

An analysis is made of the nutrient composition of cassava shoots. Data refer to content of moisture, ether, fibre, ash, minerals, vitamins and amino acids. Most of the paper is devoted to foodstuffs other than cassava. *(Summary by H.J.S.)* H01.

1123-3293 PELE, J. and LE BERRE, S. **Les aliments d'origine vegetale au Cameroun; les tubercules.** *(Vegetable foodstuffs from Cameroon; the tubers).* Le Cameroun Agricole Pastoral et Forestier no. 108:26-29. 1967, Fr., Illus.

Cassava. Yams. Taro. Cocoyams. Human nutrition. Nutritive value. Cameroon.

Brief notes are given on cassava, mainly concerning its utilization in human nutrition. Similar data are given of *Xanthosoma sagittifolium*, taro, yams and sweet potatoes. A classification is given of the Cameroon foodstuffs according to their botanical and nutritional characteristics. A table on chemical composition is also given. *(Summary by H.J.S.)* H01

1124-0525 ADRIAN, J. and PEYROT, F. **Possible use of the cassava leaf** *(Manihot utilissima)* **in human nutrition.** Plant Foods for Human Nutrition 2(2):61-65. 1971. Engl., Sum. Engl., 11 Refs.

Cassava. Cassava leaves (vegetable). Amino acids. Diets. Human nutrition. Composition.

Dry cassava leaves contains 20% fibrous matter and 30% protein, which is low in methionine but high in lysine, tryptophan and other essential amino acids. Cassava leaf proteins can supplement cereal diets more efficiently because their fibrous content only slightly affects their digestibility. Cassava leaves, enriched with a slight amount of lysine, reach a protein value that is 91% of that of milk protein when added to a cereal diet. *(Author's summary)* H01

1125-3272 PECHNIK, E. and GUIMARAES, L. R. **Sobre o aproveitamento da folha de mandioca (Manihot sp.) na alimentacao humana. I. Teor de acido cianidrico.** *(On the use of cassava, Manihot sp., leaves in human nutrition. I. Hydrocyanic acid content).* Arquivos Brasileiros de Nutricao 17:9-16. 1961. Port., Sum. Port., Engl., Fr., 23 Refs.

Cassava. Leaves. Boiling. Detoxification. Human nutrition. HCN content. Composition. Detoxification processes.

The authors studied the HCN content of cassava **Manihot** sp. leaves originating from Pernambuco. Analyses cover leaves that are fresh, dried and finely ground (meal), and cooked (1.2 and 3 h) meal that has been pressed and dehydrated. The observed decrease in HCN value, which declined from 23 mg| 100 mg in raw meal to 0.9 mg after 3 h of cooking, was much slower than that reported by other authors for cassava roots. The authors point out that caution should be exercised in dietary use of this material, which may be used for human consumption only after the toxic factor has been almost totally eliminated by some technological process. *(Author's summary)* H01 H04

1126-3281 SISKIND, J. **Manioc,a Sharanahua example.** Newark, N. J., Newark College of Arts and Sciences, 1971. 5p. Engl.

Presented at Symposium, "Manioc in Lowland South America," 1971.

Cassava. Uses. Human nutrition. Brazil.

This is a study (from an anthropological point of view) on the relationship between cassava cultivation and riverine or "true tropical forest culture," taking the Sharanahua Indians of the upper Purus River as ar example. Their methods of cultivation and preparation of foods are described. *(Summary by T.M.)* H01

1127-3277 GUERNELLI, O. **Estudo sobre as possibilidades de enriquecimento da farinha de mandioca** *(Study on the possibilities of enriching cassava meal).* Arquivos Brasileiros de Nutrição 9:205-240 1953. Port., 8 Refs.

Cassava. Cassava meal. Composition. Food enrichment. Processing. Vitamin content. Production. Humar nutrition. Brazil.

A program for enriching cassava meal with vitamins and minerals is presented. The author discusses the physiological role in human beings. Economic aspects of the program are also discussed. Tables are presented on the food composition of cassava and other starch products and on Brazilian production data for cassava and maize. Notes are included on anatomy, chemical composition of tubers and meal and mea manufacturing. *(Summary by H.J.S.)* H01

1128-3376 **NOTE SUR des analyses de fecule de manioc et de gari.** *(Notes on the analysis of cassava starcl and gari). In* Nogent-Maine, France. Section Technique de Agriculture Tropicale. Rapport annue 1954. 2p. Fr.

Cassava. Food products. Gari. Analysis. Organoleptic examination.

A study was carried out to establish standards for cassava starch and gari. Samples of these products were chemically and organoleptically analyzed. Results indicated that cassava starch is equal to the "superior" quality of potato starch. A survey was started among starch users to establish the standards for adoption. The author feels that gari is not of any commercial interest. *(Summary by H.J.S.)* H01.

1129-1717 PECHNIK, E. and GUIMARAES, L. R. **Sôbre o aproveitamento da fôlha de mandioca Manihot sp., na alimentação humana. IV. Efeito da suplementação de amino-ácidos sintéticos sôbre o valor alimentício da folha de mandioca-mansa secada ao ar e em refrigerador.** *(Use of cassava Manihot sp., leaves in human nutrition. IV. Effect of synthetic amino acid supplementation on nutritive value of sweet cassava leaves dried at room temperature and by refrigeration).* Arquivos Brasileiros de Nutrição 19(2):11-20. 1963. Port., Sum. Port., Engl., Fr., 2 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Leaves. Cassava meal. Drying. Amino acids. Analysis. Methionine. Protein deficiencies. Nutritive value. Lysine. Histidine. Human nutrition. Processing. Food enrichment. Brazil.**

The purpose of the present study was to determine the effects of meal prepared from sweet cassava leaves (*Manihot aipi* Pohl) dried at room temperature (± 25°C) and in a refrigerator (± 5°C), unsupplemented and with supplemental methionine, lysine and histidine (added individually or in combination) on the growth rate of young rats. The diet containing material dried in a refrigerator proved to be superior in most instances, except when supplemented with lysine and histidine individually. The best growth response was produced with diets supplemented with methionine alone. It should be noted that with 0.3% of methionine, the diet containing leaf meal dried in a refrigerator yielded results that compare well with casein. Thus, it seems that methionine is the most limiting amino acid of the cassava leaf protein. Determination of the point of interception indicated 0.3% as the minimal amount of methionine to produce optimal feed efficiency. Surprisingly, the addition of lysine and histidine resulted in a decreased feed efficiency and body weight gain. The reason for this depressing effect has not been determined, but it could possibly be attributed to an unfavorable balance of the aminoacids that make up the protein molecule of the leaf. *(Author's summary)* H01.

1130-3362 MORTON, J. F. **Tropical fruit tree and other exotic foliage as human food.** Proceedings of the Florida State Horticultural Society 81:318-329. 1968. Engl., 30 Refs., Illus.

Cassava. Leaves. Human nutrition. Nutritive value. Vitamin content. Protein content. Composition. Amino acids.

Information is given on several tropical tress and small plants, whose leaves are used for human nutrition and for animal feeding. Most data refer to plants other than cassava; however, young cassava leaves contain 6-10% protein and are fairly rich in methionine with large amounts of Ca, Fe, thiamine, riboflavin, niacin and ascorbic acid. Nitrogen content is high for a green vegetable. The new leaves and shoots are prepared and eaten like spinach, or chopped and added to soups, stews, etc. *(Summary by H.J.S.)* H01

1131-0929 OKE, O. L. **Chemical studies on some Nigerian foodstuffs, "lafun."** West African Journal of Biological and Applied Chemistry 8(3):53-56. 1965. Engl., Sum. Engl., 16 Refs.

Cassava. Food products. HCN. Oxalic acid. Processing. Ca. Drying. Dry matter. Human nutrition. Nutritive value. Toxicity. Protein content. Cassava pastes. Cassava meal. Composition. Mineral content. Ash content. Fibre content. Nigeria.

The changes that occur when cassava is processed to make "lafun" have been discussed in relation to the food value, mineral composition and poisonous substances (HCN and oxalic acid). In the process, nearly 70% protein is lost. In general there is an increase in the mineral content; the amount of Ca is almost doubled while about 1|5 of the P remains. *(Author's summary)* H01.

1132-3425 JADOT, J and MAGHUIN-ROGISTER, G. **Un disaccharide nouveau extrait de la farine de manioc. I. Establissement de la formule de structure.** *(A new disaccharide extracted from cassava flour. I. Establishing the structural formula).* Bulletin des Societes Chimiques Belges 77:569-574. 1968. Fr., Sum. Fr., Engl., 12 Refs.

Cassava. Cassava flour. Analysis. Glucose. Sugars. Hydrolysis.

A new disaccharide, isolated from cassava flour after hydrolysis and alcoholic fermentation, is composed of two d-glucose molecules linked by a 1-5 α glycosidic bond. Its structure has been determined by periodic acid oxidation and by comparison of its derivative properties with the properties of corresponding derivatives of known disaccharides. *(Author's summary)* H01.

1133-0522 RAO, K. K. P. N. **Cassava in the human diet.** FAO Nutrition Newsletter 8(3):31-32, 1970. Engl., Sum. Engl., 4 Bibl.

Cassava. Human nutrition. Diets. Cassava flour.

Cassava is playing an increasingly important role in the diets of the people of certain tropical areas of Africa, the Far East and Latin America. The cultivation of cassava has spread as a "famine reserve," mainly due to the ease of its production and its much higher yield in terms of calories than other common staples. However, cassava is very poor from the viewpoint of nutritional quality, especially in protein value. This poses a very serious nutritional problem, especially where it is used as a weaning food for babies. Recent interest in cassava has been stimulated by the possibility of using protein-enriched cassava flour in bread production. It is concluded that replacement of cereals by cassava is nutritionally detrimental and that cassava flour should be enriched with protein where-ever it is commonly used. *(Author's summary)* H01

1134-3419 GRIMME, C. **Uber Maniokmehl.** *(Cassava meal).* Zeitschrift für Untersuchung der Nahrungs und Genussmittel 41:172-175. 1921. Germ. 4 Refs.

Cassava. Cassava meal. Processed products. Composition. Carbohydrate content. Starch content. Mineral content.

This work describes briefly some aspects of cassava: origin, sweet and bitter varieties, botanical, anatomical and taxonomic characteristics, main uses in human and animal feeding, and cassava meal preparation. Emphasis is given to the components of the fresh root. Based on several experiments, the following conclusions were drawn: (1) The composition of cassava roots, as reported in literature, varies greatly because analyses are based on both peeled and unpeeled roots. (2) An average of 88.28% carbohydrates for the dry roots is a high estimate. The carbohydrates are 90% starch. (3) The ash of cassava roots is high in potassium and phosphoric acids. (4) The thickening ability of cassava starch is about equal to that of maize or wheat but is less than that of arrowroot or potato starch. *(Summary by A. van S.)* H01.

1135-3276 PECHNIK, E., GUIMARAES, L. R. and PANEK, A. **Sobre o aproveitamento da folha de mandioca, Manihot sp., na alimentação humana. II. Contribuição ao estudo do valor alimenticio.** *(On the use of cassava, Manihot sp., leaves in human nutrition. II. Contribution to the study of the nutritive value).* Arquivos Brasileiros de Nutrição 18(1-2):11-23. 1962. Port., Sum. Port., Engl., Fr., 26 Refs.

Cassava. leaves. Human nutrition. Lysine. Rats. Methionine. Nutritive value. Mineral content. Protein content. Vitamin content. Analysis. Diets. Amino acids. Composition.

In the present study carried out to assess the nutritive value of cassava leaves meal, the authors present the results of chemical composition, mineral and vitamin content. Qualitative analysis, carried out by paper chromatography, revealed the presence of 6 essential and 9 nonessential amino acids. The results obtained with biological tests were not encouraging for growing animals. This was true of both cooked and uncooked meal associated with cassava meal. Addition of small quantities of methionine and lysine produced no corrective action. *(Author's summary)* H01

1136-0528 ADRIAN, J. *et al.* **Etude nutritionnelle de la feuille de manioc,** ***Manihot utilissima.*** *(Nutritional study of cassava, Manihot utilissima, leaves).* Revista de Ciencias Agronómicas Lourenco Marques 2:43-60. 1969. Fr., Sum. Fr., Port., Engl., 15 Refs.

Cassava. Leaves. Lysine. Methionine. Digestibility. pH. ***Manihot esculenta.*** **Nutritive value. Human nutrition. Proteins. Deficiencies. Dietary value. Amino acids.**

The dry cassava leaf contains 30% proteins and 20% nondigestible glucide matter. The amino acids composition shows a serious deficit in methionine (-67%) but a high percentage of the other essential amino acids, in addition to more than 5% lysine. Because of the lack of methionine, the introduction of cassava leaves in a diet based on groundnuts and cassava tubers does not improve protein quality substantially. The increase in nondigestible carbohydrates does not affect digestibility. On the other hand, the introduction of the leaves in a whole grain (sorghum) diet improves protein quality because of the high lysine content in the leaves. The industrial extraction of proteins from cassava leaves is difficult because the nitrogenous fractios is soluble only at pH 12. Since the nondigestible matter does not affect the utilization of cassava leaves, their use is suggested in diets for adults (adding minute amounts of methionine) and for growing children (adding lysine) *(Author's summary)* H01

1137-3361 KWEE, W. H. *et al.* **Quality and nutritive value of pasta made from rice, corn, soya, and tapioca enriched with fish protein concentrate.** Cereal Chemistry 46(1):78-84. 1969. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Cassava flour. Soybean flour. Maize flour. Composite flours. Flours. Protein content. Nutritive value. Cooking. Human nutrition. Organoleptic examination. Rice. Food enrichment.

Fish protein concentrate (FPC) used to supplement rice, corn, soybean and cassava flours could contribute significantly to the protein intake of the population of developing countries. As pasta may well be considered a universal food, it was chosen as a carrier for FPC. The different pastas were evaluated organoleptically as well as objectively, and in animal feeding studies. Both 10 and 20% FPC additions were efficient in increasing the protein content and nutritional value. From sensory and objective evaluations, rice pasta appeared to be the most acceptable. Of corn, soybean and cassava pasta, cassava seemed most promising for further investigation; it had a more attractive color and counteracted grittiness in the FPC, but its texture became too soft during cooking. *(Author's summary)* H01

1138-3325 BAINS, G. S. *et al.* **Investigations on the utilization of tapioca flour for chapatis, pooris and vermicelli.** Bulletin of the Mysore Central Food Technological Research Institute 2:38-42. 1952. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Palatability. Human nutrition. Proteins. Drying. Cassava flour. Breads. Bakery products. Food products. Organoleptic examination. Analysis. India.

A simple method of processing cassava flour to be used instead of wheat flour in the preparation of "chapatis," "pooris" and vermicelli has been developed and standardized. Partial gelatinization of cassava flour with boiling water, prior to kneading, imparted certain desirable physical properties to the dough, almost similar to those of wheat flour dough. The optimum proportions of boiling water to cassava flour for making doughs suitable for chapatis and pooris on the one hand and for vermicelli on the other were found to be 1:1 and 3| 4:1, respectively. Addition of 20-30% cassava "soji" flour to plain cassava flour improved the handling properties of the dough. Organoleptic tests showed that these local products prepared from cassava compared favorably in quality and palatability to the corresponding products made from wheat flour. Cassava flour can be advantageously mixed with 10-15% of protein-rich flours made from common pulses, 5-10% of oilseed cake flours, as well as with flours of other common food grains. *(Author's summary)* H01

1139-4329 LOPEZ DE A., J. M., SANTOS R., A. and DEAN G., M. **Oligoelementos en alimentos españoles de origen vegetal. I. Cereales y legumbres.** *(Trace elements in Spanish foods of vegetable origin. I. Cereals and legumes).* Anales de Física y Química 41:1358-1367. 1945. Span., Sum. Span., 4 Refs.

Cassava. Cassava flour. Analysis. Biochemistry.

An analysis was made of trace elements in Spanish foods of vegetable origin. As regards cassava (starch), the following were found: ash (0.27%), silver (10^{-6}), aluminum, barium ($<10^{-4}$), calcium, copper (10^{-3} - 10^{-6}), iron (10^{-2}), potassium, lithium (10^{-4}), magnesium, manganese (10^{-4}), sodium, nickel ($>10^{-5}$), phosphorus, lead (10^{-2} - 10^{-3}), silicon (10^{-2}) and titanium (10^{-4}). The presence of nickel is accounted for by the fact that the samples of Spanish soils examined spectroscopically contained between 10^{-4} and 10^{-5} nickel. *(Summary by T.M.)* H01.

1140-5329 BOOHER, L.E., BEHAN, I. and McMEANS, E. **Biological utilizations of unmodified and modified food starches.** Journal of Nutrition 45(1):75-99. 1951. Engl., Sum. Engl., 20 Refs., Illus.

Cassava. Cassava starch. Biochemistry. Analysis. Digestibility. Particle size. Animal physiology. Modified starches.

Wide differences in physiologic assimilability were found in unmodified starches, from cereal grains (wheat, rice, maize and waxy maize), from aerial stems (sago palm) and from plant roots and subterranean stems (arrowroot, cassava, sweet potatoes and white potatoes). Unmodified starches isolated from cereal grains and cassava showed very high degrees of assimilability coincident with roughly 98% digestibility. From the standpoint of physiologic processes, the relatively low digestibilities of unmodified sweet potato, potato, arrowroot and sago starches were caused by an insufficient amount of amylase or of some agent in the digestive juices required to modify these starches prior to attack by amylase. From the standpoint of the digestion-resistant properties of these same starches, it appears that this property resides consistently and exclusively in the outermost layers of the organized granules and is therefore associated with the hydrogen bonding of these structures of with a granule integument of nonstarch substance. Conditions that increase the digestibility ot these starches include various modifications that produce obvious hydration of the granules, distinct changes in chemical nature, or disruption of the organized granule structures. Despite the **frequent** association between large-sized starch granules and digestion-resistant properties, data presented here suggest that this is merely coindicental and **not exclusive.** Lack of homogeneity as regards digestion-resistant properties among granular of such unmodified starches as those of potatoes or sago palm offers no basis for explaining the low digestibility coefficients of these starches. Technologically speaking, it is suggested that the digestion-resistant properties of starch granules from certain sources exist as a protective factor during storage in situ under conditions of high moisture. Unmodified wheat starch granules showing no signs of injury are quite susceptible to digestion in vitro by U.S.P. pancreating preparations, and very likely the same is true of cereal starches in general. *(Author's summary)* H01

1141-3229 ANASANWO, S. A. **The importance of cassava as food.** Farm and Forest 3:185-187. 1942. Engl., 1 Ref.

Cassava. Human nutrition. Processing. FooFoo. Gari. Cassava products. Food products. Fermented products. Uses. Cassava starch. Cassava flour. Nigeria.

Brief notes are given on the preparation of cassava starch and some of its food products. Information deals with foofoo, gari (white and yellow) and cassava flour. *(Summary by H.J. S.)* H01 102

T-1692

1142-3179 **PRATOS FEITOS a base de mandioca.** *(Dishes based on cassava).* Brazil, 1973. 3p. Port.

Cassava. Human nutrition. Tubers. Leaves. Brazil.

Five recipes are given using cassava tubers and leaves. *(Summary by H.J.S.)* H01

1143-2334 **LE TAPIOCA; valeur nutritive et utilisation diététique.** *(Tapioca, nutritive value and dietary uses).* Paris, Institut Français du Manioc, 1960. 8p. Fr., 6 Refs.

Cassava. Tapiocas. Food products. Uses. Human nutrition. Nutritive value. Food energy. Dietary value.

The energy value of tapioca is comparable to wheat and potato flours. Milk is rapidly digested when accompanied with tapioca. Since presence of proteins and amino acids modify starch digestion by means of enzymatic blocking, and experiment was undertaken to determine wheter milk was digested differently according to the origin of the accompanying starch. Three pastes made of milk, wheat flour, potato flour and maize or cassava starch were submitted to the action of pepsin and trypsin; peptic digestion of cassava starch was weaker (8%), but followed by a particularly strong tryptic digestion (36%). Tapioca is considered a light food; its cation content is 0.88 (meq| 100 g D.M.). *Summary by J.L.S.)* H01

1144-3799 AGARWAL, P. N. **Adverse effect of mixing tapioca and sweet potatoes in wheat flour.** Current Science no. 8:294. 1949. Engl.

Cassava. Cassava flour. Wheat flour. Human nutrition. Diets. Proteins. Food enrichment. India.

The Indian Ministry of Food recommended the mixture of cassava and sweet potato meal with wheat flour to meet the country's food shortage. However this mixture could produce an adverse effect on the people's health as a result of their poorly balanced diets. The resulting mixture of these flours has less protein and fat and much more carbohydrate; these changes are proportionate to the quantity of cassava or sweet potatoes incorporated. In order to make this project practicable, the proposed mixture will have to be fortified with good-quality proteins and yeast, a rich source of the Vitamin B complex. *(Summary by L. C. Trans. by T.M.)*

1145-3226 CASSAVA IN **new-type bread from non-wheat flours.** Journal of the Agricultural Society of Trinidad 71(1):28-29. 1971. Engl.

Cassava. Cassava flour. Wheat flour. Composite flours. Human nutrition. Breads. Economics. Trinidad and Tobago.

The traditional bread loaf, a valuable protein food, is made from wheat, which does not readily grown in tropical and subtropical areas. Wheat importation imposes a drain on badly needed foreign exchange. An acceptable bread was produced using only 60% wheat, the remainder being cassava starch and high-protein soy flour. *(Summary by H.J.S.)* H01

1146-3223 INSTITUTO NACIONAL DE NUTRICION. (Colombia). **Tabla de composición de alimentos colombianos.** *(A table on the composition of Colombian foodstuffs).* Bogot a, 1967. 4p. Span., 14 Refs.

Cassava. Cassava flour. Cassava starch. Cassava bread. Cassave. Food energy. Composition. Colombia.

In addition to other foods, the chemical composition of edible portions of cassava starch, dry and toasted cassava flour, dried meal cake and Bogota cassava bread, which is a special bread prepared with 1 part cassava starch, 2 parts maize and 2 parts cheese, are presented in table. *(Summary by J.L.S.)* H01

1147-3217 KOCH, L. **Producten van de cassaveplant.** *(Products of the cassava plant).* De Indische Mercuur, Amsterdam; Juli 4, 1934:411-413. Dutch., 65 Refs.

Cassava. Tubers. Animal nutrition. Human nutrition. Gaplek. Processing. Uses. Industrialization. Fresh products. Cassava tubers (vegetable). Processed products. Cassava products. Dried tubers. Cassava starch. Cassava flour. Cassava leaves (vegetable).

The fresh roots are used for feedstuffs for swine, calves, cows, etc. The young fresh roots are sometimes eaten raw by human while goats get the peeles. The roots are boiled and used for human consumption, they are sometimes also eaten fried or steamed. Fermented flour is baked into cakes and eaten. Fresh, undamaged roots can be stored for some weeks in a dry, dark place. Gaplek (sun-dried, sliced or ground cassava roots) is used for several purposes. It is used for human and animal nutrition to replace part of the maize diet. Gaplek is also used for starch, alcohol or flour preparation. Cassava starch is also mechanically obtained and used for many purposes; e.g., in the textile industry, mixed with wheat flour for bread, etc. Leaves are a good vegetable or are used for baking. *(Summary by A. van S.)* H01 I02

1148-4385 MELOTTI, L. **Contribuição para o estudo da composição química e valor nutritivo dos resíduos da industrialização da mandioca, *Manihot utilissima* Pohl, no estado de São Paulo.** *(Contribution to the study of the chemical composition and the nutritive value of cassava, Manihot utilissima Pohl, root industrial residues in the state of Sao Paulo).* Boletim de Indústria Animal (Brazil) 29(2):339-374. 1972. Port., Sum. Port., Engl., 93 Refs.

Cassava. Wastes. Nutritive value. Analysis. Dry matter. Fibre content. Protein content. Fat content. Ca. Mineral content. N. Factories. Brazil.

Because of the scarcity of raw materials in the animal feed industry the use of certain by- products is being studied. Chemical analyses were made as to the nutritive value of 35 samples of cassava (*Manihot utilissima* Pohl) was products from different industries in the state of Sao Paulo. Samples included (a) fibrous residue from starch extraction, (b) middlings from cassava flour, (c) middlings from grated cassava meal, and (d) waste products from washing cassava and from the sweepings around the desiccator. Analysis was made for dry matter, crude protein, crude fiber, ash, ether extract, N-free extract, Ca, P, cellulose, soluble ash and silica. Total Digestible Nutrient values were estimated according to the formula established by Schneider et al; results are given in tables. No significant statistical differences were found among estimated TDN values. Chemical composition showed that the by-products were low in protein, in ash (mainly P) and in ether extract; they were high in N-free extract. Some variations were observed, probably because of different processing methods employed in industrial plants and variations in cassava varieties. As a source of energy in animal feeds, the carbohydrate content of these by-products was good; the content of N-free extract was better than corn, sorghum and most samples of sweet potatoes. *(Author's summary)* H01

1149-1671 HANSSON, N. and BENGTSSON, S. **Tapiokarotternas sammansattning och fodervarde.** *(The composition and food value of cassava roots).* Landbruksakademiens Handlinger och Tidskrift 69:132-147. 1929. Swed., Sum. Germ.

Cassava. Tubers. Cassava meal. Protein content. Fat content. N. Carbohydrate content. Nutritive value.

Cassava meal gave the following analysis: crude protein 1.79%, albumin 0.77%, fats 0.61% and N-free extracts 80.05%. For maize the corresponding figures were 10.0, 6.5, 4.7 and 67.1%. While cassava meal is deficient in protein, albumin and fats, it contains many more carbohydrates than maize; 100 kg cassava should contain about 105-106 food units, or about the same as medium-quality maize. It is a rather one-sided food, but if products high in albumins and fats (such as fish meal) are added, ti becomes a very desirable food for hogs. *(Summary by Chemical Abstracts)* H01

1150-4878 TASKER, P. K. **Supplementary value of groundnut flour and blends of groundnut flour and skim milk powder to a maize-tapioca diet.** Food Science 11(6):181-186. 1962. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Cassava flour. Groundnut flour. Maize flour. Dietary value. Laboratory animals. Diets. Animal physiology. Biochemistry. Protein deficiencies. India.

A diet based on a 1:2 blend of maize and cassava had a low protein content (5.08%) and promoted very little growth (0.63g|wk) in albino rats. Supplementation of the diet with groundnut flour, skim milk powder or a mixture of the two so as to provide 15% extra protein in the diet resulted in a highly significant ($P < 0.001$) increase in the growth rate of rats (17.5-19.1 g|wk). There were no significant differences in the mean weekly growth rates of rats receiving the protein supplements. The serum albumin content of rats receiving the maize-cassava diet was lower than those of rats receiving the protein supplements. The mean fat content of livers of rats fed on the maize-cassava diet was significantly ($P > 0.001$) higher and the protein content significantly lower ($P > 0.001$) than those of rats receiving the protein supplements. There was a moderate degree of parenchymal damage of the protein deficiency type and severe periportal fatty infiltration in the livers of rats receiving the maize-cassava diet. On the other hand, the livers of animals receiving the protein supplements were quite normal, indicating that when providing 15% extra protein, a food based on 4:1 blend of groundnut flour and skim milk powder was as effective as skim milk powder in correcting the protein deficiency in the diet and in preventing liver damage. There were no significant differences in the mean retentions of protein (19.86-20.72g) per 100g increase in body weight of rats receiving skim milk powder or a protein food based on a 4:1 blend of groundnut flour and skim milk powder. *(Author's summary)* H01

1151-3057 SCHMIDT, H. L. **Die Mikroflora der Maniokafuttermittel.** *(Microflora of cassava food products).* Getreide und Mehl 16(10):105-110. 1966. Germ., Sum. Germ., 19 Refs.

Cassava. Cassava products. Processed products. Cassava meal. Cassava chips. Pests. Diseases and pathogens. Mycoses. Bacterioses. Aspergillus.

In an analysis of 50 cassava food products from different origins, a high level of bacteria and fungi was frequently found. Half the samples contained more than 18 million bacteria|g, among which there were aerobic spore formers. In 78% of the material enterococci were found; and in approx. 10% of the cases, Cytophagaceae appeared. Salmonella were found in cassava meal. Almost 1|3 of the samples contained high levels of fungi (over 100,000|g), and approx. 1|4 of the meals and chips contained more than 200,000 fungi|g. Among the Aspergillaceae predominent in flora, *Aspergillus flavus*, *A. fumigatus*, *A. chevalieri* and *Penicillium rubrum* all causing mycoses were found. There were also sizable quantities of *A. terreus*, which was te only fungi previously reported in cassava food products. The composition of the microflora and the mineral particles found on a number of chips indicate that soils are highly contaminated, which often leads to the slow deterioration of the product. The amount of free sugars in the tubers is sufficient to allow the microorganisms to grow. There was no relation between the shipping grade and the germ content of cassava meals. Meal color and texture were influenced by different factors: The yellow coloring of the meals was caused by polyphenol oxidase and occurs in the cork cambium first. The high microorganism content of many cassava food products may make them harmful for human consumption unless they are adequately prepared. *(Author's summary)* H01 E01

1152-0805 ELIAS, L. G., BRESSANI, R. and BUSTO, J.A. DEL. **Evaluación de la calidad de la proteína de alimentos de bajo contenido proteínico.** *(Evaluation of the protein quality of low protein foods).* Arquivos Latinoamericanos de Nutrición 24(1):81-96. 1974. Span., Sum. Span., Engl., 24 Refs., Illus.

Cassava. Protein content. Dietary value. Nutritive value. Food enrichment. Amino acids. Rice. Maize. Potatoes. Cassava meal. Guatemala.

Foods containing less than 10% protein are consumed in large amounts by large population groups. Because of their importance as sources of protein, it is necessary to evaluate their protein quality more precisely. Present biological evaluation methods specify 9-10% protein in the diet to be fed; therefore, most foods with these or lower amounts of protein cannot be evaluated according to the standard procedure. This report describes a method whereby the quality of low-protein foods can be evaluated. It compares the weight gained in rats in 28 days in relation to the protein intake of diets containing from 0 to 7 or 8% protein in the diet. The response is linear, which permits the calculation of a regression equation between protein intake and weight gain. The regression coefficient represents the quality of the protein. The method was applied to various samples of rice and corn, as well as to samples of potato flour and cassava flours, which had the lowest protein content (1.4 g| 100 g). An inverse relationship was found between protein content in the cereal grains and protein quality, which was not evident when the conventional methods were applied. *(Author's summary)* H01

1153-4929 RIBEIRO, O. **A acidez das farinhas de raspa de mandioca.** *(The acidity of grated cassava flour).* Anais da Associação Quimica do Brasil no. 1:264-269. 1942. Port., 4 Refs.

Cassava. Cassava flour. Analysis. pH. Brazil.

The acidities of 56 samples of grated cassava flour were determined by titrating a 10% suspension in 95.5% ethyl alcohol after standing for 24 h; the pH of the same samples on a 10% suspension in water after 30 min was also determined with a glass electrode. Previous drying or humidifying of the samples had no effect on either total acidity or pH; but if alcohol of lesser strength is employed, the acidity increases. The titrated acidity of the samples ranged from 0.05-10.25 cc N alkali| 100 g, the pH from 4.8-6.6. There is no fixed relation between them; in many cases samples high in total acid nevertheless had a high pH. This is attributed to buffers, varying in nature and quantity, present in the flours. Flours to be used for bread-making should have a maximum titrated acidity of 3.0 cc N alkali| 100 g. It is not necessary or desirable to replace this determination by that of pH. *(Summary by Chemical Abstracts)* H01.

1154-3106 HANSSON, N. and BENGTSSON, S. **Zusammensetzung und Futterwert der Tapiokawurzeln.** *(Compositoin and feed value of cassava roots).* Tierernahrung 1(4):369-387. 1930. Germ.

Cassava. Maize. Cassava flour. Potato flour. Fat content. Dietary value. Composition. Nutritional value. Animal nutrition. Swine. Palatability. Domestic animals.

Cassava flour is a very limited nutrient, with a low protein or fat content, but with a high and valuable carbohydrate content. It compares with potato flour but contains less proteins. With the addition of high-quality protein (fish flour) cassava flour is a good gattening medium for swine. It can be used to replace up to

65-70% of the total rations (1.3-1.4 kg| animal| day). One kg cassava flour can replace 1 kg wheat or maize; there are indications that cassava flour is used better when fed with wheat than with maize. The general food value of cassava flour is about equal to that of maize. Cassava flour like maize, tends to produce fat. Cassava flour was given mixed and fed dry, together with cheese factory by-products. When moistened long before feeding, it loses some of its palatability. *(Summary by A. van S.)* H01.

1155-0412 **MANDIOCA FORTIFICATION meeting,** Rio de Janeiro, 1971. 25p. Engl.

Cassava. Cassava flour. Food enrichment. Proteins. Methionine. Lysine. Cassava programs. Human nutrition. Brazil.

A meeting was held in Brazil in July, 1971 to discuss the results of studies carried out on the enrichment of cassava *(Manihot esculenta)* flour. The following conclusions were accepted as guidelines: The artificial enrichment of cassava flour constitutes a temporary solution, restricted to the evolutionary period of the country, characterized by low purchasing power and low cultural level of a large portion of the population. An increase of the protein level of cassava flour is being sought through crossing of wild varieties of cassava with domestic varieties in use and through the enrichment of cassava flour with fish protein concentrate, calcium caseinate, soy protein isolate, soy milk residue and synthetic amino acids (methionine, lysine). From the technological standpoint, cassava flour enriched with soy protein isolate presents a good level of protein and maintains the organoleptic characteristics of a good-quality flour. The group recommended that genetic studies be continued in order to increase the nutritional (protein) value of *M. esculenta.* Studies on nutritional aspects, in both animals and humans, should be encouraged in order to develop the most efficient an inexpensive products. Fortification formulae should be determined and their respective costs established once they have been tested thoroughly. Taste and acceptability tests should also be continued. *(Summary by H.J.S.)* H01

1156-5324 KAMALA, B. and SREERAMAMURTHY, V.V. **Liberation of tyrosine, tryptophane, cystine and arginine from proteins.** Indian Journal of Medical Research 32(2):145-148. 1944. Engl., Sum. Engl., 10 Refs.

Cassava. Proteins. Analysis. Tyrosine. Tryptophane. Cystine. Arginine. India.

Seven proteins (including cassava) prepared from a variety of sources, after 18-20 h hydrolysis, were analyzed for 4 essential amino acids; viz, tyrosine, tryptophane, cystine and arginine. Complete liberation of the amino acids was achieved by hydrolysis of the proteins in an autoclave for 30-45 min at 15 lb pressure and at 120°C. The results given by the new procedure agreed well with those given by earlier methods. Recovery of cystine and arginine added to protein solutions prior to autoclaving was good. cassava protein was found to contain these essential amino acids in adequate amounts. It is especially rich in arginine. The low nutritive value of cassava appears to be attributable to the quantity rather than the quality of the protein it contains. *(Author's summary)* H01

1157-4879 VENKAT RAO, S. *et al.* **Studies on a processed protein food based on a blend of groundnut flour and full-fat soya flour fortified with essential amino acids, vitamins and minerals.** Journal of Nutrition and Dietetics (India) 1(1):8-13. 1964. Engl., Sum. Engl., 9 Refs.

Cassava. Cassava flour. Groundnut flour. Soybean flour. Food enrichment. Amino acids. Minerals. Vitamin content. Diets. Maize flour. Protein deficiencies. Laboratory animals. Dietary value. Animal physiology. Biochemistry. India.

A diet based on a 1:2 blend of maize and cassava contained only about 5% protein and did not promote any growth in rats. Supplementation of the diet with a protein food based on a 1:1 blend of full-fat soy flour and groundnut flour fortified with l-lysine and dl-methionine so as to provide 10% extra protein in the diet resulted in a highly significant increase in the growth rate of rats, comparable to that obtained with a supplement of skim milk powder. The serum of rats receiving the maize cassava diet had a lower albumin content and a higher -globulin content than that of rats receiving the protein foods. The mean fat content of the livers of rats fed on the maize-cassava diet was significantly higher and the protein content significantly lower than those of the rats fed on the supplemented diets. The xanthine oxidase activity of the livers of rats receiving the maize cassava was very low. Supplementation of the diet with the protein food resulted in a marked increase in the activity of the enzyme. The mean protein and fat contents of the carcass of rats fed on the maize-cassava diet were significantly lower than those of rats receiving the protein supplements. The livers of rats fed on the maize-cassava diet showed a moderate degree of cytoplasmic vacuolation of the protein deficiency type and severe periportal fatty infiltration. On the other hand, the livers of rats receiving the protein food and skim milk powder were quite normal, indicating that supplementation of the maize-cassava diet with a protein food based on soy flour and groundnut flour at 10% extra protein level is as effective as skim milk powder in correcting the protein deficiency in the diet and in preventing liver damage *(Author's summary)* H01.

1158-0810 KOHLMANN, R. F. **Acceptability of enriched cassava flour with isolate soy protein in the institutional nutrition.** Sao Paulo, Sanbra, 1972. 7p. Engl.

Paper presented at the III Meeting About Enrichment of Cassava Flour, Rio de Janeiro, 1972.

Cassava. Cassava flour. Food enrichment. Proteins. Methionine. Palatability. Human nutrition. Brazil.

Research was carried out in Brazil to study the quality and acceptability of enriched cassava flour in the preparation of "farofas" and paps at a level of 7% Proteimax 90 (an isolated soybean protein having 90% protein), fortified with 1% methionine. An organoleptic test was conducted in a restaurant serving the product to more than 600 people. There was 100% acceptability with regard to taste. *(Summary by T.M.)* H01

1159-4880 SUBRAHMANYAN, V. *et al.* **Large-scale feeding experiments with Mysore flour in distress areas of Madras State.** Mysore, India, Central Food Technological Research Institute. Bulletin no. 3. 1954. pp.267-269. Engl., Sum. Engl., 7 Refs.

Cassava. Mysore flour. Diets. Nutritive value. Digestibility. Protein content. Vitamin content. Mineral content. Food energy. Human nutrition. India.

Large-scale feeding experiments with Mysore flour (a mixture of 3 parts cassava flour and 1 part groundnut flour) were carried out at 5 gruel centers in Madras State. The gruel was relished by the recipients, and there was no complaint of digestive troubles. The gruel supplement increased to a considerable extent the intake of calories, proteins and vitamin B complex, which were deficient in the basal diet. The investigation shows that Mysore flour can be used to advantage as a partial substitute for cereals in the diet of the poorer classes of people. *(Author's summary)* H01

1160-4542 GUIMARAES, M. L. and BARROS, M.S.C. DE. **Sobre a ocorrencia de β caroteno em variedades de mandioca amarela** *(The occurrence of β-carotene in varieties of yellow cassava).* Brasil. Ministerio de Agricultura. Divisão de Tecnologia Agrícola e Alimentar. Boletim Técnico no.4. 1971. 4p. Port., Sum. Port., Engl., 3 Refs.

Cassava. Cultivars. Vitamin A. Analysis. Cassava meal. Cassava flour. Cassava milk. Laboratory experiments. Brazil.

Total carotenoids, total carotenes and B-catotene were determined in 2 yellow varieties of cassava from Amazonas. The products examined were meal, flour, and latux. β-corotene was isolated and identified by means of its chromatographic behavior on clumn as well as thing layers, color reactions and the infrared spectru. Some observations were included on the influence of the age of the plants and samples on the carotenoid content. *(Author's summary)* H01

1161-0905 DENDY, D.A.V. and CLARKE, P. A. **Interim report on the use of non-wheat flours in breadmaking.** London. Tropical Products Institute Report no. G50. 1969. 26p. Engl., Sum. Engl., Illus.

Cassava. Human nutrition. Wheat flour. Cassava flour. Proteins. Soybeans flour. Bakery products. Composite flours. Breads. Analysis. Cassava bread. England.

Experiments in the Test Bakery at the Industrial Development Department of TPI have led to the development of good-quality bread, made by mechanical dough development from a blend of 50% wheat flour and 50% cassava starch. This bread can be satisfactorily fortified with protein concentrates derived from coconut or soy bean, for example; this has been done successfully in a commercial bakery. Full details are given of the work carried out during the evolution of suitable formulas and methods, and a brief note on future work is appended. *(Author's summary)* HOI 102

See also *0124 0134 0149 0162 0174 0175 0208 0220 0332 0453 0572 0725 1371 1419 1432 1497 1512 1538 1550 1560 1581 1615 1631 1647 1699 1716 1718 1758 1774 1775 1777 1778 1780 1782 1783 1787 1841 H01*

H02 Nutritive Disorders in Humans

1162-2380 WILSON, J. **Cyanide and human disease.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp. 121-125. Engl., Sum. Engl., Fr., 20 Refs.

Cassava. Human health. HCN. Anaemia. Thiocyanates. Vitamin B_{12}. Ataxic neuropathy. Human nutrition. Clinical manifestations. Toxicology. Cyanides.

There is only circumstantial evidence linking human disease to chronic cyanide exposure although there are many papers describing a variety of neuropathological changes in experimental animals. The diseases which have so far been considered to result from abnormal detoxication of cyanide (mostly derived from tobacco smoke) are retrobulbar neuritis in pernicious anaemia, tobacco amblyopia, subacute combined degeneration of the cord in vitamin B_{12} deficiency, Leber's hereditary optic atrophy, and dominantly inherited optic atrophy. In the first case, the abnormal sensitivity to cyanide may be conditioned by acquired vitamin B_{12} deficiency. In Leber's disease an inborn metabolic error may prevent mobilization of substrates sulfur containing for thiocyanate formation. In dominantly inherited optic atrophy, the metabolic basis is not known, but there is an abnormally high concentration of cyanocobalamine present in the plasma of most patients. While it is acknowledged that the etiology is probably multifactorial in the ataxic neuropathy of West Africa, heavy exposure to cyanide or cyanogens from cassava may be particularly damaging in the nutritional context of lack of protein and riboflavin. *(Author's summary)* H02

1163-0352 EKPECHI, O.L., DIMITRIADOU, AU. AND FRASER, R. **Goitrogenic activity of cassava (a staple Nigerian food).** nature 210(5041):1137-1138. 1966. Engl., 14 Refs.

Cassava. Diets. RAATS. Iodine. Animal physiology. Animal nutrition. Analysis. Laboratory experiments. Deficiency diseases. Deficiencies. Endocrine disorders. Etiology. Nigeria.

Five different diets, each at 10 g| day, were given to a group of 3 female albino rats for 7 days. The diets were a standard Bruce and Parkers diet; an iodine-deficient diet with 100 μg I | kg; 100% cassava; 50% cassava; and 50% standard diet; or 100% cassava with tap water containing 40 μg I| 100 ml and added vitamin drops. Carrier-free ^{131}I, 20 μc, was injected intraperitoneally into each rat 24 h before it was killed. Thyroid function was estimated from thyroid weight in mg| 100 g body weight, percentage of dose of ^{131}I taken up by the thyroid in 25 h, and serum protein-bound ^{131}I after 24 h as a percentage of dose per ml. Digests of thyroid tissue were used to find total I concentration and the monoiodotyrosine diiodotyrosine ratio and the presence of thyroxine or triiodothyroxine as a proportion of the total ^{131}I in the gland. Marked decreases in precursor and hormone I stores, a high mono- to diiodotyrosine ratio, high transfer of ^{131}I to iodothyronines and increases in serum protein-bound ^{131}I and thyroid weight occurred after cassava diets, even when I was added. Uptake of ^{131}I by the thyroid was increased after the cassava or I-deficient diets but was normal after cassava with I supplements. It is suggested that the cassava diet is not only I-deficient but also contains a goitrogen. *(Summary by Tropical Abstracts)* H02

1164-0723 MONEKOSSO, G. L. and WILSON, J. **Plasma thiocyanate and vitamin B12 in Nigerian patients with degenerative neurological disease.** Lancet 1(7446):1062-1064. 1966. Engl., Sum. Engl., 31 Refs.

Cassava. Human health. Diets. Vitamin B12. HCN. Absorption. Detoxification. Metabolism. Cyanides. Etiology. Clinical manifestations. Gari. Thiocyanates. Malnutrition. Nigeria.

Epidemiological studies in western Nigeria have suggested that high dietary cyanide intake in a malnourished population may be a contributory factor in the pathogenesis of certain endemic, degenerative, neurological disorders because of the neuropathic effects of chronic exposure to cyanide. Comparison of plasma thiocyanate concentrations and serum-vitamin B12 levels in patients with such conditions to levels in control groups confirms that these patients have a high cyanide intake. *(Author's summary)* H02

1165-1775 OSUNTOKUN, B. O. and OSUNTOKUN, O. **Tropical amblyopia in Nigerians.** American Journal of Ophthalmology 72(4):708-716. 1971. Engl., Sum. Engl., 42 Refs., Illus.

Cassava. Clinical manifestations. Cyanides. Metabolism. Thiocyanates. Etiology. Biochemistry. Human physiology. Hydroxocobalamin. Vitamin B12. Toxicology. Human health. Diets. Nigeria.

In Nigerians tropical amblyopia is a major component of a syndrome of tropical ataxic neuropathy which comprises bilateral optic atrophy, sensorineural deafness, myelopathy and polyneuropathy. In a series of 360 Nigerian patients with this disease, more than 80% had visual signs and symptoms. In 18 patients, visual symptoms antedated other manifestations of the disease. Severe impairment of visual acuity, sometimes progressing to complete blindness, bilateral temperal pallor, and complete optic atrophy were common findings. The commonest visual field loss was peripheral constriction (in 84%). Central or paracentral scotomas were uncommon. This suggests that retrobulbar neuritis was uncommon and that relatively unprotected retinal receptors in the periphery and the macula were damaged by a diffusible toxin. In the Nigerians, such a toxin is probably cyanide of dietary origin (from cassava meals). *(Author's summary)* H02

1166-1605 OSUNTOKUN, B. O., SINGH, S. P. and MARTINSON, F. D. **Deafness in tropical nutritional ataxic neuropathy.** Tropical and Geographical Medicine 22(3):282-288. Engl., Sum. Engl., 30 Refs.

Cassava. Ataxic neuropathy. Clinical manifestations. Toxicology. Human nutrition. Etiology. Human physiology. Cyanides. Diets. Nigeria.

The Nigerian nutritional ataxic neuropathy comprises panmyelopathy of insidious onset, bilateral optic atrophy, nerve deafness, and polyneuropathy in varying combinations. Tinnitus and impaired hearing are common symptoms in the NNAN, occurring in about two-fifths of 320 patients, tinnitus being slightly more frequent than impaired hearing. Tinnitus and impaired hearing are very rarely the initial symptoms of the syndrome. In descending order of frequency, paraesthesiae or dysaesthesiae in the lower limbs, visual symptoms, ataxic gait, tinnitus, deafness and weakness of lower limbs are the commonest symptoms. Vertigo and diplopia are extremely rare. Otological investigations show that deafness is sensorineural or perceptive. At audiometric examination, in mild impairment of hearing, there is loss of hearing in low and high frequencies. Abnormal temporary threshold drift is found at low frequencies (250-1000 cps) in patients with less severe impairment of hearing. Caloric tests are usually normal. These suggest retrocochlear lesion. It is suggested that the cause of the impaired hearing is due to demyelination of the auditory nerve, as found in the peripheral nerves of the lower limbs in these patients. The evidence which incriminates chronic cyanide intoxication of dietary origin as the cause of the demyelination is briefly presented. The main source of the cyanide is culinary derivatives of cassava. *(Author's summary)* H02

1167-3764 DAWOOD, M. Y. **Acute tapioca poisoning in a child.** Journal of the Singapore Pediatric Society 11(2):154-158. 1969. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Toxicity. Human health. HCN. Cyanides. Rhodanese. Enzymes. Detoxification. Analysis. India.

A case of tapioca poisoning in a 3 1 | 2-year-old Indian child is reported. A brief review of the toxic properties of tapioca, its adverse effects in man, its detoxification in the body, and treatment of such poisoning is discussed. *(Author's summary)* H02 H04

1168-1586 AYANRU, J. O. **Blindness in the midwestern state of Nigeria.** Tropical and Geographical Medicine 26(3):325-332. 1974. Engl., Sum. Engl., 24 Refs.

Cassava. Clinical manifestations. Toxicology. Human health. Nigeria.

The major blinding conditions in the midwestern state of Nigeria are cataract (33.2%), uveitis (20.4%), chronic simple glaucoma (17.1%), trauma (7.9%). The primary causes of uniocular blindness are uveitis (28.3%) cataracts (23.9%), chronic simple glaucoma (13.2%) and trauma (9.9%). Comparisons of the main causes of blindness in midwestern, northern, western and eastern Nigeria and Great Britain are made. *(Author's summary)* H02 H04

1169-0988 BAILEY, K. V. **Food problems in Indonesia.** Australian Outlook 14(3):299-305. 1960. Engl., 6 Refs.

Cassava. Malnutrition. Rice. Forestry. Hunger oedema. Protein deficiencies. Maize. Legume crops. Sorghums. Human physiology. Human nutrition. Indonesia.

A study is made of the effects of malnutrition, especially in the Gunung Kudul limestone area of southern Java, where cassava is the staple food so the diet is very poor in protein. The Indonesian Government propagates the extension of cassava planting, contrary to FAO recommendations. The diet could be improved by increased production of pulses, maize and sorghum and by the milking of goats. It would be desirable to transfer a large proportion of the population to more fertile areas, followed by large-scale reforestation with *Leucaena glauca* and *Acacia villosa.* The author suggests the formation of a World Fertilizer Pool to distribute fertilizer to underdeveloped regions. *(Summary by Tropical Abstracts)* H02

1170-1687 NAISMITH, D. J. **Kwashiorkor in western Nigeria: a study of traditional weaning foods, with particular reference to energy and linoleic acid.** British Journal of Nutrition 30(3):567-573. 1973. Engl., Sum. Engl., 20 Refs.

Cassava. Human nutrition. Human health. Maize. Yams. Malnutrition. Human health. Kwashiorkor. Diets. Deficiency diseases. Food energy. Composition. Fat content. Protein content. Protein deficiencies. Carbohydrate content. Nigeria.

The fatty-acid composition of the plasma total lipids of children with kwashiorkor and of healthy infants was determined by gas-liquid chromatography. Breast milk from Yoruba mothers and traditional weaning foods were also analyzed for fatty acids and for protein, fat and carbohydrates. Evidence of essential fatty acid (EFA) deficiency was obtained in the children with kwashiorkor. The proportions of linoleic and arachidonic acids were reduced in the plasma lipids, whereas the endogenous eicosatrienoic acid showed a marked increase. The triene:tetraene ratio 'ad the abnormally high value of 1.08. These changes were consistent with the prolonged ingestion of suboptimal amounts of linoleic acid. Breast milk was of good quality, with a particularly high concentration of retinol. The milk was also rich in linoleic acid, and was thus discounted as a factor in the development of EFA deficiency, but the weaning foods were found to provide substantially less than the minimum recommended intake of 1% of the total energy as linoleic acid. The maize pap with which the children with kwaskiorkor had been fed for several months before the appearance of acutes symptoms provided almost 7% of the energy as protein, but only 1.21 MJ(290 kcal)| kg. To satisfy energy requiments, it would have been necessary to consume 3-4 kg of the pap each day. It is concluded that the protein deficiency which leads to the development of kwashiorkor in the Yoruba community arises from a very severe restriction in energy intake rather than from the consumption of foods very low in protein at adequate or excessive levels of energy intake. *(Author's summary)* H02

1171-3905 ERMANS, A. M. *et al.* **Goitrogenic action of cyanogenic glucosides present in cassava: a possible etiologic factor of endemic goiter in the Idjwi Island (Kivu).** Acta Endocrinologica (Denmark) no. 179:31. 1973. Engl.

Cassava. Cyanogenic glycosides. Iodine. Metabolism. Linamarin. Endemic goitre. Toxicology. Thiocyanates. Zaire.

Data reported by Delange et al. (Amer. J. Clin. Nutr. 24: 1354, 1972) suggest that the high prevalence of endemic goiter on Idjwi Island is related to the simultaneous influence of iodine deficiency and the consumption of large amounts of cassava. The object of the present study was to investigate the antithyroid activity of linamarin, a cyanogenic glucoside of cassava, whose degradation mainly leads to the production of thiocyanate. (1) The investigations first show that in rats, continuous intake of cassava can cause changes in iodine and thiocyanate metabolism which are both qualitatively and quantitatively identical to those obtained by prolonged administration of thiocyanate. (2) Ingestion of thiocyanate or cassava entails marked depletion of iodine stores; depletion is fairly moderate in iodine-supplemented rats. This depletion is very severe in iodine deficient rats and is associated with major changes in intrathyroidal metabolism which iodine deficiency alone is incapable of causing. (3) Chronic ingestion of thiocyanate does not necessarily cause blocking of the thyroidad iodide pump; iodine uptake by the gland seems, on the contrary, to be increased, probably due to thyrotropic stimulation triggered by iodine depletion. This does not preclude transitory inhibition during the phase of thiocyanate absorption. (4) Administration of thiocyanate or its precursors even in increasing doses does not necessarily entail a very marked rise of SCN concentration in the blood. Evidence of increased ingestion is only obtained by measurements of urinary excretion or estimation of plasma turnover of SCN. (5) The iodine depletion seems to be mainly due to an increased loss of iodine in urine related to a blockage of the tubular reabsorption of this ion by an excess of SCN. The experimental observations fit with the metabolic findings reported for subjects living in the goitrous area of Idjwi Island (Delange et al. J. Clin. Endocr. 28:169, 1968). They are also compatible with the concept that iodine deficiency only plays a permissive role in the development of endemic goiter. *(Full text)* H02

1172-2001 DELANGE, F. *et al.* **Endemic cretinism in Idjwi Island (Kivu Lake, Republic of the Congo).** Journal of Clinical Endocrinology and Metabolism 34(6):1059-1066. 1972. Engl., Sum. Engl., 38 Refs. Illus.

Cassava. Cretinism. Iodine. HCN. Linamarin. Thyocyanates. Etiology. Toxicity. Deficiency diseases. Endemic goitre. Human health. Endocrine disorders. Toxicology. Human physiology. Clinical manifestations. Zaire. Africa.

Endemic cretins comprise 1.1% of the population of the northern half of Idjwi Island (Kivu Lake, Republic of the Congo). Goiter is common in this area, whereas no cretin was found in the southwest of the island, where goiter is much less prevalent. Ninety percent of the cretins are hypothyroid with severe growth and mental retardation, incomplete maturation of the features, myxedematous thickened dry scaly skin, and markedly delayed sexual development. Only 10% of the Idjwi cretins are clinically euthyroid, and most of those are deaf-mute and spastic. Studies on 21 typical myxedematous cretins showed lower ^{131}I uptake and PBI than euthyroid controls from the same area, marked retardation in bone maturation, epiphyseal and metaphyseal dysgenesis and failure of modeling. The bone changes were consistent with hypothyroidism appearing by birth or during the first months of life. Electrocardiograms showed low voltages of the QRS complexes and T waves. Extremely high blood TSH levels indicated primary hypothyroidism. Thyroid scannings showed small glands in normal position. Some showed nonhomogeneous localization of the radioiodine suggesting a degenerative process. Thus, most of the cretins in the Idjwi goiter endemia are myxedematous, possibly as a result of a degenerative process of the thyroid gland by birth or in early infancy. The cause of this phenomenon is unknown. Endemic goiter is not exclusively due to iodine deficiency; the cause could be the action of a food toxin, most probably thiocyanate, resulting from the detoxification of considerable quantities of cyanide. Cyanide is known to be produced by the hydrolysis of linamarin, which cassava,a principal Idjwi dietary item, contains in large amounts. *(Author's summary)* H02

1173-3411 OSUNTOKUN, B. O. **Ataxic neuropathy associated with high cassava diets in West Africa.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973. pp. 127-138. Engl., Sum. Engl., Fr., 66 Refs.

Cassava. Human health. Human nutrition. Ataxic neuropathy. Analysis. HCN. Endemic goitre. Clinical manifestations. Dietary value. Thiocyanates. Composition. Deficiency diseases. Toxicology. Metabolism. Amino acids. Vitamin B12. Nigeria. Tanzania.

In Nigerians, a syndrome referred to as tropical ataxic neuropathy comprises lesions of the skin, mucous membranes, optic and auditory nerves, spinal cord, and peripheral nerves. The disease affected all age groups but was rare in the 1- to 10-year-olds. Familial cases accounted for two-fifths of the patients, but there was no evidence of genetically determined predisposition. Patients subsisted mainly on a cassava diet. The thiocyanate content of food items commonly eaten by Nigerians is low, whereas the cyanide content, especially of cassava derivatives, is high. Plasma levels of thiocyanate, cyanide and urinary thiocyanate excretion were high in patients. The levels fell when patients were fed on a low-cassava hospital diet and rose again when they reverted to cassava meals. Levels of free cyanide in blood were raised. Sulfur-containing amino acids were absent in the plasma in 60% of the patients and were greatly reduced in others. The level of sperm cyanocobalamin (probably a product of cyanide detoxication) as measured by chromatology and bioautography was high. Total serum B12 (microbiological) was normal. Normal urinary excretion of methylmalonic acid before and after valine loading excluded abnormal B12 metabolism. Epidemiological studies showed correlation of prevalence of the disease with intensity of cassava cultivation, frequency of cassava meals and plasma thiocyanate levels. The prevalence of the disease in one high cassava-eating village was 3% and in the 50- to 60-year-old age group,8%. Cassava farmers and processors appeared to have the highest risk of developing the disease. The neuropathology of the disease would be compatible, with a few exceptions, with the effects of chronic cyanide intoxication. The prevalence (2-5%) of goiter in patients was higher than in the population and appeared to be related to a cassava diet and high plasma thiocyanate level. Detailed studies to exclude dietary deficiencies, other intoxications and metabolic derangements showed only low plasma levels of riboflavin and caeruloplasmia and low urinary excretion of riboflavin; and cystine tablets gave no beneficial effects. *(Author's summary)* H02

1174-0995 OSUNTOKUN, B. O. **Chronic cyanide neurotoxicity and neuropathy in Nigerians.** Plant Foods for Human Nutrition 2:215-256. 1972. Engl., Sum. Engl., 140 Refs., Illus.

Cassava. HCN. Toxicity. Etiology. Ataxic neuropathy. Protein. Amino acids. Etiology. Biochemistry. Thiocyanates. Diets. Rhodanese. Human nutrition. Deficiencies. Proteins. Vitamin deficiencies. Endemic goitre. Hepatic disorders. Clinical manifestations. Nigeria.

A brief account is presented of the clinical features of Nigerian ataxic neuropathy as found in 320 patients. It is established that other systemic neurological degenerations may coexist with ataxic neuropathy. Evidence is produced to show that protein-caloric deficiency, and deficiency of water-soluble vitamins are not important factofs in the etiology of the disease. It is possible that riboflavin intake is low in patients, but riboflavin intake appears to be low in most Nigerians. Histological examination of peripheral nerves of patients with ataxic neuropathy showed demyelination. The finding of reduced motor nerve conduction velocity supports the histological finding. Biochemical evidence of increased exposure to cyanide of dietary origin, is presented. The cyanide comes from the staple diet of cassava. The plasma thiocyanate, cyanide and urinary excretion of thiocyanate rise in these patients (as compared with controls), and fall when they are fed on diets free of cassava. The levels rise again when the patients return to a cassava diet. The serum "hydroxocobalamin" level is reduced in these patients. The sulfur-containing amino acids in plasma are reduced or absent. Hepatic rhodanese activity in patients is normal. Epidemiological data show a positive correlation between the prevalence of the disease and consumption of cassava. Cassava processers and farmers who grow and handle cassava may be at special risk. Goiter is not uncommon in patients. The endemic belt for ataxic neuropathy is geographically the same southern belt for goiter in western Nigeria. There is no evidence at the moment of genetic factors in determining susceptibility to the disease. The evidence suggests a common environmental factor responsible for the disease in multiple familial or conjugal cases. This appears to be diet. Though chronic cyanide intoxication of dietary origin is the most important factor in the etiology of ataxic neuropathy and the main source of the cyanide is cassava, it is likely that some other factors, such as lack of first-class protein and riboflavin deficiency may summate with the neuropathological effects of chronic cyanide poisoning. *(Author's summary)* H02

1175-1858 NWOKOLO, C. **New foci of endemic goitre in Eastern Nigeria.** Transactions of the Royal Society of Tropical Medicine and Hygiene 60(1):97-108. 1966. Engl., Sum. Engl., 28 Refs., Illus.

Cassava. Toxicology. Clinical manifestations. Endemic goitre. Etiology. Nigeria.

An investigation of endemic goiter in eastern Nigeria by means of a simple, rapid, case-finding technique (market count) is described. It is suggested that an incidence of over 10% goiter in females, discovered by this technique, should be regarded as abnormal. Foci of endemic goiter are concentrated in the northern parts of eastern Nigeria and these foci are parallel to foci in Northern Nigeria and the neighboring Cameroon. No constant relationship is found between high altitude and endemic goiter, nor is endemic goiter confined to geological areas of Precambrian granite. Available evidence suggests that environmental iodine deficiency may be of importance in Nigeria. The status of goitrogens is as yet undetermined, but recent work on rats has suggested that cassava (**Manihot**) contains a goitrogen, the action of which resembles that of brassica vegetables and thiourea derivatives. *(Author's summary)* H02

1176-0557 SERCK—HANSSEN, A. **Aflatoxin-induced fatal hepatitis? A case report from Uganda.** Archives of Environmental Health 20:729-731. 1970. Engl., 8 Refs., Illus.

Cassava. Human nutrition. Hepatic disorders. Clinical manifestations. Human physiology. Malnutrition. Human health.

A report is given of a fatal case of acute hepatic disease in a boy in whom the histological changes in the liver were identical to those observed in species of monkeys treated with aflatoxin and where circumstantial evidence strongly suggests that aflatoxin was the cause. When investigating the possible source of aflatoxin, the boy's family's food stock was examined;the staple diet consisted of cassava(eaten daily), beans, fish and meat. Cassava was found to be moldy. A specimen was submitted for analysis and the aflatoxin content was 1.7 mg/kg, an unusually high concentration. In the aflatoxin experiments on the African monkey, a daily dosage of 0.01 mg aflatoxin caused the death of an animal weighing 1.5 kg (3 lb.) in 22 days; i.e., after a total amount of 0.22 mg. If at the time of consumption, the cassava contained the same amount of aflatoxin found on assay (i.e., 1.7 mg/kg), the boy would have had to have eaten 3.1 kg of cassava in order to have ingested the same amount of aflatoxin per kg of body weight as the monkey by the time it died. The boy could have done this within 22 days since his diet consisted of little else. *(Summary by J.L.S.)* H02

1177-0807 WILLIAMS, A. O. and OSUNTOKUN, B. O. **Peripheral neuropathy in tropical (nutritional) ataxia in Nigeria.** Archives of Neurology 21:475-492. 1969. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Human nutrition. Ataxic neuropathy. Toxicity. Clinical manifestations. Cyanides. Deficiencies. Deficiency diseases. Thiocyanates. Human physiology. Nigeria.

The tropical nutritional ataxic syndrome in Nigeria may be due to a dietary deficiency or an increased dietary cyanide derived from cassava meals prepared in a particular way and consumed frequently by some patients. The clinical, electrophysiologic and biochemical features of 4 of these patients are presented in detail. The pathologic changes, as demonstrated by light microscopy in the anterior tibial nerves of 23 Nigerian patients, have been studied and described; and peripheral nerves from 4 of these patients, whose clinical features are described in detail, have been studied by light and electron microscopy. The observed changes on light microscopy are consistent with segmental demyelination. These are confirmed in the cases studied by electron microscopy and are characterized by disintegration and lysis of myelin lamallae and|or myelin digestion in a patchy fashion. These changes are not specific and simulate, in many respects, other segmental demyelinative neuropathies. The role of cyanide in causing peripheral neuropathy was investigated by studying the ultrastructural changes in cyanide-treated sciatic nerves of rats. Myelin digestion, which is evidence of demyelination, was observed a few weeks after injection of a single dose of potassium cyanide. From epidemologic and experimental evidence, it can be inferred that cyanides damage the peripheral nerves and may play a significant role in the pathogenesis of ataxic neuropathy in Nigerians. *(Author's summary)* H02

1178-0573 BAILEY, K. V. **Rural nutrition in Indonesia. II. Clinical studies of hunger oedema in the cassava areas of Java.** Tropical and Geographical Medicine 13:234-254. 1961. Engl., Sum. Engl., Span., 44 Refs., Illus.

Cassava. Malnutrition. Diets. Hunger oedema. Clinical manifestations. Anaemia. Human nutrition. Etiology. Hypoalbuminaemia. Cellular hydraemia. Endocrine disorders. Hepatic disorders. Java.

Clinical studies of hunger edema (famine edema) were carried out in a cassava region (Gunung Kidul) where it was endemic. Dietary intakes of adult male subjects were estimated at less than 1000 calories and 5 g protein daily. Clinically, the 62 subjects studied resembled the nutritional edema syndrome described in Asians and protein malnutrition in Africans. Hypoalbuminemia was common. There was imperfect correlation between edema and serum protein levels and colloid osmotic pressure (calculated). There was anemia and evidence of malabsorption. Recovery was slow on relatively high-calorie, high-protein diets. Serum albumin levels rose steadily: serum globulin levels rose more slowly and irregularly. Relapse after discharge was not found. Poverty was extreme; caloric intakes were usually chronically inadequate. Edema is considered to be a useful public health index of nutritional status in villages. Therapy was reasonably successful at the village level by distribution of green gram only. Responses in different dietary groups indicated slower restoration of serum albumin levels when soybean milk was the chief protein supplement. This is attributed to its relatively low sulfur-containing amino acid content; this deficiency is the same as that of the Gunung Kidul diets. In Asians and Africans hunger edema differs from that in Caucasians with respect to the consistent hypoalbuminemia, cellular hydremia, and evidence of endocrine and hepatic disorders. While caloric deficiency appears to be the major proximate cause, chronic protein deficiency is a predisposing and modifying factor in Asians and Africans; a relatively greater role of protein deficiency is found in the Gunung Kidul subjects. *(Author's summary)* H02

1179-0736 OSUNTOKUN, B. O. **An ataxic neuropathy in Nigeria: A clinical, biochemical and electrophysiological study.** Brain 91:215-248. 1968. Engl., Sum. Engl., 132 Refs. Illus.

Cassava. Human nutrition. Human physiology. Thiocyanates. Cyanides. Clinical manifestations. Toxicology. Ataxic neuropathy. Biochemistry. Proteins. HCN. Nigeria.

Eighty-four cases of an ataxic neuropathy common in the coastal towns of Ijebu Province (western Nigeria) have been studied. The sex incidence is equal. The highest incidence is in the 30-50 age group; it is a disease of the poorer classes. The commonest symptoms are sensory, initially confined to the legs, visual impairment, ataxic gait, weakness of lower limbs, tinnitus, deafness and recurrent mucocutaneous lesions of ariboflavinosis. The commonest physical findings are posterior column sensory loss, ataxic gait, rombergism, bilateral optic atrophy, perceptive deafness and wasting and weakness in the legs. Extensor plantar reflexes and superfical sensory loss are less common. One third had mucocutaneous evidence of ariboflavinosis. Cerebrospinal fluid examination showed no abnormality. Protein nutrition is normal, but caloric intake is subnormal. Riboflavin and to a lesser extent, thiamine intake is low as measured by urinary excretion. Serum folic acid and B12 are normal or high. Plasma and urinary thiocyanate levels are high, but fall with an improved diet containing little or no cassava. Electromyography confirms lower motor neurone lesions in patients with clinical evidence of polyneuropathy. Motor nerves conduction is slowed in the lateral popliteal nerve and normal in the ulnar and median nerves. The evidence suggest that the syndrome is related to chronic exposure to dietary cyanide. The source of this dietary cyanide is found in culinary derivatives of cassava. *(Author's summary)* H02

1180-2311 OSUNTOKUN, B. O. **Epidemiology of tropical nutritional neuropathy in Nigerians.** Transactions of the Royal Society of Tropical Medicine and Hygiene 65(4):454-479. 1971. Engl., Sum. Engl., 67 Refs., Illus.

Cassava. HCN. Hydrolysis. Ataxic neuropathy. Iodine. Diets. Human nutrition. Clinical manifestations. Thiocyanates. Endemic goitre. Cyanides. Toxicology. Toxicity. Nigeria.

Nigerian nutritional ataxic neuropathy comprises panmyelopathy, bilateral optic atrophy, sensorineural deafness and polyneuropathy. In a third of the patients studied, mucocutaneous signs of malnutrition were present. The disease is prevalent in the areas of Nigeria where cassava is most intensely cultivated. Cassava contains a cyanogenetic glycoside, from which HCN is released on hydrolysis. The incidence in sexes is equal. It is a disease of the poor who subsist entirely on culinary derivatives of cassava; it reaches its peak in the 4th to 6th decades. In 41% of 320 patients studied, it was found that someone else in the household or family suffered from the disease. In familiar cases, 50% are conjugal. There is biochemical evidence of increased exposure to cyanide in ataxic families. There is no evidence so far of a genetically determined predisposition to the disease. Field surveys in 2 villages in an endemic area and one village in a nonendemic area showed a positive correlation between the prevalence of the disease and consumption of cassava and biochemical evidence of chronic cyanide intoxication. The rate of incidence in the endemic foci is 18 to 26| 1,000 with a peak rate of 80| 1,000 in the 6th decade. Cassava processors and farmers who grow and handle cassava may be exposed to greater risk. Goiter is not uncommon in patients and may be related to inhibition of iodine uptake by the thyroid due to the high concentration of plasma thiocyanate (a detoxification product of cyanide). The epidemiological data support the hypothesis that chronic cyanide intoxication of dietary origin in Nigerians in the most important factor in the etiology of ataxic neuropathy. The main source of the cyanide is cassava. *(Author's summary)* H02

1181-0832 OSUNTOKUN, B. O. *et al.* **Controlled trial of hydroxocobalamin and riboflavine in Nigerian ataxic neuropathy.** Journal of Neurology, Neurosurgery and Psychiatry 33:663-666. 1970. Engl., Sum. Engl., 21 Refs.

Cassava. Medicine. Ataxic neuropathy. Human physiology. Vitamin B12. Toxicity. HCN. Diets. Malnutrition. Thiocyanates. Amino acids. Nigeria.

The results are given of a double-blind therapeutic trial of hydroxocobalamin and riboflavin in Nigerian patients suffering from a degenerative neuropathy. Although no benefit from either vitamin was demonstrated, this may reflect the inadequacy fo the dosages. used. The results are discussed in relation to the hypothesis that dietary cyanide and cyanogens are responsible, at least in part, for the cccurrence of this disease in a malnourished population. *(Author's summary)* H02.

1182-0458 OSUNTOKUN, B. O. **Cassava diet and cyanide metabolism in Wistar rats.** British Journal of Nutrition 24:797-800. 1970. Engl., Sum. Engl., 25 Refs.

Cassava. Diets. Rats. Ataxic neuropathy. Clinical manifestations. Analysis. Cyanides. Toxicity. Thiocyanates. Metabolism. Human physiology. Etiology. Manihot. Animal physiology. Toxicology. Nigeria.

In the etiopathogenesis of a degenerative neuropathy in Nigerians, know as tropical ataxic neuropathy, chronic cyanide intoxication is believed to be the most important factor. The source of the cyanide is cassava **(Manihot)**; and in Nigerian patients, plasma concentration of thiocyanate, a major detoxication product of cyanide, is high. Since there is considerable doubt as to whether cyanide is readily released from cassava after ingestion, rats were fed on 80 and 100% purupuru (a cassava derivative) diets for periods varying from 6 and

18 months; and their plasma thiocyanate levels were studied. Control rats were fed on a normal diet for the same periods. Rats fed on the 100% purupuru diet were malnourished; rats on the 80% diet appeared normal although their mean weight was less than the mean weight of rats fed on the control diet. Plasma thiocyanate was significantly higher in rats fed the purupuru diets than in the control. The concentration of thiosulfate sulfurtransferase, the enzyme that catalyzes the conversion of cyanide into thiocyanate, was the same in rats fed on the purupuru diets as in the control. The results suggest that raised plasma thiocyanate levels found in Nigerian patients with ataxic neuropathy, as in rats fed cassava, is the result of detoxication of cyanide, as the concentration of thiocyanate in cassava and most food products eaten by Nigerians is low. *(Author's summary)* H02.

1183-3033 OGIHARA, T. *et al.* **Endemic goiter in Sarawak, Borneo Island; prevalence and pathogenesis.** Endocrinologia Japonia 19(3):285-293. 1972. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Endemic goitre. Clinical manifestations. Deficiencies. Iodine. Human nutrition. Human physiology. Diets.

A survey was carried out for endemic goiter on Iban natives (Sea Dayak) in 4 districts along the Rajang River in Sarawak (Borneo Island). Among 608 subjects (271 male and 337 female) examined, 134 subjects (22 male and 112 female) were found to be goitrous, the prevalence of goiter being 8.1% for male and 33.2% for female. None were clinically hypo- or hyperthyroid; no cretinism was detected. In goitrous subjects 24-h thyroidal ^{131}I-uptake was 54.3±13.1% (mean= S.D.) while 47.1±10.2 in nongoitrous subjects (no statistical significance). Urinary excretion of iodine was 45 ± 27 μg| day in the goitrous group and 49±25 μg in the nongoitrous group (no significance). Iodine content of drinking water was extremely low in all 4 districts, the lowest one being from the region in which the prevalence of goiter was highest. Thyroid parameters such as PBI, T_3 resin sponge uptake and cholesterol were all within normal limits. Antithyroid antibodies were not demonstrated in sera from either goitrous or nongoitrous subjects. Among 33 cases studied the KSCN discharge test was positive in 2 cases in a single family. Cassava was fed to expedition members for 2 weeks; this experiment did not result in any change in thyroid parameters, including the KSCN discharge test. It is thought that iodine deficiency is probably a major causative factor of endemic goiter in Sarawak. Other factors such as an organification defect or defective thyroxine binding proteins might play some role in individual cases. *(Author's summary)* H02

1184-0484 MAKENE, W. J. and WILSON, J. **Biochemical studies in Tanzanian patients with ataxic tropical neuropathy.** Journal of Neurology, Neurosurgery, and Psychiatry 35:31-33. 1972. Engl., Sum. Engl., 11 Refs.

Cassava. Biochemistry. Ataxic neuropathy. Vitamin B12.,Thiocyanates. Cyanides. Analysis. Human physiology. Clinical manifestations. Malnutrition. Cyanogenic glycosides. Tanzania.

Data are presented on thiocyanate and vitaminB12concentrations in plasma from Tanzanian patients with ataxic tropical neuropathy. They support the hypothesis that, as in Nigeria, the condition may result from chronic exposure to cyanide or cyanogens from a diet including large amounts of cassava. *(Author's summary)* H02

1185-3400 ERMANS, A. M. *et al.* **Mechanism of the goitrogenic action of cassava.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 153-157. Engl., Sum. Engl., Fr., 8 Refs., Illus.

Cassava. Human health. Toxicology. Endemic goitre. Tubers. HCN. Thiocyanates. Rats. Biochemistry. Iodine.

The long-term action of cassava tubers added to a Remington diet has been tested in rats and compared to the supplementation of graded doses of thiocyanate. Both cassava and thiocyanate induce (1) depletion of the thyroidal iodine stores, major abnormalities of intrathyrodial metabolism, reduction of plasma PB I^{127}, and (2) a moderate increase of plasma thiocyanate and a striking increase of plasma ^{35}SCN turnover. Thyroidal ^{131}I uptake is not inhibited at all. All findings show a qualitative and quantitative similarity between the effects of 10g of cassava tubers and 1-2 mg of SCN. It is concluded that (a) the antithyroid action of cassava is caused by the endogenous production of SCN related to the conversion of cyanide, and (b) in rats overloaded with large doses of SCN, a renal adaptation mechanism is induced, which strikingly reduces the plasma level of SCN. *(Author's summary)* H02.

1186-2385 ADAMS, J. H., BLACKWOOD, W. and WILSON, J. **Further clinical and pathological observations on Leber's optic atrophy.** Brain 89:15-26. 1966. Engl., Sum. Engl., 24 Refs., Illus.

Cassava. Human health. Human nutrition. Human physiology. Toxicology. Clinical manifestations. Cyanides. Cyanogenic glycosides.

Clinical and pathological observations on the neurological syndrome accompanying Leber's hereditary optic atrophy were made on the basis of 5 cases. If the hypothesis that there is an inability to metabolize cyanide normally is true, cyanide exposure must be restricted. Tobacco smoking is inadvisable, and urinary-tract infections should be eradicated. Possible association with other disorders (e.g., tropical ataxic-spastic syndromes) is discussed. Dietary cyanide could be a factor in the etiology of West African retrobulbar neuritis; it is well known that certain tropical foods (e.g., cassava) contain large quantities of cyanogenetic glycosides. *(Summary by T.M.)* H02

1187-1913 PEIXOTO, R. R. **Contribuição ao estudo da mandioca na alimentacao dos animais.** *(Contribution to the study of cassava as an animal feed).* Dipan 11(119-120):23-40. 1958. Port., Sum. Port., Engl., 28 Refs.

Cassava. Cassava meal. Animal nutrition. Feeds and feeding. Dietary value. Palatability. Swine. Domestic animals. Proteins. Supplements. Finishing. Feed constituents. Nutritive value. Fattening. Tubers.

Berkshire pigs were used in a feeding experiment comparing cassava roots, furnished either as a dry meal or fresh. Twenty pigs, distributed in 4 equal groups according to current experimental techniques, were kept in dry-lot the necessary time to reach 100| kg. The two rations used were the following: Lots I and IV, cassava meal plus a 32% digestible protein-containing concentrate mixture; lots II and III, fresh cassava roots plus the same supplement. At the end of the trial, all pigs were killed and their carcasses examined. Cassava meal-fed pigs reached 100 kg 8 weeks before those fed fresh cassava roots. Cassava meal consumption, as well as its palatability, was good. The cassava meal ration was much more efficient (about 64%). Cassava meal ration TDN was 21% more efficient than fresh roots ration TDN. From both a technical and practical viewpoint, cassava meal proved to be better. *(Author's summary)* H02

1188-0483 OSUNTOKUN, B. O., MONEKOSSO, G. L. and WILSON, J. **Cassava diet and a chronic degenerative neuropathy: an epidemiological study.** Nigerian Journal of Science 3(1):3-15. 1969. Engl., Sum. Engl., 33 Refs.

Cassava. Diets. Ataxic neuropathy. Gari. Clinical manifestations. Cyanides. Thiocyanates. Human nutrition. Toxicity. Etiology. Human physiology. Toxicology. Malnutrition. Vitamin B^{12}.

It has been suggested that tropical ambylopia and a chronic degenerative neuropathy, manifested as optic atrophy, bilateral nerve deafness, myelopathy and polyneuropathy (ataxic neuropathy) may be a manifestation of chronic cyanide intoxication from dietary sources, especially cassava. The level of plasma thiocyanate, the major detoxication product of cyanide, is raised in these conditions. Epidemiological studies have been carried out in two villages on high and low cassava intake. The high cassava consuming village showed a high prevalence of neurological diseases (17 per 1,000 cases of a.n.) there were less than 1 | 1000 low cassava consuming village. There appears to be a positive correlation between cassava intake and mucocutaneous signs of malnutrition, plasma thiocyanate and vitamin B^{12} levels. *(Author's summary)* H02

1189-0353 OSUNTOKUN, B.O., MONESKOSSO, G.I. and WILSON, L. **Relationship of a degenerative tropical neuropathy to diet; report of a field survey.** British Medical Journal no. 1:547-550. 1969. Engl., Sum. Engl., 24 Refs.

Cassava. Cyanides. Toxicity. Ataxic neuropathy. Toxicology. Human health. Metabolism. Etiology. Vitamin deficiencies. Thiocyanates. Diets. Nigeria.

A survey of neurological abnormalities in 2 Nigerian villages, preselected for their differing consumption of cassava, has shown that a degenerative neuropathy occurs with relatively high frequency in the village (Ososa) where cassava consumption was high. It is suggested that eating cassava results in exposure to cyanide, as shown by a raised plasma thiocyanate level, and that the latter, together with other factors, may contribute to the pathogenesis of tropical neuropathy. *(Author's summary)* H02.

1190-3410 EKPECHI, O. L. **Endemic goiter and high cassava diets in Eastern Nigeria.** *In* Chronic Cassava Toxicity, London, 1973. Proceedings of an interdisciplinary workshop. pp.139-145. Engl., Sum. Engl., Fr., 13 Refs., Illus.

Cassava. Human health. Human nutrition. Iodine. Endemic goitre. Analysis. Rats. Deficiency diseases. Nigeria.

Subsequent to the discovery of patchy distribution of endemic goitre and the low but markedly varying environmental iodine deficiency in eastern Nigeria, experimental studies were undertaken of the possible goitrogenic action of dry, unfermented cassava on rats. Results showed that cassava has an adverse action on the function of the thyroid, comparable to that of thionamide goitrogen. *(Author's summary)* H02.

1191-0507 ERMANS, A. M. *et al.* **Permissive nature of iodine deficiency in the development of endemic goiter.** *In* Standbury, J. B., ed. Endemic goiter. Washington. Panamerican Health Organization. Scientific Publication no. 193. 1969. pp.101-116. Engl., Sum. Engl., 46 Refs., Illus.

Cassava. Iodine. Etiology. Metabolism. Cretinism. Starch crops. Cereals. Consumption. Deficiency diseases. Clinical manifestations. Endocrine disorders. Endemic goitre. Thiocyanates. Nutritive value. Vegetable crops. Human physiology. Diets. Africa. Congo.

Insufficient iodine supply is usually considered as the main factor causing endemic goiter, but the part played by other factors has often been underlined. This question of relative roles arises once again in view of the particular epidemiological characteristics observed on the island of Idjwi, Lake Kivu (Congo). In the greater part of the island, there is a high prevalence of goiter (54.4%); this value drops to 5.3% in a well-defined area in the southwest. Yet iodine deficiency is shown to be of about equal severity in the two regions. This observation suggests the intervention of a goitrogenic factor distinct from the inadequate iodine supply. However, the administration of iodized oil reduced the incidence of goiter by two thirds after one year. While it is not the causative factor, iodine deficiency acts as a permissive factor in the development of goiter on the island. Parallel, systematic studies of the diet conditions of the 2 populations over a full year have revealed that larger quantities of cassava are consumed in the goitrous region. Furthermore, the level of thiocyanate is very high in the serum and urine of the 2 populations, whereas urinary excretion is greater in the goitrous region. The geographic locations of the goitrous and nongoitrous areas correspond to 2 different geological areas of the island. In the first the soil has a granite base; and in the second, basalt. *(Author's summary)* H02

192-0506 DELANGE, F., HERSHMAN, J. M. and ERMANS, A. M. **Relationship between the serum thyrotropin level, the prevalence of goiter and pattern of iodine metabolism in Idjwi Island.** Journal of Clinical Endocrinology and Metabolism 33(2):261-268. 1971. Engl., Sum. Engl., 39 Refs., Illus.

assava. Deficiency diseases. Iodine. Endemic goitre. Endocrine disorders. Zaire. Africa.

adioimmunoassay of serum thyrotropin was performed in 185 patients, 4-30 years old, living in Brussels ontrol group), in the nongoitrous (southwest) and in the goitrous (north) areas of Idjwi Island (Congo).

Both regions on Idjwi Island have a severe and quite similar iodine deficiency. The serum TSH level was higher in the inhabitants of Idjwi Island than in the Belgian controls; it was still higher in the goitrous area (in both goitrous and nongoitrous subjects) than in the nongoitrous area. There was a significant correlation between the TSH level and the plasma PBI (^{127}I) in the goitrous area. There was no correlation between the TSH level, the 6-h thyroidal radioiodine uptake, the PBI (^{127}I) estimated at the time of equilibrium in isotopic distribution and the organic exchangeable iodine pool of the thyroid in all 3 areas. The results observed in southwest Idjwi show that the human thyroid is capable of adapting itself adquately to a very severe iodine deficiency under the influence of an increased thyrotropic stimulation without clinical evidence of thyroidal hyperplasia. The higher serum TSH level observed in north Idjwi suggests that thyrotropic hyperstimulation is responsible for endemic goiter on Idjwi Island. On this island, the serum TSH level seems to be more closely related to the geographic environment than to the age os the subjects or the individual size of the thyroid. *(Author's summary)* H02

1193-0501 DUMONT, J. E., DELANGE, F. and ERMANS, A. M. **Endemic cretinism.** *In* Stanbury, J.B., ed. Endemic goiter. Pan American Health Organization. Scientific Publication no. 193. 1969. pp.91-98. Engl., Sum. Engl., 34 Refs.

Cassava. Endemic goitre. Human health. Deficiency diseases. Clinical manifestations. Endocrine disorders. Cretinism. Africa. Congo. New Guinea.

The endemic cretin, as defined by the Pan American Health Organization, is an individual with irreversible changes in mental development, born in an endemic goiter area, and exhibiting a combination of some of the following characteristics not explained by other causes: irreversible neuromuscular disorders, irreversible abnormalities in hearing and speech, impairment of somatic development and hypothyroidism. Critical examination of the results of research on endemic cretinism carried out in the Congo and in New Guinea suggests that the broad definition of the PAHO includes two different syndromes, both related to endemic goiter: (1) nervous endemic cretinism which is characterized by mental deficiency of deaf-mutism or both and in the most severe cases by both defects and by neuromuscular disorders; and (2) myxedematous endemic cretinism which is a form of hypothyroidism that begins early in infancy or in fetal life and is caused by thyroid hypoplasia. *(Author's summary)* H02

1194-0504 THILLY, C.H., DELANGE, F. and ERMANS, A. M. **Further investigations of iodine deficiency in the etiology of endemic goiter.** American Journal of Clinical Nutrition 25:30-40. 1972. Engl., Sum. Engl., 30 Refs., Illus.

Cassava. Etiology. Metabolism. Deficiency diseases. Endemic goitre. Thiocyanates. Iodine. Clinical manifestations. Ecology. Human physiology. Human nutrition. HCN. Endocrine disorders. Deficiencies. Human health. Africa. Zaire.

Endemic goiter prevalence was systematically measured in 85% of the populations of Idjwi Island. The average prevalence of goiter on the island as a whole was 32.3%. There are very marked geographical variations. Three regions are distinguishable: a hyper-endemic region in the north, where the average prevalence of goiter is 52.8%, a region with a very low endemicity (7.7%) in the southwest, and a region of intermediate severity (26.0%) in the southeast. There is a distinct relationship between goiter prevalence and age and sex. The familial tendency to goiter on Idjwi is only slight and may be explained either by a form of multigenic heredity or by the intervention of etiological factors of the microenvironment. Relationships between regional goiter prevalence and parameters of thyroid function were studied in 693 subjects from 30 villages scattered throughout the island. No relationship was observed between goiter prevalence and the degree of iodine deficiency; this deficiency is homogeneous and severe throughout the island. The rise in goiter prevalence is accompanied by a significant increase of ^{131}I thyroidal uptake at the 6th h and by a significant decrease in the PB^{127}I level in the plasma. In goitrous adults, thyroidal uptake is higher and PBI lower than in nongoitrous adults. However, the modifications of thyroid metabolism are influenced far less by the presence of absence of goiter in a particular subject than by regional variations in the prevalence of goiter. Iodine deficiency constitutes the main etiological factor of endemic goiter on Idjwi Island. Howerver the pattern of goiter prevalence and the extent to which thyroid metabolism varies cannot be explained by the degree of iodine deficiency; it was found that they are determined essentially by a geographical factor. This factor is closely related to the nature of the soil. Furthermore, when compared with nongoitrous subjects, goitrous individuals appear to be less efficient in their adaptation to environmental conditions in the Idjwi endemic goiter area. *(Author's summary)* H02

1195-3409 DELANGE, F., VELDEN, M. VAN DER and ERMANS, A. M. **Evidence of an antithyroid action of cassava in man and in animals.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 147-151. Engl., Sum. Engl., Fr., 14 Refs.

Cassava. Human health. Animal health. Endemic goitre. Deficiency diseases. Rats. Thiocyanates. HCN. Toxicology. Iodine. Etiology. Zaire.

Previous epidemiological and metabolic studies concerning the etiology of endemic goitre on Idjwi Island (Kivu Lake, Republic of Zaire) led to the conclusion that iodine deficiency was not the single causal factor. Indeed, goitre prevalence exhibited striking regional variations although the whole island was subjected to severe and uniform iodine deficiency, and the possible role of a dietary goitrogen was suspected. The present work was undertaken in order to detect antithyroid activity (in men and in rats) of the foods eaten in this area. In men, the absorption of cassava induces an inhibition of the penetration of iodide into the thyroid as expressed by a considerable drop in radioiodine thyroidal uptake and a rise in urinary excretion of stable and labelled iodide. Inhibition of thyroid uptake, together with a striking rise in the plasma thiocyanate concentration and urinary thiocyanate excretion, is also obtained in rats fed cassava. Results are similar to those obtained in separate experiments where rats were fed thiocyanate. These trials show that cassava grown on Idjwi Island has an antithyroid action in men and in rats. Cassava could constitute a dietary goitrogen responsible —at least partially— for endemic goitre in this area. The antithyroid action of cassava is due to thiocyanate, which is probably endogenously produced from cyanide, which is released by a cyanogenic glucoside present in large quantities in cassava. *(Author's summary)* H02 H04.

1196-0354 OSUNTOKUN, B. O. *et al.* **Plasma amino acids in the Nigerian nutritional ataxic neuropathy.** British Medical Journal no. 3:647-649. 1968. Engl., Sum. Engl., 23 Refs.

Cassava. Cyanides. Ataxic neuropathy. Amino acids. Thiocyanates. Etiology. Human health. Diets. Metabolism. Toxicology. Nigeria.

Investigation of 9 patients with tropical ataxic neuropathy showed an absence or diminution of sulfur-containing amino acids (cysteine and methionine) and a variable concentration of most other essential amino acids.The pattern was unlike that found in kwashiorkor.The levels of serum cholesterol and total protein were normal, and the serum vitamin B12 levels were normal or high. Plasma thiocyanate concentration was high. All the patients had a history of a steady diet of cassava derivatives. Cassava contains a cyanogenetic glycoside (linamarin) from which cyanide is released on hydrolysis. The excessive cyanide detoxication may be responsible for the low concentration of the sulfur containing amino acids. *(Author's summary)* H02.

1197-0502 DELANGE, F. and ERMANS, A. M. **Role of a dietary goitrogen in the etiology of endemic goiter on Idjwi Island.** American Journal of Clinical Nutrition 24:1354-1360. 1971. Engl., Sum. Engl., 45 Refs., Illus.

Cassava. HCN. Iodine. Absorption. Deficiency diseases. Clinical manifestations. Cyanogenic glycosides. Thiocyanates. Endemic goitre. Human nutrition. ***Manihot esculenta.*** **Human physiology. Etiology. Toxicology. Zaire.**

The purpose of this study was to detect the antithyroidal activity in man of the foods eaten in the endemic goitrous area on Idjwi Island. The presence of a dietary goitrogen in this region was suspected when earlier works showed that goiter prevalence is 10 times higher in the north of the island than in the southwest although the whole of Idjwi is subjected to a severe and uniform iodine deficiency. The ingestion of cassava grown in the goitrous area of the island induces a considerable drop in thyroid uptake of radioiodine. This effect was observed by comparing several groups of patients who had eaten different types of foods and also by giving them successive meals of a control food and then cassava. The drop in uptake was accompanied by a rise in urinary excretion of ^{131}I and ^{127}I. In contrast, the ingestion of cassava grown in the nongoitrous area of the island did not modify thyroid uptake to any appreciable extent. These results suggest that the absorption of cassava grown in the goitrous area of the island inhibits the penetration of iodine into the human thyroid, whereas the same plant *(Manihot utilissima)* grown in the nongoitrous area of the island is free of this effect. The substance responsible for this action is probably of a thiocyanate-like nature, resulting from the catabolism of a cyanogenic glucoside contained in large quantities in cassava. *(Author's summary)* H02

1198-0505 DELANGE, F., THILLY, C. and ERMANS, A. M. **Iodine deficiency, a permissive condition in the development of endemic goiter.** Journal of Clinical Endocrinology and Metabolism 28(1):114-116. 1968. Engl., 19 Refs., Illus.

Cassava. Toxicology. HCN. Iodine. Deficiencies. Clinical manifestations. Deficiency diseases. Endemic goitre. Clinical manifestations. Human physiology. Endocrine disorders. Etiology. Zaire.

Epidemiological studies were carried out on Idjwi Island. Three distinct zones were found on the island where goiter was prevalent. Studies showed a marked iodine deficiency in these areas, with two strikingly different epidemiological features. In the north, I deficiency is associated with severe endemic goiter; in the southwest the same situation exists with a very wide prevalence of goiter. It is concluded that iodine deficiency is not the direct cause of the high prevalence of goiter in the north. Participation of a supplemental goitrogenous factor is postulated. The possible role of cassava is being investigated. *(Summary by P.A.C.)* H02

1199-4390 BAILEY, K. V. **Rural nutrition studies in Indonesia. I. Background to nutritional problems in the cassava areas.** Tropical Geographical Medicine 13:216-233. 1961. Engl., Sum. Engl., Span., 28 Refs., Illus.

Cassava. Dietary value. Nutritive value. Hunger oedema. Malnutrition. Diets. Food energy. Proteins. Amino acids. Human nutrition. Rice. Maize. Indonesia.

Studies on endemic hunger edema in Indonesia were carried out in the limestone hill regions in central Java, where cassava is the staple food. The agricultural and economic poverty in these regions is extreme. Cassava is the main crop and foodstuff because it is the sole relatively productive plant on the poor soil and goes farthest in meeting the caloric requirements. Dietary surveys in 1938-39 and 1958-59 showed the predominance of cassava, the low caloric and the extremely low protein intakes. In 1958-59, the average per capita daily intake was 1,350 calories and 15.6 g protein; the protein figure is believed to be the lowest on record. According to FAO standards, only 75% of the caloric requirements and 19% of the minimal protein requirements are covered by this diet, the children's requirement being even less adequately met than that of the adults. The quality of the protein is very poor, sulfur-containing amino acids appear to be markedly deficient in the overall diet. A correct perspective on the relative importance of the caloric, protein and amino acid deficiencies demands the assessment of the prevalent malnutrition syndromes and growth patterns. The apparent maintenance of good health in the major part of the population calls for a closer structiny of the existing standards for caloric, protein and amino acid requirements on once hand and of the evidence of malnutrition on the other. *(Author's summary)* H02

1200-3353 CRAWFORD, M. A. *et al.* **Studies on plasma amino acids in East African adults in relation to endomyocardial fibrosis.** British Journal of Nutrition 24(2):393-403. 1970. Engl., Sum. Engl., 37 Refs., Illus.

Cassava. Banana-plantains. Human nutrition. Human health. Kwashiorkor. Protein deficiencies. Amino acids. Malnutrition. Deficiency diseases. Kenya.

Plasma amino acids were compared in adult Ugandans from areas where endomyocardial fibrosis was known to occur commonly and where the disorder is rare. The amino acid profile, both free and in the protein of the main staples, has also been examined. Plasma tryptophan was found to be low in adult Ugandans and intermediate in other Africans receiving a higher protein intake, as compared with Europeans whose protein intake might include more than 40% as animal products. Leucine and valine were also low in the plasma of adult Ugandans, and the nonessential amino acids, alanine and glycine, were increased. The similarity of these changes to the changes seen in kwashiorkor by other workers suggests that limited vegetable diets may introduce a chronic stress with regard to certain essential amino acids. Studies on the vegetable staples used by Africans established that they are particularly poor in tryptophan, and such Africans are probably dependent on other sources for their tryptophan. None of the staples was a rich source of leucine. Plantain contained relatively large amounts of histidine and cassava, arginine. A comparative study of muscle protein suggested that the composition is similar, regardless of diet and species. Leucine is quantitatively one of the most important amino acids in the muscle profile. These findings are discussed in the context of the requirements for heart muscle and the high incidence of cardiomyopathies within such African communities. *(Author's summary)* H02.

1201-2194 EKPECHI, O.L. **Pathogenesis of endemic goitre in Eastern Nigeria.** British Journal of Nutrition 21(3):537-545. 1967. Engl., Sum. Engl., 20 Refs. Illus.

Cassava. Rats. Diets. Endemic goitre. Clinical manifestations. Iodine. Deficiency diseases. Human health. Animal health. Analysis. Nigeria. Africa.

A survey in Eastern Nigeria revealed an area of endemic goitre with a marked variation in incidence from village to village, not accounted for by iodine deficiency alone. As dried, unfermented cassava was consumed in large quantities in the highly goitrous areas, experiments with rats were undertaken to assess the significance of this factor. Groups of rats were fed (a) cassava, (b) equal parts cassava and a standard diet, (c) cassava with added iodine and (d) standard diet; each rat received an intraperitoneal injection of 20 μCi ^{131}I 24 h before being killed. The iodine content and hardness of the water in the various areas were estimated and the chemical and bacteriological indexes of pollution determined. The following effects were observed: thyroid weight, iodine uptake and PBI were all increased in the cassava-fed animals, the last markedly so. The thyroid's precursor and hormone iodine stores were severely depleted in these animals, which also showed an impaired transfer of iodine from monoiodotyrosine to diiodotyrosine and a high proportion of the iodine present as iodothyronine. The addition of iodine to the cassava diet did not prevent these changes from taking place. Many of the observed effects suggest that cassava was acting like the thionamide group of an antithyroid drug. *(Author's summary)* H02

See also 0120 1381 1396 H02

H03 Animal Feeding

1202-0281 ALBA, J. DE *et al.* **Valor nutritivo de la cáscara de cacao para producción de leche en comparación con maíz molido y harina de yuca.** *(Nutritive value of cacao pods for milk production, as compared to ground corn and cassava meal).* Turrialba 4(1): 29-34. 1954. Span., Sum. Span., Engl., 9 Refs., Illus.

Cassava. Diets. Cacao pod meal. Cassava meal. Feed constituents. Nutritive value. Dairy cattle. Domestic animals. Dietary value. Maize. Animal nutrition.

Dried cacao pod meal was used as a concentrate in rations for dairy cows in 2 experiments. In the first experiment, the cacao pod meal was artificially dried. Its feeding value was compared to dehydrated cassava meal and recently harvested ground corn with 7.5% protein content. Each concentrate tested represented 50% of the ration. In the 3 treatments, total milk production of 12 cows for 28 days was: corn, 2,295.8 kg; cassava meal, 2,244.3 kg; and cacao pod meal, 2,462.0 kg. Differences were highly significant. In the second experiment, the cacao pods were sun dried. The cacao pod meal had superior feeding value to corn with 9% protein content although the differences were not statistically significant. Milk production per cow for 63 days was 523 kg with cacao pod meal and 500 kg with corn. *(Author's summary)* H03.

1203-2357 WOODMAN, H.E. **Recent advances in Science. Agriculture: animal nutrition.** Science Progress 24:409-417. 1930. Engl., 11 Refs.

Cassava. Cassava meal. Swine. Palatability. Animal nutrition.

During recent years this carbohydrate-rich food has been imported into England in increasing amounts. Feeding trials with swine carried out at the Harper Adams Agricultural College (J. Fullerton, Jour. Min. Agric., XXXVI, 130, 1929) have shown that high-grade cassava meal is a satisfactory food with regard to palatability and other dietetic properties. It may be regarded as suitable to replace maize or barley meal up to at least 25% of the total ration. The bacon and hams resulting from tapioca-fed animals are of distinctly better quality than those from maize-fed pigs. At current prices, the use of tapioca meal in place of mai.e or barley effects a sensible reduction in the cost of feeding. *(Full text).* H03

1204-0047 VOGT, H. and STUTE, K. **Prufung von Tapiocapellets im Geflugelmast-Alleinfutter.** *(Testing cassava pellets in complete broiler feed).* Archiv für Geflügelkunde 28: 342-358. 1964. Germ., Sum. Germ., Fr., Engl., 4 Refs.

Cassava. Animal nutrition. Chicks. Poultry. Domestic animals. Feeds and feeding. Pellets. Dietary value Digestibility. Diets. Cassava meal. Processed products. Composition. Fattening. Germany.

In 2 tests with a total of 1,216 broiler chicks, the use of ground cassava pellets versus cassava meal wa investigated. The use of cassava pellets seemed to induce greater weight gains. It seems that fee consumption may be negatively influenced by the excessively fine structure of cassava meals; the coarse structure of ground cassava pellets had no adverse effect on feed consumption. The digestibility of the crud nutrients was not influenced by pressing. A mixture containing 10% cassava pellets can be administere without hesitation. The use of higher proportions of pellets can be recommended only for the second half o broiler feeding as it seems that higher proportions have no adverse influence from the 5th week on; however, the use of higher proportions of cassava in broiler feed is always connected with a certain risk. In cassava meal, the average digestibility of the crude fiber is 0.0 % and that of the nitrogen-free extract, 87%. *(Author's summary)* H03.

1205-2326 VELLOSO, L. *et al.* **Substituição parcial e total do milho pelo farelo de mandioca em raçoes de suinos em crescimiento e engorda.** *(Partial and total replacement of corn by cassava meal in rations for swine).* Boletim de Indústria Animal 23:129-137. 1965-1966. Port., Sum. Port., Engl., 10 Refs.

Cassava. Cassava meal. Diets. Swine. Fattening. Feed contituents. Finishing. Dietary value. Feeds and feeding. Animal nutrition. Domestic animals. Brazil.

Thirty-two Duroc-Jersey castrated male pigs, about 4 months old, with an average weight of 54 kg were distributed in randomized blocks to test 4 rations in which corn was partially and totally substituted by cassava as a source of carbohydrate. The rations were as follows: (A) corn only; (B) 22% cassava; (C) 45% cassava, and (D) 62% cassava. Cassava was administered in the form of root meal: pressed, sun dried and ground. The average weight gains were: (A) 73.7 kg, (B) 64.1 kg, (C) 60.6 kg and (D) 46.4 kg in an 84-day experiment. Average feed conversions were (A) 1:3.69kg; (B) 1:4.08kg; (C) 1:4.26kg; (D) 1:4.97kg. With the increase of cassava percentages, the weight gains and conversions decreased. The death of an animal in treatment A was not related to the ration, according to necropsy. *(Author's summary)* H03

1206-0282 VALDIVIESO, C. A. and ALBA, J. DE. **Uso del maiz y la harina de yuca en mezclas simples para criar terneras de lechería.** *(Use of corn and cassava meal in simple mixtures for dairy calves).* Turrialba 8(4):148-152. 1958. Span., Sum. Span., Engl., 10 Refs.

Cassava. Animal nutrition. Dairy cattle. Domestic animals. Dietary value. Cassava meal. Maize. Feed constituents. Feeds and feeding. Diets. Costs. Palatability.

Experimental data is presented on a growth study with 24 dairy calves (14 females and 10 males) assigned at random to 2 treatments of simple formula calf starters: one with 35% corn meal and 10% cassava meal and the other with these ingredients in reversed proportions. Both rations contained equal amounts of copra meal, sesame oil meal, wheat bran, molasses and 5% powdered skim milk. No differences were found between the 2 rations in gain weights from birth to 4 months. Gains favored the ration with 35 % corn. Efficiency of dry matter utilization, as well as palatibility, also favored the corn meal ration. The feeding schedule in which these simple calf starters were used was successful in cutting the cost of feed to 4 months of age, 100% over what the cost might have been with whole milk used to 4 months of age, at the rate of 10% of body weight to a maximum daily intake of 6 kg. *(Author's summary)* H03

1207-1911 BARBOSA, A.S. et al. **A Raspa de mandioca como substituto dos subprodutos de trigo no crescimento de suinos.** *(Dried cassava as a substitute for wheat by-products in fattening swine).* Arquivos da Escola Superior de Veterinaria (Brazil) 10:15-24. 1957. Port., Sum. Port., Engl., 23 Refs.

Cassava. Cassava meal. Animal nutrition. Swine. Fattening. Domestic animals. Feed constituents. Wheat flour. Groundnut. Substitutes. Diets. Feeds and feeding. Nutritive value. Brazil.

The use of dried cassava roots, supplemented with peanut oil meal to equal the protein content in a ration for fattening swine on dry lot has been tested in replacement of wheat flour. They used four treatments: (a) control (40% of wheat by-products); (b) 20% of wheat by-products + 20% cassava-peanut oil meal mixture; (c) 10% of wheat by-products + 30% cassava-peanut oil meal mixture and (d) 40% of cassava-peanut oil meal mixture. Treatments b, c and d were superior to the control as far as gain, feed efficiency and feed consumption. However, there was no statistically significant difference among the treatments. This was possibly due to the great variability within the groups. Preliminary results show it is possible to replace the wheat by-products entirely with cassava roots and a peanut oil meal supplement. Further study should be made. *(Author's summary)* *H03*

1208-0270 TABAYOYONG, T.T. **The value of cassava refuse meal in the ration for growing chicks.** Philippine Agriculturist 24:509-518. 1935. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Feeds and feeding. Chicks. Fattening. Rice bran. Costs. Animal nutrition. Feed constituents. Wastes. Waste utilization. Domestic animals. Economics. Poultry. Philippines.

It was found that (1) rice bran-fed chicks (control lot 1) grew faster than those fed cassava refuse meal (lot 3). Chicks fed a combination of cassava refuse meal and rice bran (lot 2) were intermediate in size between the other two groups, their growth rate tending to be closer to that of the control lot. (2) The amount of feed | kg weight gain in lot 1 was 5.3 kg; in lot 2, 5.2 kg; and in lot 3, 6.3 kg. (3) The percentage of mortality for those fed cassava refuse meal was 59.4%, for those fed rice bran, 41.5%, and for those fed cassava refuse meal-rice bran, 42.5%. (4) Considering the efficiency of the ration given to lot 1 as 100% in its effect on the growth rate of chicks, the ration containing a combination of cassava refuse meal and rice bran was 92.3%, and the cassava refuse meal was only 77.3%. *(Summary by T.M.)* H03

1209-0274 ECHANDI M., O. **Valor de la harina de hojas y tallos deshidratados de yuca en la producción de leche.** *(Value of dehydrated cassava leaf and stalk meal for milk production).* Turrialba 2(4):166-169. 1952. Span., 5 Refs.

Cassava. Cassava meal. Stems. Protein content. Fibre content. Fat content. Ash content. Carbohydrate content. Composition. Feed constituents. Dairy cattle. Animal nutrition. Leaves. Milk. Production. Silage.

This experiment compares the effect on milk production of feeding dairy cattle meal prepared from ground, dehydrated young leaves and stalks of cassava *(Manihot utilissima)* or alfalfa. It is concluded that under similar conditions and with similar proportions (1) this cassava meal does not upset the digestive system of the cows, and (2) it is economically recommendable to use cassava meal rather than dehydrated alfalfa meal in rations of dairy cows, using as a basis the price of ¢ 30 (¢ US$ 0.12) per 100 pounds of cassava meal and ¢ 40 for alfalfa meal. *(Summary by P.A.C.)* H03

1210-3806 ALCACID, E. **Preliminary report of certain fattening feeds for hogs.** Philippine Agricultural Review 20(3):295-309. 1927. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Cultivars. Composition. Water content. Ash content. Starch content. Protein content. Fibre content. HCN content. Animal nutrition. Domestic animals. Swine. Feeds and feeding. Prices. Economics. Diets. Fattening. Cassava meal. Feed constituents. Maize meal. Molasses. Philippines.

Three sets of experiments were carried out to determine the average daily weight gain per pig (3 lots) on 3 different diets. Lot 1: molasses, gained .478 kg on 2.409 kg feed. Lot 2: cassava, gained .447 kg on 2.361 kg feed. Lot 3: corn, gained .444 kg on 2.49 kg feed. Corn was the most expensive feed. Lot 3 consumed an average of 5.62 kg feed to produce 1 kg weight gain, whereas lot 2 consumed 5.24 kg and lot 3, 5.09 kg. Average daily weight gains in Experiment 1 were higher than in the others, which may be attributed to the breed of animal used: Duroc-Jersey-Yorkshire-Berkshire in experiment 1 and crossbred in the other two. *(Summary by T.M.)* H03

1211-2005 ASSIS, F. DE P. *et al.* **efeitos da administração de raízes e tubérculos, como suplemento de inverno, na alimentação de vacas em lactação.** *(Effects of feeding dairy cows roots and tubers as winter feed suplements).* Boletim de Industria Animal 20:55-61. 1962. Port., Sum. Port., Engl., 6 Refs.

Cassava. Sweet potatoes. composition. Feeds and feeding. Dairy cattle. Milk. Animal nutrition. Domestic animals. Production. Tubers. Brazil.

Bulk feeds, such as cassava (*Manihot utilissima* Pohl), sweet potatoes (*Ipomea batatas* Lam) and edible canna (*Canna edulis* Kerr, Gawl) are commonly used in feeding dairy cattle during the dry winter season. In this trial the above 3 feeds were studied in a switchback design; 4 treatment groups (24 Holstein cows in 3 experimental periods of 3 weeks each) were put out to pasture twice daily, but did not receive any other bulk feed during the time they were in the barn. The results show that (a) cassava and sweet potatoes had a more pronounced effect on milk yield, the former increasing milk production 19.5% as compared to treatment 4 (no supplementation); (b) sweet potatoes were less effective, the increase being 7.8%; (c) edible canna had no effect. Chemical composition explains the better results obtained with cassava and sweet potatoes, which both have higher levels of dry matter (34.99% and 30.52%, respectively) as compared with 15.32% in edible canna. *(Author's summary)* *H03*

1212-0301 MONDOÑEDO, M. and BAYAN, P. V. **A comparative study of corn and cassava as feeds for hogs.** Philippine Agriculturist 15:523-529. 1927. Engl., Sum. Engl., 7 Refs.

Cassava. Animal nutrition. Maize. Dietary value. Feeds and feeding. Swine. Diets. Tubers. Domestic animals. Processed products. Philippines.

With 3-6 month old pigs fed sweet potato silage and corn rations, one half of the corn may be substituted by three times its weight in cooked cassava. On dry lot, a greater part of corn may be substituted. With 6-9 month old pigs on dry lot (on a corn ration), the substitution of cooked cassava for one half the corn, at a ratio of 3 parts (by weight) of cassava for 1 part corn, proved beneficial, both from the standpoint of gain and economy in feed. In producing gain, ground corn proved to be slightly better than either whole corn or 3 parts cooked cassava. From the standpoint of cost of gain, ground corn was equal to cooked cassava but better than whole corn. No difference in the condition and finishing of the hogs in the 3 lots was observed. Three parts of peeled, cooked cassava, which is equivalent to 2 parts of raw cassava, had approximately the same feeding value as one part flint corn grain. *(Author's summary)* H03

1213-0294 MONDOÑEDO, M. and ALONTE, F. **A comparative study of corn, cassava,sweet potatoes and pong-apong as feeds for swine.** Philippine Agriculturist 2:113-119. 1931. Engl., Sum. Engl., 5 Refs.

Cassava. Sweet-potatoes. Economics. Swine. Feeds and feeding. Diets. Costs. Palatability. Animal nutrition. Dietary value. Maize. Philippines.

Two feeding experiments with swine were conducted during a 140-day period. Results were (1) Considering rate of gain, cassava and sweet potatoes were 87% as efficient as corn; pong-apong was 75% as efficient. (2) To produce 1 kg of weight gain required 6.92 kg of corn, 9.56 kg of cassava, 9.38 kg of sweet potatoes, and 8.88 kg of pong-apong. (3) Based on feed costs| kg of gain, corn was the cheapest, pong-apong was second and sweet potatoes and cassava, third. An important result of combining two experiments into one period of 140 days is the ability of the pong-apong ration to maintain almost as good a rate of gain as the cassava and corn rations, with a comparatively smaller amount of feed and at less cost. This result explains why pong-apong, in spite of its unpalatability, is in general use by the small farmers for feeding their hogs. Conclusions: (1) Cassava or sweet potato is a good substitute for corn in the ration of pigs over 5 months old when fed in dry lot. (2) Two parts by weight of cassava or sweet potato are about 87% as efficient as one part corn in feeding value, and two parts of pong-apong are 75% the value of corn; that is, 2.3 parts cassava or sweet potato and 2.67 parts of pong-apong are equivalent to 1 part corn. *(Author's summary)* H03

1214-0411 AUMAITRE, A. **Valeur alimentaire du manioc et de differentes cereales dans les régimes de sevrage precoce du porcelet: utilisation digestive de l'aliment et effet sur la croissance des animaux.** *(Nutritive value of cassava and different cereals in early-weaning diets for the piglet: digestive utilization of feed and its effects on growth of the animals).* Annales de Zootechnie 18(4):385-398. 1969. Fr., Sum. Fr., Engl., 36 Refs.

Cassava. Swine. Diets. Proteins. Feeds and feeding. Cereals. Maize. Oats. Feed constituents. Animal nutrition. Dietary value. Cellulose. Digestibility. Food energy. Animal physiology.

The effect of the type of basic component (cassava, cereals) in the ration has been studied in the early-weaned piglet. In 2 experiments, the effect on growth rate, feed efficiency, and digestibility of the main elements in the ration were measured when barley, cassava, decorticated oats and corn were introduced in proportion to wheat. There was a significant effect on growth and feed consumption. Maximum performances were obtained with cassava and barley (416 and 386 g of weight gain| day) as against 360 g for wheat. These results may be explained as a special effect on the health of the animals (decreased incidence of diarrhea). The apparent digestibility of all the elements in the diet varied, depending on the kind of cereal (especially when the animals were full fed). Thus, contrary to what has been observed in the growing pig, barley, corn and wheat were comparatively digestible when animals were fed equal quantities. Cassava improve digestibility by 4-5% in relation to wheat and decreased incidence of diarrhea after weaning. The overall results show that wheat, barley and decorticated oats have comparable digestible energy value in association with the same complementary feed (about 4,000 kcal| kg) and that cassava is more energetic (about 4,200 kcal). *(Author's summary)* H03.

1215-0397 TORRES, A. DE P. **A raspa de mandioca como sucedaneo dos farelos de trigo na alimentação de pintos.** *(Cassava meal as a substitute for wheat bran in feeding chicks).* Anais da Escola Superior de Agricultura "Luis de Queiroz" 14-15:143-150. 1957-1958. Port., Sum. Engl., 3 Refs.

Cassava. Feeds and feeding. Chicks. Wheat bran. Cassava meal. Poultry. Domestic animals. Feed constituents. Substitutes. Animal nutrition. Dietary value. Brazil.

In a feeding trial, cassava root meal was used as a substitute for wheat bran and wheat middlings (mixed) in 4 different proportions: 10, 15, 20 and 30% of a ration. Five groups of 32 seven-day old Rhode Island Red chicks were used during the 6 weeks of the trial. There was a high mortality rate in the group receiving 30% cassava root meal and no wheat by-product. The rate of growth in the chicks decreased in accordance with the increase in the proportion of cassava meal in their ration. The author suggests cassava root meal might have an antagonistic factor acting as a "toxic," which he imagines could be corrected by a higher vitamin and mineral content. This hypothesis must be investigated. *(Author's summary)* H03

1216-0262 ZARATE, J. J. **The digestibility by swine of sweet potato vines and tubers, cassava root, and green papaya fruits.** Philippine Agriculturist 40:78-83. 1956. Engl.

Cassava. Feeds and feeding. Swine. Dietary value. Animal nutrition. Composition. *Manihot esculenta.* Sweet potatoes. Digestibility. Tubers. Processed products. Philippines.

The different digestion coefficients of the nutrients in vines and cull tubers of the sweet potato (*Ipomea batatas* Linn., Poir.), cooked roots of cassava (*Manihot utilissima* Pohl) and green fruits of papaya (*Carica papaya* Linn.) were estimated; and the digestive efficiency of the Philippine, Berkjala and Berkshire pigs fed these nutrients was studied. There were no significant differences among the breeds in digestion coefficients for organic matter, fat and crude protein in sweet potato tubers and vines, cassava roots and green papaya fruits. Philippine pigs had the highest digestion coefficients for fiber and nitrogen-free extract in sweet potato vines. *(Summary by P.A.C.)* H03

1217-0273 WOODMAN, H. E., MENZIES KITCHIN, A. W. and EVANS, R. E. **The value of tapioca flour and sago pith meal in nutrition of swine.** Journal of Agricultural Science 21(3):526-546. 1931. Engl., 8 Refs.

Cassava. sago. Feeds and feeding. Swine. Digestibility. Cassava flour. Meals. Feed constituents. Dietary value. Animal nutrition.

Experiments were carried out to determine the digestibility of tapioca flour and sago pith meal when fed to swine. (1) Tapioca flour is one of the most digestible feeds employed in swine husbandry and can replace barley or maize. The ration of bacon pigs from 140 lb liveweight to slaughter included 40% tapioca flour. During the 3 weeks prior to slaughter, the animals were fed 3 lb. of tapioca flour per head day. (2) Tapioca flour has a decidedly favorable effect on the color and texture of carcass fat and bacon quality. (3) Sago pith meal, a carbohydrate food from Malaya, may be introduced into the rations of bacon pigs as a substitute for barley meal, up to 20% of the ration, without depressing the rate of liveweight gain. It is more suitable for pigs of 100 lb liveweight or more than for younger animals. If the replacement is increased to 40% of the ration, efficiency is lowered because of the depressing influence of the sago pith meal on the digestibility of the other foods in the diet, especially protein. Sago pith meal appears to contain no digestible protein. (4) Sago pith meal plus a small allowance of bran was an efficient substitute for middlings in the rations of bacon pigs of more than 100 lb liveweight, provided it amounted to no more than 20% of the ration. (5) Sago pith meal had a favorable effect on quality and conformation. Of 29 carcasses from pigs given rations containing sago pith meal in partial replacement of barley meal, 27 were graded as prime. Only 5 prime carcasses were obtained from a group of 10 pigs which had received sago pith meal and bran as a substitute for middlings. *(Summary by P.A.A.)* H03

1218-0730 SERRES, H. **L'engraissement des zébus dans la région de Tananarive selon la technique du "boeuf de fosse".** *(Zebu cattle fattening in the area of Tananarive by the "cattle in pit" method).* Revue d'élévage et de Medicine Vétérinaire des Pays Tropicaux 22(4):529-539. 1969. Fr., Sum. Fr., Engl., Illus.

Cassava. Cattle. Rice. Sweet-potatoes. Feeds and feeding. Leaves. Fattening. Animal nutrition. Finishing. Diets. Domestic animals. Malagasy Republic.

Near Tananarive, lean Zebu cattle are fattened while confined in pits excavated in the hillsides near the villages. From Dec. to March, the animals are fattened on grass; from March to July they are fed culled rice, sweet potato and cassava leaves. The animals become very fat, with a carcass yield reaching 65%. *(Summary by Biological Abstracts)* H03

1219-0840 SOARES, P.R. **Mandioca e trigo na alimentação dos pintos.** *(Cassava and wheat in chick feed).* Sitios e Fazendas 32(11):40-41. 1966. Port.

Cassava. Feeds and feeding. Cassava meal. Animal nutrition. Diets. Sorghums. Wheat flour. Domestic animals. Chicks. Brazil.

The main source for producing concentrates for chick feed in Brazil is millet, which sometimes becomes scarce and expensive. Fifteen rations were tested using cassava meal and wheat flour to substitute millet. The maximum yield was attained when substitution was 10.36%. Feed consumption did not vary when substitution was lower than 30% *(Summary by H.J.S.)* H03

1220-0881 MATHUR, M. L., SAMPATH, S. R. and GHOSH, S. N. **Studies on tapioca: effect of 50 and 100 per cent replacement of oats by tapioca in the concentrate mixture of dairy cows.** Indian Journal of Dairy Science 22:193-199. 1969. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Milk. Production. Cereals. Groundnut. Oats. Wheat bran. Concentrates. Feeds and feeding. Metabolism. Diets. Dry matter. Digestibility. N. Ca. P. Substitutes. Dairy cattle. Cakes. Cassava chips. Domestic animals. Proteins. Feed constituents. Animal nutrition. Dietary value. Feed mixtures. Cassava flour. Animal physiology. India.

The effect of substituting cassava (50 and 100%) for oats in concentrate rations was studied from the standpoint of milk and fat production in cows. Three groups, each with 6 crossbred cows, were used. The control group received a concentrate mixture consisting of 25% oats, 20% gram, 20% groundnut cake, 20% wheat bran and 15% gram husk at the rate of 1 kg mixture for every 3 kg milk yielded by the animal. For group II, 50% of the oats in the mixture was replaced by cassava while in group III, 100% oats was replaced by cassava. The 3 mixtures were made isoproteinous and isocaloric by a slight adjustment in the quantities of gram and cake. The trial lasted 20 weeks; after 18 weeks of feeding, a metabolism trial was conducted. The average total digestible nutrients of the ration in the control group and experimental groups II and III were 61.5, 58.9 and 60.7 kg| 100 kg dry matter consumed. The data on weekly milk yield, fat percentages, fat corrected milk and body weights of the animals in each of the three groups were statistically analyzed. The analysis of variance showed that the differences in the values of the experimental groups as compared to that of control groups were not significant. The cereal portion of the concentrate ration of milch animals can be replaced by less costly cassava chips without any adverse effect. *(Author's summary)* H03

1221-0106 **A FARINHA de mandioca na alimentação dos bezerros.** *(Cassava meal in calf feeding).* Evolução Agricola 3(35):22-23. n. d. Port.

Cassava. Animal nutrition. Cassava meal. Calves. Domestic animals. France.

Cassava meal was tested as a feed for calves in France. In terms of weight gain, it was the best feed, requiring very little supplementation in the form of forage, rice meal and skim milk. *(Summary by H.P.)* H03

1222-0726 TEJADA DE H., I. and BRAMBILA, S. **Investigaciones acerca del valor nutritivo de la yuca para el pollito.** *(Investigation of the nutritional value of cassava for growing chicks).* Técnica Pecuaria en México no. 12-13;5-11. 1969. Span., Sum. Span., Engl., 18 Refs.

Cassava. Feeds and feeding. Chicks. ***Manihot esculenta.*** **Fattening. Feed constituents. Nutritive value. Cassava meal. Meals. Poultry. Animal nutrition. Composition. Domestic animals. Diets. México.**

Three experiments were conducted to assess the nutritional value of cassava meal *(Manihot utilissima)* for growing chicks. A high-yielding variety (Señora está en la mesa) of cassava was used. This was compared with control diets of corn starch, dehulled soybean meal, DL methionine, corn oil plus minerals and vitamins. Diets were fed from the first day of age in duplicate groups of 15 chicks. Each experiment lasted 4 or 5 weeks. The main observations were (1) Proximate analysis of 30 varieties of cassava showed considerable differences in chemical composition. (2) The main constituent of cassava meal is nitrogen-free extract, which includes starch. (3) HCN content of fresh cassava roots, chemically determined after hydrolysis, was 23 ppm for the poorest variety and 345 ppm for the richest one, with an average of 152 ppm. (4) Chicks fed diets containing cassava meal grew as well as those receiving corn starch, but feed efficiency was better in the latter group. Mortality was low and essentially the same for control and experimental groups. (5) High levels of cassava meal can be included in rations for chicks; in this case, 50% was the highest level used. (6) The nutritional significance of residual HCN in cassava meal is not clear at the present time. *(Author's summary)* H03

1223-0105 KOK CHOO, T. L. **The nutritive value and utilization of tapioca leaf on the performance of swine.** Thesis. B. Agr. Sc. Kuala Lumpur, University of Malaya, Faculty of Agriculture, 1972. 88p. Engl., Sum., Engl., 49 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Leaves. Animal nutrition. Swine. Domestic animals. Diets. Feeds and feeding. Fattening. Feed constituents. Cassava meal. Composition. Protein content. Fibre content. Water content. Ash content. Cyanides. Digestibility. Dietary value. Amino acids. Animal physiology. Methionine. Molassses. Finishing. Fattening. Malaysia.**

Two experiments were conducted using 40 Landrace x Yorkshire crossbred pigs to study the effects of tapioca leaf and the supplementation of methionine, molasses and palm oil on the performance of growing-finishing pigs. In experiment 1, 20 pigs were allocated to 5 dietary treatments to study the effects of 2 levels of tapioca leaf (10 to 20%) in combination with either methionine (0 and 0.20%) or sodium thiosulphate (0 and 0.15%) supplementation on the performance of growing pigs. In experiment 2, 20 pigs were assigned to 5 dietary treatments to study the effects of either molasses (0 and 5%) or palm oil (0 and 3%), with or without methionine (0 and 0.20%) addition to the tapioca leaf diets (20%) on the performance of growing-finishing pigs. The inclusion of tapioca leaf meal in the diet depressed ($P<0.01$) feed consumption, body weight (10 and 20%) gain and feed conversion ratios of growing pigs. Sodium thiosulphate and methionine supplementation slightly improved the performance of growing pigs, although not significantly. Methionine seemed to be more efficient in improving the utilization of tapioca leaf than the sodium thiosulphate addition. Molasses or palm oil additions to the tapioca leaf diets tended to improve feed consumption and daily gain. Molasses supplementation to the tapioca leaf diets containing methionine improved the performance of growing-finishing pigs significantly ($P < 0.01$). The incorporation of palm oil to the methionine tapioca leaf diets has a trend to improve the feed conversion ratio and daily gain. Levels of cyanide present in pigs receiving the tapioca leaf diets did not reveal any toxicity symptoms throughout the experimental periods. *(Author's summary)* H03

1224-2227 ANAIS. **Le manioc dans l'alimentation du bétail.** *(Cassava in livestock feeding).* Revue Agricole (Guadeloupe) 2:20-22. 1945. Fr.

Cassava. Animal nutrition. Domestic animals. Dairy cattle. Composition. Cassava chips. Cattle. Swine. Guadeloupe.

Cassava is discussed as a feedstuff for swine and dairy cows. Comparative data on chemical composition demonstrate the advantages of cassava chips over other feeds, particularly guinea grass. Recommended feed mixtures containing cassava chips for swine of different ages are also given. *(Summary by H.J.S.)* H03

1225-0080 STECK, K. H. **Tapiocamehl, ein begehrtes Schweinefutter.** *(Cassava meal, a popular feed for pigs).* Chemie und Technik 10(6):169-170. 1959. Germ.

Cassava. Animal nutrition. Feeds and feeding. Nutritive value. Swine. Domestic animals. Cassava meal.

Demand has increased for cassava meal for fattenings pigs, especially in areas with poor potato harvests. A short description is given of cassava production and areas of production. The relative nutritive value of cassava flour is compared to several other products such as potatoes, wheat, maize and barley. The utilization of a diet supplemented with cassava can be higher than an unsupplemented diet, but addition of a protein source is needed. For fattening pigs, the diet may contain up to 30% cassava flour, with protein added. The meat quality is positively influenced. *(Summary by A. van S.)* H03

1226-3408 MAUST, L. E., POND, W. G. and SCOTT, M. L. **Energy value of cassava-rice bran diet with and without supplemental zinc for growing pigs.** Journal of Animal Science 35(5):953-957. 1972. Engl., Sum. Engl., 14 Refs.

Cassava. Animal nutrition. Swine. Maize. Zn. Fattening. Supplements. Dietary value. Rice bran. Diets. Cassava flour. Digestibility. Food energy. Animal health.

An experiment was completed with 24 young growing pigs to determine the feeding value of diets consisting of cassava flour and rice bran (CM-RB diet) as major sources of energy as compared to a diet consisting of corn (C diet) as the major source of energy and to determine the effect of Zn supplementation of the CM-RB diet on parakeratosis and energy digestibility. Weight gain, efficiency of feed utilization and digestion coefficients were used to evaluate the two diets. Pigs fed the C diet gained more weight and had a higher efficiency of feed utilization than the pigs fed the CM-RB diet. Pigs fed the CM-RB diet developed Zn-deficiency symptoms including parakeratosis and depressed serum alkaline phosphatase (SAP) levels despite the similar Zn content of the two diets (40 and 48 ppm for the CM-RB and C diets, respectively). Zn supplementation (52 ppm of Zn as ZnCo) of the diet of one-half of the pigs fed the CM-RB diet beginning at day 33 increased weight gain and serum alkaline phosphatase within 7 days as compared with values for pigs continued on the same unsupplemented diet. Apparently a factor (or factors) present in the CM-RB diet decreased the biological availability of the zinc present. A digestibility trial was completed with 4 pigs fed each diet (C, CM-RB and CM-RB+Zn) beginning on day 40 of the experiment (7 days after Zn supplementation began). Apparent digestibilities of dry matter (DM) and gross energy (GE) of the CM-RB diet were significantly ($P < .0.5$) lower than those of the C diet when the CM-RB diet was unsupplemented with Zn, but not significantly different when it was supplemented with 100 ppm ZnCo (digestibility coefficients for DM were 79.4, 67.0 and 73.6% and those for GE were 78.7, 68.0 and 74.8% for the C, CM-RB and CM-RB+Zn diets, respectively). Apparent digestion coefficients for protein followed the same trend as those of dry matter and gross energy, but the differences were not statistically significant (75.2, 58.7 and 66.8% for protein from the C, CM-RB and CM-RB+Zn diets, respectively. *(Author's summary)* H03

1227-0960 WALKER, A. **Un aliment de famine: L'écorce de Manioc.** *(A famine food: cassava peel).* Revue International de Botanique Appliquée 31:542. 1951. Fr.

Cassava. Feeds and feeding. Swine. Sheep. Goats. Animal nutrition. Domestic animals. Cortex. Waste utilization. Uses. Gabon.

In the Gabon, French Equatorial Africa, the inner of the 2 coats of cassava tubers, which is thick and of a whitish or reddish color, is generally fed to pigs, sheep or goats; but in periods of famine, it is also eaten by the people. *(Summary by Herbage Abstracts)* H03

1228-2955 MOHME, H. and PFEFFER, E. **Briketts aus heissluftgetrocknetem Gras mit unterschiedlicher Tapioka-Erganzung als Alleinfutter fur milchkuhe.** *(Pellets of hot air-dried grass with various tapioca supplements as complete feed for cows).* Wirtschaftseigene Futter 19(4):247-253. 1973. Germ., Sum. Germ., Fr., Engl., 9 Refs.

Cassava. Cattle. Animal nutrition. Feeds and feedings. Food energy. Dietary value. Concentrates. Domestic animals. Supplements.

Pellets were given as sole feed in a trial with 7 first lactation cows over the first 150 days of lactation. All pellets had 1.6% mineral salts mixed with the dried grass. Three levels of energy utilization were compared by addition of 0, 8.4 and 18.4% of tapioca to the compressed material. Daily average consumption of pellets was 15.5 kg (89% DM). Average milk production over the 150 lactation days was 16.1 kg| day with 4% butterfat. Variations due to the different tapioca additions were not significant. The lactation curve for each animal was very smooth. Increases in weight during the trial were insignificant. *(Author's summary)* H03

1229-3235 MARSH, T. D. and KANAGARATNAM, N. **Feeding trials with purebred Chinese pigs.** Malayan Agricultural Journal 26:361-368. 1938. Engl., 2 Refs.

Cassava. Swine. Animal nutrition. Feeds and feeding. Rice. Soybeans. Tubers. Dietary value. Diets. Domestic animals. Finishing. Malaysia.

The Chinese breeds of swine in Malaya are generally considered to be slow to mature, despite the standard practice of mating them before they are fully grown. An experiment was undertaken with the piebald type to find the difference in the rate of increase of liveweight in pigs fed on balanced rations and those fed under small-holding management. Rations included cassava, rice, coconut, soybeans, palm oil, guinea grass, minerals and local materials. Two experimental groups were taken from carefully matched groups of 4 pigs each. Results gathered indicate that the liveweight increase of pigs fed on a balanced ration was almost double that of the pigs under the small-holding management. Costs of feeding are also discussed. *(Summary by H.J.S.)* H03

1230-2498 MANTEL, K. **Wirkung von Legemehlen mit unterschiedlichen Getreideanteilen und Ausgleich der fehlenden Energiemengen durch Maniokamehl.** *(Effect of laying meals with different proportions of cereals and the deficit of energy made up with cassava meal).* Archiv fur Geflügelkunde 25(6):373-382. 1961. Germ., Sum. Germ., Engl.

Cassava. Cassava meal. Feeds and feeding. Chicks. Poultry. Domestic animals. Dietary value. Diets. Food energy. Cereals. Substitutes. Feed constituents. Animal nutrition. Pellets.

During a 317-day test, 4 groups of each 60 white single comb Leghorns were given grain rations as well as laying mash, in which part of the ground grain was replaced by cassava meal and soybean oil meal. The portion of cassava meal was 0-8-16-24%. Of each group, one subgroup was given the laying mash in the form of pellets, and the other in the form of meal. According to the results of the test, laying mash may contain a portion (16%) cassava meal. With higher portions (24%), the results were not so favorable. The different physical nature of the laying mash (pellets-meal) made no difference in the effect of the rations. *(Author's summary)* H03

1231-2496 GROPP, J., TIEWS, J. and HEIDECKE, F. W. **Ein neues wachstumswirksames Futter-Additiv in der Schweinehaltung. II. Carbadox in der Schweinemast.** *(A new fodder additive which influences growth. II. Carbadox in swine fattening).* Zeitschrift fur Tierphysiologie, Tierernahrung und Futtermittelkunde 28 (8):300-306. 1972. Germ., Sum. Germ., Engl., 16 Refs.

Cassava. Cassava meal. Animal nutrition. Feed constituents. Feeds and feeding. Fattening. Finishing. Swine. Diets. Dietary value. Domestic animals.

The effect of Carbadox on weight gains and feed efficiency in growing-finishing pigs has been tested in comparison to a control and a CTC group. Carbadox or CTC were added to the ration (barley 49%, cassava meal 18%, wheat 13%, soybean meal 11% and fish meal 7%) with 20 ppm. This ration was limited to a maximum intake of 1.5 kg daily. In the latter part of the experiment, the total ration consisted of 1.5 kg grower ration and increasing amounts of a barley (78.5%) and cassava meal (20%) mixture. The experimental diets were offered to pigs that had been previously fed with a starter containing no antibiotics or Carbadox and CTC, respectively. The average age of the 270 pigs was 94 days at the beginning of the experiment, which was concluded after 122 feeding days. Without considering the different feeding regimes in the starter period, daily weight gains and feed:gain ratio for the control, the Carbadox and CTC group were as follows: 548 (3.29), 620 (3.16) and 582 g (3.29). Carbadox significantly increased weight gains and feed efficiency. None of the treatments was found to have influenced the values of carcass quality. The results indicate a definite growth promoting activity of Carbadox in grower-finisher diets for pigs. *(Author's summary)* H03

1232-2983 GRAMACHO, D. D. **Contribução ao estudo químico-tecnológico do feno de mandioca.** *(Chemical study of cassava as forage).* Cruz das Almas, Brasil. Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):143-152. 1973. Port., Sum. Port., Engl., 19 Refs.

Cassava. *Manihot esculenta.* Forage. Animal nutrition. Analysis. Leaves. Petioles. Stems. Foliage. Nutritive value. Toxicity. Detoxification processes. Detoxification. Drying. Solar drying. Composition. Protein content. Ash content. Fat content. Fibre content. Carbohydrate content. Brazil.

The study focused on the possibility of utilizing the foliage of cassava plants as livestock feed in order to solve the problem of shortage of forage, especially in the tropical regions during the dry season. The HCN content of fresh cassava leaves and stems was determined. The stage at which the leaves and stems to be used for forage can be removed without affecting root yield or quality was also studied. The theorical nutritive value was established for forage use in comparative studies with dry alfalfa. The constituents of cassava hay and its nutritive value were also determined. *(Author's summary)* H03 H04

1233-2986 CHOU, K.C., NAH, K.C. and MULLER, Z. **Replacement of maize by high level of tapioca meal in rations for growing and finishing pigs.** Kajian Veterinaire (Malaysia - Singapore) 5(1):3-10. 1973. Engl., Sum. Engl., 18 Refs.

Cassava. Cassava meal. Animal nutrition. Domestic animals. Swine. Fattening. Finishing. Maize meal. Feeds and feeding. Pellets. Feed constituents. Malaysia.

Nine experiments were carried out on growing and finishing pigs fed diets containing 38, 60 or 75% cassava meal as compared with conventional maize-based diets, to evaluate the feasibility of a cheaper cassava diet and to determine the extent of replacement of maize by cassava meal in pig rations. In the first 4 experiments comparing diets containing 60% maize to diets containing 38% cassava meal, balanced with 19-34% maize and variable amounts of soybean meal, fish meal, lysine and methionine gave no significant differences in liveweight gain and feed efficiency although pigs were found to dislike the latter because of its fine powdery texture. In the subsequent 4 experiments, pigs fed pelleted cassava, containing less protein and energy but more lysine, had higher liveweight gains ($P < 0.05$) and feed conversion efficiency ($P < 0.025$) than those on maize diets. The ninth experiment clearly showed that replacement of maize by tapioca is possible at much higher levels (60 and 75%) than generally accepted. No significant difference in carcass quality was observed between pigs fed cassava diets and those fed maize diets. *(Author's summary)* H03

1234-3899 FRASER, D.M.K. **Manioc unsuitable for turkeys.** Veterinary Record 93(8):238. 1973. Engl.

Cassava. Animal nutrition. Domestic animals. Poultry. Animal health. Diets. Germany.

In these days, where substitution of nutrients in animal feed occurs daily, there may be on occasions a consideration of the use of manioc. It is true that this material has been used in the European Economic Community for many years, and it was quite a common ingredient in turkey rations in Western Germany. In our experience, many of the health problems occurring in turkeys in that country seemed to coincide with the use of this ingredient. No investigation was carried out by workers in Western Germany to find out why this ingredient seemed to cause problems; and one can only state that for some reason, the intestine of a turkey finds manioc incompatabile with normal health. At around 4 to 5 weeks of age, nearly every bird in Western Germany showed a profuse watery diarrhea. One can assume that during this time, absorption of nutrients was impaired and high incidence of lameness and leg deformities became noticeable as the bird got older. The slaughter age in Germany was in many cases later than in the United Kingdom since they use the turkey for processing into sausages, meat loaf, etc. The big incidence of lameness seemed to be around 17 to 20 weeks of age. After a great deal of pressure, we persuaded one feed company to remove this ingredient. The result of this was that this feed company soon became a major supplier to the German turkey industry since birds did better on this feed than on any other. Within one year, most feed compounders had taken this ingredient out. The purpose of this letter is to show that a feed ingredient may be acceptable from the point of view of chemical ingredients by analysis but, in practice, this same material may show quite disastrous effects in certain species of the animals in which it is used. *(Full text)* H03

1235-2399 EERLEY, R. W. **Utilization of cassava as a livestock feed.** *In* Hendershott, C. H. *et al.* A literature review and research recommendations on cassava. Athens, Ga., University of Georgia, 1972. pp. 157-182. Engl., 59 Refs.

Cassava. Animal nutrition. Domestic animals. Swine. Cattle. Poultry. Economics. Trade. Marketing. Cassava products. Roots. Leaves. Composition. Fat content. Protein content. Cassava chips. Fibre content. Pellets. Stems. Cassava meal. HCN content. Productivity. Dietary value. Feeds and feeding.

A comprehensive review of literature is presented. Main headings are as follows: introduction; types of cassava products used in animal feeds; chemical composition; livestock feeding experiments carried out with swine, poultry and cattle; discussion; conclusions and recommendations. It is stated that possibly the greatest potential of cassava utilization is through increased live stock feeding and production. *(Summary by H.J.S.)* H03

1236-1580 NIELSEN, H. E. *et al.* **The nutritional value of yeast grown on alkanes determined in experiments with rats and piglets on mixed grain and tapioca meal base diets.** Zeitschrift fur Tierphysiologie, Tierernahrung und Futtermittelkunde 33(3):151-158. 1974. Engl., Sum. Engl., Germ., 16 Refs.

Cassava. Cassava meal. Yeast production. Animal nutrition. Domestic animals. Swine. Piglets. Laboratory animals. Proteins. Food enrichment. Diets. Concentrates. Feeds and feeding. Nutritive value. Germany.

The results from the experiments with rats and piglets show that yeast cultivated from pure n-alkanes is an excellent source of protein if correction is made for a low level of methionine. Alkane-grown yeast was used as a protein source in a normal cereal-base diet and in a tapioca meal-base diet. In the latter, nearly all protein was furnished from alkane-grown yeast, and the results from the experiment with pigs show that alkane-grown yeast can be used as the only protein source. No palatability problems were encountered for diets containing up to 28% alkane-grown yeast. Tapioca meal contains 2 to 3% crude protein only, and the experiment with rats shows that the quality of this protein is of low value. However, the experiment with rats shows that the quality of this protein is of low value. However, the experiment with pigs shows that tapioca meal is a good source of energy for pigs. Alkane-grown yeast and tapioca meal might be a future feed for pigs, and this study has shown that they may be used as the major ingredients in feed for piglets. *(Author's summary)* H03 H00

1237-3855 NORMANHA, E. S. **Farelo de rama de mandioca.** *(Meal of cassava stalks).* Chácaras e Quintais 105(3):279-283. 1962. Port.

Cassava. Cassava meal. Leaves. Petioles. Animal nutrition. Composition. Brazil.

The use of ground, dried cassava leaves and stalks as animal feed is discussed. Cassava leaves may contain up to 20% crude protein, 2% calcium and 0.5% phosphoric acid. The chemical composition of meal of cassava leaves and stalks is included. *(Summary by J.L.S.)* H03

1238-2329 MORIMOTO, H. **On the feeding value of pineapple bran and tapioca "ampas" for dairy cows.** Japanese Journal of Zootechnical Science 21:49-53. 1950. Jap., Sum. Engl., 24 Refs.

Cassava. Waste utilization. Animal nutrition. Dairy cattle. Diets. Feed constituents. Feeds and feeding. Nutritive value.

Two feeding experiments were carried out simultaneously, each using 2 mature milk cows that averaged 10 kg milk yields daily and 500 kg liveweight. Group 1 received a ration of tapioca "ampas" (2.26 kg) and mixed concentrates (0.68 kg) per 1,000 kg liveweight, as a substitute for beet pulp (3.11 kg). Group 2 received 2.72 kg of pineapple bran and 0.63 kg of mixed concentrates. Rations for both groups were equal in digestible pure protein and starch value. The quantitative changes in milk and milk fat, etc. produced by the two groups were studied. The conclusions drawn were that feeding cows either tapioca ampas or pineapple bran mixtures, whose low protein content was balanced by the addition of ground soybean oil cakes, resulted in greater milk and milk fat yields than feeding them beet pulp (control group). *(Author's summary)* H03

1239-2228 ALQUIER, J. **Le manioc et son utilization alimentaire.** *(Cassava and its utilization as food).* Comptes Rendus des Séances de l'Académie de'Agriculture de France 22: 665-669. 1936. Fr.

Cassava. Animal nutrition. Feeds and feeding. Swine. Cattle. Domestic animals.

The author discusses a paper by Raymond Jacquot and Berthé Nataf under the direction of Professor Terroine from the Institut de Physiologie General of Strashourg. The importance of including physiological studies as part of animal and human nutrition research is emphasized. A soup for swine feeding based on milk, cassava and malt and enriched with minerals is briefly described. *(Summary by H.J.S.)* H03

1240-2143 GOUIN, A. and ANDOUARD, P. **Emploi de la farine de manioc en élevage.** *(Using cassava meal for animal feeding).* Journal d'Agriculture Tropicale no. 94:127-128. 1909. Fr.

Cassava. Boiling. Processing. Tubers. Animal nutrition. Cassava meal. Processed products. Water requirements (processing).

Brief notes are given on the preparation of cassava meal for animal feeding. Cassava should be mixed in twice its weight of water, then mixed with the same quantity of boiling water for 10 minutes. *(Summary by H.J.S.)* H03

1241-1882 KLEIN, W. and BARLOWEN, G. VON. **Tapioka-mehl im aufzuchtfutter.** *(Cassava meal as a feedstuff).* Archiv fur Geflugelkunde 18:415-428. 1954. Germ., Sum. Engl., 1 Ref.

Cassava. *Manihot esculenta.* Cassava meal. Feeds and feeding. Animal nutrition. Chicks. Poultry. Domestic animals. Diets. Dietary value. Digestibility.

An experiment was made to study the influence of cassava *(Manihot utilissima)* meal on baby chicks. An all-mash feed for baby chicks should contain not more than 10% tapioca meal in order to obtain the best growth results. It is not possible to replace the ground grain by cassava meal. The cassava meal contains a factor which decreases the feed consumption. *(Author's summary)* H03

1242-0114 SQUIBB, R. L. and WYLD, M. K. **Effect of cassava meal in baby chick rations.** Turrialba 1(6):298-299. 1951. Engl., Sum. Engl., 2 Refs.

Cassava. Feeds and feeding. Chicks. Diets. Animal nutrition. Cassava meal. Poultry. Domestic animals. Dietary value. Costa Rica.

Cassava meal replaced corn in rations containing several sources of proteins and dried forage meals. In 3 out of 7 experiments, chicks fed corn showed a significant increase in growth over chicks fed cassava meal. In the remaining experiments there were no significant differences in growth rates. It is important for cassava to be free of contaminants. Under Guatemalan conditions, cassava meal may satisfactorily replace corn in baby chick rations. *(Author's summary)* H03

1243-2231 **LES COSSETTES et la farine de manioc "Nosybéenne" dans l'alimentation des animaux.** *(Chips and flour of Nosybéenne cassava for animal feeding).* Bulletin Economique de Madagascar no. 3:293-296. 1921. Fr.

Cassava. Animal nutrition. Feeds and feeding. Cassava flour. Cassava chips. Cassava products. Cattle. Domestic animals. Processed products. Factories. Malagasy Republic.

The Nosybéenne Company in Madagascar cultivates cassava and produces cassava chips and flour for animal feeding. Its products have proved to be of high quality for the feeding of swine, dairy cows, oxen, horses and even for dogs. Experiences gathered in using these types of cassava products for animal nutrition are briefly described and discussed. *(Summary by H.J.S.)* H03

1244-1578 LE DIVIDICH, J. and CANOPE, I. **Valeur alimentaire de la farine de banane et du manioc dans le régime du porcelet sevré a 5 semaines: Influence du taux de protéines de la ration.** *(Feeding value of banana meal and cassava meal in diets of piglets weaned at 5 weeks: Effect of the protein level of the ration).* Annales de Zootechnie 23(2):161-169. 1974. Fr., Sum. Fr., Engl., 23 Refs.

Cassava. Cassava meal. Bananas. Meals. Animal nutrition. Domestic animals. Swine. Piglets. Diets. Proteins. Feeds and feeding. Dietary value. France.

Two experiments were conducted on 62 piglets weaned at 5 weeks in order to compare the feeding value of cassava meal constituting 52% of the diet. Two levels of protein (19 and 21.5%) were considered. The diets were pelleted and the animals fed ad libitum. There was no significant difference between the performance of the animals fed the diets based on either cassava meal or banana meal. On the other hand, the high level of protein (21.5%) significantly improved the average daily gain ($P < 0.01$) and feed efficiency ($P < 0.05$). The apparent digestibility of the diet based on cassava meal was significantly higher for dry matter and organic matter ($P < 0.01$) and protein ($P < 0.05$). The incidence of diarrhea was low, and the use of these tropical products may be recommended up to 52% of the diet, with a protein level of about 21.5% for the weaning of 5-week-old piglets. *(Author's summary)* H03

1245-2219 YOSHIDA, M. **Bioassay procedure of energy sources for poultry feed and estimation of available energy of cassava meal.** Japan Agricultural Research Quarterly 5(4):44-47. 1970. Engl., 47 Refs.

Cassava. Cassava meal. Feeds and feeding. Animal nutrition. Poultry. Diets. Chicks. Food energy. Nutritive value. Composition. Animal health. Domestic animals.

Standard diets with 10% maize starch or half or all the starch replaced by soybean oil had 60.6, 67.3 and 74.0% total digestible nutrient (TDN). When the diets were given to day-old chickens for 4 weeks, gain in weight (y) was related to g TDN| g diet (x) by the equation $y=3.396x+5.82$. TDN of diets with 10, 20 or 30% cassava meal were estimated from growth of similar chickens. With 10% cassava the diet had 67% TDN; 20% gave only 59% TDN. The cassava in the largest amount was soaked in water or autoclaved, giving 69 and 65% TDN. The poor growth with 20% raw cassava was attributed to the 7.2 ppm HCN, which it contained.

By difference, the TDN of the cassava was calculated to be 67% when 10% of the diet, 28% when 20% and 75 and 64% when 32%. The cassava meal had 86.5% DM, 2.0% crude protein, 76.9% N-free extract and 36 ppm HCN. *(Summary by Nutrition Abstracts of and Reviews)* H03

1246-1635 LEROY, A.M. and FRANCOIS, A. **Les plantes féculentes tropicales dans l'alimentation des animaux.** *(Starchy tropical plants in animal nutrition).* *In* Congrés du Manioc et de Plantes Féculentes Tropicales, Marseille, 1949. Marseille, Institut Colonial, 1949. pp.75-78. Fr., 5 Refs.

Cassava. Animal nutrition. Domestic animals. Lambs. Swine. Feeds and feeding. Diets. Composition. Mineral content. Vitamin content. N. HCN content. Toxicity. Cellulose.

Cassava and sago, when properly balanced with proteins, minerals and vitamins, can be used successfully in feeds for adult bovine and swine. Swine rations may contain up to 60% cassava. The HCN content of some varieties of cassava may limit their use in feeds. *(Summary by Chemical Abstracts)* H03

1247-0305 MEJIA C., T. R. **Valor comparativo entre la yuca y el maíz en la alimentación de cerdos.** *(Comparative value between cassava and corn in swine feeding).* Revista de la Facultad Nacional de Agronomía. Medellín 22(55):95-113. 1960. Span., Sum. Span., 16 Refs.

Cassava. Feeds and feeding. Swine. Animal nutrition. Fattening. Maize. Dietary value. Cassava meal. Colombia.

Comparative trials between cassava and maize were performed on 3 groups of 7 pigs each. Ration 1 was composed of 40% cassava; ration 2, 20% cassava and 20% corn; ration 3, 40% corn. The remaining 60% in all rations was constituted as follows: 20% corn flour, 9% wheat bran, 15% sesame oil meal, 5% fish flour, 10% cottonseed meal and 1% mineralized salt. One pound of Aurofac was added to every ton of feed. The experiment was carried out at the Facultad Nacional de Agronomía, located in the Medellín Valley (150 m above sea level, with an average temperature of 21°C). Pigs were weighed at 14-day intervals at the same time of day before they were fed. Ration 1 exceeded ration 2 and ration 3 for the growing and finishing periods. Daily gains fluctuated greatly throughout the experiment, but an average of 0.607 kg in lot 1, 0.544 kg in lot 2, and 0.527 kg in lot 3 was obtained at the end of the experiment. Feed consumption was approximately the same for all lots. Pigs fed ration 1 showed an efficiency ratio of 4.63:1; those fed rations 2 and 3 showed ratios of 5.19:1 and 5.29:1, respectively. *(Author's summary)* H03

1248-3163 TORRES, A. P. DE. **A raspa da mandioca na alimentacao das galinhas.** *(Cassava meal as a chicken feed).* Anais da Escola Superior de Agricultura "Luis de Queiroz" 3:329-338. 1946. Port., Sum. Port., Engl., 9 Refs.

Cassava. *Manihot esculenta.* **Cassava meal. Animal nutrition. Diets. Maize meal. Feed constituents. Substitutes. Dietary value. Costs. Poultry. Domestic animals. Brazil.**

The author studied the partial and total substitution of ground corn by ground dried cassava. Three rations of 17.5% protein were given to 6-week old chicks for 4 weeks. One ration contained 100% corn; another 50% corn and 50% cassava; the third, 100% cassava meal. After 30 days chicks on cassava rations weighed less than those on the control (corn) diet. No injury was observed in the animals, and the difference between the two rations with cassava was not significant, although both proved to be significantly different from the contro. *(Author's summary)* H03

1249-3725 OH SAW YIN and JALALUDIN, S. **The effect of feeding tapioca on growth rate of chicks.** Malayan Agricultural Research 1:144-146. 1972. Engl., Sum. Engl., Mal., 1 Ref.

Cassava. Chicks. Poultry. Domestic animals. Feeds and feeding. Diets. Cassava meal. Animal nutrition. Toxicology. HCN. Malaysia.

A small-scale trial to study the use of cassava meal for growth of chicks was carried out on 40-day-old chicks. Two diets, one with and the other wihout cassava supplementation, were fed to two groups of chicks. Feed intake and body weight indicated that the growth rate and feed conversion ratio of chicks were inferior when cassava was added to the diet. The factors affecting cassava utilization are discussed. *(Author's summary)* H03

1250-2212 AINA, J. A., STRATMAN, F. W. and TOMPKINS, W. A. **The economics and performance of growing-finishing swine on maize or maize and cassava as a carbohydrate source.** Nigerian Agricultural Journal 5(1):21-23. 1968. Engl., Sum. Engl., 9 Refs.

Cassava. Maize. Swine. Feeds and feeding. Animal nutrition. Diets. Costs. Economics. Fattening. Finishing. Nigeria.

A maize-dried cassava mixture was compared to maize as the major carbohydrate source for feeding swine from 40 to 200 lb body weight. Swine which had been fed maize were nonsignificantly more efficient and faster in gaining weight than those fed maize-cassava. Feed costs were slightly lower whereas labor, equipment, and building and repair costs were slightly higher for maize-cassava fed swine than those fed maize. Profits were slightly higher for maize-cassava fed swine than those fed maize. *(Author's summary)* H03 J00

1251-2305 PATEL, B. M. and SHUKLA, P. C. **Effect of supplementation of carbohydrate feeds to legume roughages on their nutritive values.** Indian Journal of Animal Sciences 42(10):767-771. 1973. Engl., Sum. Engl., 4 Refs.

Cassava. Animal nutrition. Dietary value. Diets. Legume crops. Dairy cattle. Domestic animals. India.

The effect of supplementation of carbohydrate feeds, molasses and cassava on the nutritive values of cluster bean fodder (guar gotar) and pigeon pea fodder (tur gotar) fed to lactating cows was studied. Results showed that the nutritional quality of tur gotar was much lower than that of guar gotar, and it could not be used even as a maintenance feed although on the basis of approximate composition, it could be assessed as a good-quality feed. Tur gotar feeding also reduced dry matter intake. Observations indicated that supplementation of carbohydrates failed to improve the utilization of protein nitrogen available from the two feeds. Supplementation of groundnut cake exhibited definite improvement in cows fed tur gotar, but it was still not so good as guar gotar. *(Author's summary)* H03

1252-2079 **FENO DE soja perene, ramas de mandioca e pangola podem substituir alfafa em rações para suinos.** *(Perennial soybean hay, cassava branches and pangola grass can replace alfalfa in swine diets).* Revista Fir 11(11):32-33. 1969. Port.

Cassava. Alfalfa. Feed constituents. Forage. Fattening. Feeds and feeding. Swine. Soybeans. Animal nutrition. Brazil.

A summary is given of a paper by L. Velloso, "Study on the value of some tropical plant hays compared with alfalfa in swine diets." Tables are presented of rations used, chemical analysis of rations and weight gain of animals employed. All hays mentioned are adequate substitutes for alfalfa up to a 5% total substitution. *(Summary by H.J.S.)* H03

1253-0926 NORMANHA, E. S. A. **A produção de alimentos para os animais . . . .** *(The production of animal feed . .).* n.p., n.d. 3 p. Port.

Cassava. Leaves. Processing. Tubers. Foliage. Forage. Cassava meal. Nutritive value. Animal nutrition.

Brief notes are given on cassava concerning the value of the tuber meal, branches and leaves as a fodder and the preparation of the same. *(Summary by H.J.S.)* H03

1254-3184 ALVAREZ G., R. and ALVARADO R., L. **La yuca como fuente energética en la alimentación de los cerdos; I. Sustitución total del maíz por harina de yuca (*Manihot esculenta* Crantz) en raciones de crecimiento y engorde para cerdos.** *(Cassava as an energy source in swine feeding; I. A total replacement of maize by cassava (Manihot esculenta Crantz) meal in rations for swine growing and fattening).* Revista Ganagringo 8(31):32, 34-35, 38. 1973. Span., Sum. Span., 4 Refs.

Cassava. Maize. Fattening. Cassava meal. Swine. Finishing. Feeds and Feeding. Animal nutrition. Food energy. Nutritive value. Dietary value. Venezuela.

A feeding trial was carried out with growing and full-grown pigs. Animals were given a ration based on cassava meal in comparison with a maize ration. Results showed that total replacement of maize by cassava meal in diets for full-grown pigs gave 11% less body weight gain. This was probably due to a lower consumption of the cassava-based feed, especially during growth. Feed conversion decreased 5.19%, being 3.66:1 for maize and 3.85:1 for cassava. Animals that consumed the cassava ration produced firmer and better quality carcasses. The dorsal fat of these animals was 3.39 cm thick, as compared to 3.54 cm in pigs fed maize rations. Carcass production was 70.70% for maize and 70.8% for cassava. *(Author's summary)* H03

1255-2075 **A MANDIOCA tem futuro como forragem.** *(Cassava has a future as a forage).* Revista Fir 11(5):32-33. 1969. Port.

Cassava. Animal nutrition. Trade. Marketing. Economics. Forage. Prices. Germany. Netherlands. Belgium.

Economic and technical considerations are presented on the international market for cassava as an animal feed. West Germany, the Netherlands and Belgium are the largest importers in Europe. The population increase of domestic animals in these countries might increase cassava consumption. Nevertheless, to compete with other forages, the quality of cassava products should be improved. *(Summary by H.J.S.)* H03 J00

1256-0919 **FORTIFIED CASSAVA.** World farming 12(12):36. 1970. Engl.

Cassava. Cassava meal. Food enrichment. Methionine. Amino acids. Animal nutrition. Chicks. Dietary value.

Additional amounts of the amino acid methionine in cassava meal can increase the weight gain and improve the feed efficiency of chicks, according to scientists at the University of Wisconsin, U.S.A. Cassava, (mandioca), which is grown in many parts of the world, is normally inferior to maize or other feeds when it is used as the major carbohydrate source. However, because it is easy to grow and gives high yields, cassava is often used in poultry rations. The scientists varied the amino acids in the chicks' diet of 45% cassava meal. Only with the addition of methionine did weight increase and feed efficiency improve. In a later experiment, they found that 0.20% supplemental methionine gave optimum results. It was also shown that substituting cassava meal for maize increased the chicks' requirement for methionine. *(Full text)* H03

1257-0386 VOGT, H. **The use of tapioca meal in poultry rations.** World's Poultry Science Journal 22(2):113-125. 1966. Engl., 72 Refs.

Cassava. Feeds and feeding. Poultry. Chicks. Cultivation. Processing. Fattening. Digestibility. Animal nutrition. Cassava meal. Vitamin content. Composition. Dietary value. Food energy.

Literature (available in Germany) concerning the use of cassava meal in poultry rations is reviewed and is divided into two sections: cultivation and processing. The results of 8 trials carried out by the author proved that the digestibility coefficients of Axelson (1973) must be taken as a basis for energy evaluation. The use of 1% cassava meal in broiler feed can be recommended without hesitation for the entire fattening period. The employment of higher doses is only recommendable from the fourth week. In laying rations, 20% cassava meal may be employed in total feed. It is important to compensate the lower protein content of cassava meal by higher levels of protein feedstuffs. *(Summary by P.A.C.)* H03.

1258-2390 MANDIOCA E **batata-doce aumentam leite na seca.** *(Cassava and sweet potatoes increase milk production during the dry season).* Coopercotia 19(149):52. 1962. Port. Illus.

Cassava. Animal nutrition. Dairy cows. Sweet potatoes. Milk. Diets. Brazil.

An experiment on supplementing dairy rations during the dry season in Brazil is briefly described. Cassava and sweet potatoes were shown to be efficient in dairy cow feeding. *(Summary by H.J.S.)* H03

1259-2030 MAHENDRANATHAN, T. **The effect of feeding tapioca** *(Manihot utilissima* **Pohl) leaves to pigs.** Malaysian Agricultural Journal 48 (2):60-68. 1971. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Feeds and feeding. Swine. Leaves. Diets. Toxicity. Economics. Dietary value. Animal nutrition. HCN absorption. HCN. Malaysia.

An experiment was conducted to study the effect of feeding fresh cassava tops to pigs from 8-34 weeks of age. Pigs receiving 75% basal diet and an *ad libitum* amount of cassava leaves had better weight gains than those fed the basal diet up to the 28th week of age. However, the feed conversion of the pigs on the basal concentrate diet was superior to the groups that received only 50% and 75% of the basal diet and cassava leaves *ad libitum*. The 50% basal diet and the *ad libitum* feeding of cassava tops resulted in the lowest feed costs and highest economic returns. No clinical symptoms of HCN poisoning were observed in any of the pigs fed on fresh cassava leaves throughout the trial. *(Author's summary)* H03 H04

1260-3641 COURSEY, D. G. and HALLIDAY, D. **Cassava as animal feed.** Outlook on Agriculture 8(1):10-14. 1974. Engl., Sum. Engl., 12 Refs.

Cassava. *Manihot esculenta.* **Animal nutrition. Production. Productivity. Tubers. Composition. Analysis. N. Protein content. Fibre content. Mineral content. Marketing. Economics.**

Although more than 90% of the world's cassava production is used for human food, interest in this crop as an energy for inclusion in pig and poultry feeds was greatly stimulated by the artificial price situation in European Economic Community countries created by implementation of the Common Agricultural Policy. Relative European and world market prices for both protein and energy sources have since changed radically. In this article the present position and future prospects are reviewed. *(Author's summary)* H03

1261-2279 HEIM, F. and DECHAMBRE, P. **Le manioc dans l'alimentation du betail.** *(Cassava for livestock feeding)* Bulletin Economique de l'Indochine no. 130:466-468. 1918. Fr.

Cassava. Animal nutrition. Digestibility. Swine. Cattle. Tubers. Composition. Cassava meal. Feeds and feeding. Java.

Brief notes are presented on cassava used as animal feed. Data concern chemical composition of tubers and meal, digestibility, feed rations and general economic aspects. *(Summary by H.J.S.)* H03

1262-1870 MIRANDA, R. M. DE, LAUN, G. F. and COSTA, B. L. DA. **Emprêgo de feno de mandioca, de Cudzú tropical, de marmelada de cavalo e de alfalfa em rações de pintos.** *(Use of cassava meal, tropical kudzu, Desmodium dsicolor and alfalfa hay in chicks rations).* Rio de Janeiro. Instituto de Zootecnia. Publicação no. 19 1957. 18p. Port., Sum. Port., Engl., 7 Refs.

Cassava. *Manihot esculenta.* **Feeds and feeding. Animal nutrition. Leaves. Forage. Diets. Analysis. Composition. Protein content. Fat content. Fibre content. Alfalfa. Chicks. Poultry. Domestic animals. Brazil.**

The authors describe 2 experiments in which rations containing 5% alfalfa *(Medicago sativa)* hay, tropical kudzu *(Pueraria javanica)* hay, cassava *(Manihot esculenta)* hay and *Desmodium dsicolor* hay were used for growing chicks. The weights obtained with the different rations at 8 and 12 weeks did not differ significantly. It is concluded that any of the 4 hays produces satisfactory results under the conditions of the experiments. *(Author's summary)* H03

1263-1704 CICOGNA, M. *et al.* **Ricerche sperimentali sulla possiblitá di ridurre i costi di alimentazione dei polli da carne ricorrendo ad una opportuna sostituzione del mais con una miscela di chips di manioca, zucchero denaturato e gemma di riso.** *(Possibility of lowering feed costs for broilers with partial or total substitution of maize with a diet containing cassava chips, denatured sugar and rice germ meal).* Rivista de Zootecnia 43(718):502-516. 1970. Ital., Sum. Ital., Engl., Fr., 18 Refs., Illus.

Cassava. Cassava chips. Costs. Economics. Poultry. Animal nutrition. Diets. Composition. Amino acids. Feed constituents. Dietary value. Domestic animals.

Partial (1|3 and 2|3) or total substitution of maize (contained at 67% in the control group) with a lower cost diet containing cassava chips, denatured sugar and rice germ meal has been tried. Satisfactory technical and economic results have been obtained only with the 1|3 substitution of maize. No taste differences resulted in the meat of broilers from all groups. *(Author's summary)* H03 J00

1264-1786 McINTYRE, K. H. and REDDY, K. **A comparison of the rates of growth of pigs on three skim-milk-based rations and one dry ration.** Fiji Agricultural Journal 34(2):85-90. 1972. Engl., Sum. Engl., 7 Refs.

Cassava. Animal nutrition. Swine. Feed constituents. Costs. Economics. Fiji.

A trial was carried out to test the effect of 4 different rations on growing pigs: (1) skim milk plus maize, (2) skim milk plus cassava, (3) skim milk plus a commercial feed, and (4) a high-protein commercial feed plus cassava. Male pigs fed from weaning to 18 weeks (when they were slaughtered as porkers) gained an average of 430 g| day on the first three treatments, but gained only 180 g| day on the fourth. Females were slaughtered as baconers 9 weeks later; daily rates of weight gain were 545 g, 360 g, 430 g and 360 g, respectively, for the 4 treatments. At prices in effect at the time of the trial (1970), the cost of treatment 4 was more than the sale price of the pigs; however, all the skim milk treatments were profitable, especially those using maize or cassava. Since that time, cassava prices have increased, making treatment 4 even more unprofitable and treatment 2 less profitable than 1. *(Author's summary)* H03 J00

1265-3336 KOK, E. A. and RIBEIRO, C. DE A. **A mandioca crua em comparação com a quirera de milho na engorda de porcos.** *(Crude cassava compared with ground corn in feeding fattening hogs).* Boletim de Industria Animal (Brazil) 6(612):24-45. 1943. Port., Sum. Port., Engl., 7 Refs., Illus.

Cassava. Maize. Animal nutrition. Swine. Feeds and feeding. Tubers. Diets. Finishing. Domestic animals. Brazil.

In an experiment conducted at the Livestock Experimental Farm in Sertaosinho (State of São Paulo), cassava roots of the Vassourinha variety (*Manihot utilissima* Pohl) were compared with ground corn in feeding fattening hogs. Cassava and ground corn, together with a supplementary mixture of 49% meat scraps, 49% cottonseed meal and 2% mineral supplements, were fed free choice to groups of swine (Pereira, a national breed). The results indicated that the animals receiving cassava required larger amounts of supplementary mixture than those that had been fed ground corn free choice. With the protein mixture that was tried, the free choice method did not produce as good results with cassava as with ground corn. The animals that had been fed cassava free choice consumed a daily ration that has been shown deficient in dry matter and starch value. According to the efficiency of the rations, the starch value (for fattening) of cassava roots is 30.7. Cassava roots seem to have a favorable influence on the consistency of the fat in the hogs. Cassava is a good feed for fattening hogs but is not recommended as the only carbohydrate-rich feed in the rations. In the free-choice system, its utilization should be considered only when 100 kg of cassava and 23 kg of the supplementary mixture cost less than 56 kg of ground corn. *(Author's summary)* H03

1266-1618 AGUDU, E. W. **Preliminary investigations on some unusual feedstuffs as yolk pigmenters in Ghana.** Ghana Journal of Agriculture Science 5(1):33-38. 1972. Engl., Sum. Engl., Fr., 16 Refs.

Cassava. Leaves. Cassava meal. Uses. Eggs. Animal nutrition. Poultry. Xanthophyll. Pigments. Ghana.

Cassava (*Manihot utilissima* Pohl) and Madras thorn *(Pithecellobium dulce)* leaf meals, a synthetic xanthophyll material and 2 sources of yellow corn were evaluated as sources of egg yolk pigments in 4 separate experiments using White Leghorn strain-cross pullets. Visual color assessment of yolk color was based on potassium dichromate solutions. Xanthophyll assays showed that cassava leaf meal had higher total and pigmenting xanthophyll contents than Madras thorn leaf meal. Increased leaf meals in the diets resulted in increased yolk score, which was not proportional to the level of the leaf meal content of the diets. Although local yellow corn had a higher xanthophyll content than that of U.S. yellow corn, it produced eggs with a lower yolk score. The commercial xanthophyll material had an unusually low xanthophyll content and consequently has no significant effect on yolk color when supplemented at twice the recommended level to a white or yellow corn diet. *(Author's summary)* H03

1267-1712 PEIXOTO, R., GROSSMAN, J. R. and OLIVEIRA, W. M. DE. **A raiz da mandioca comparada com o grão de milho na produção de leite.** *(Cassava compared to maize in milk production).* Boletim da Directoria da Producão Animal 12(23):24-27. 1955. Port., Sum. Port., 3 Refs.

Cassava. Animal nutrition. Feeds and feeding. Diets. Dietary value. Maize. Tubers. Milk. Dairy cattle. Domestic animals. Brazil.

An 92-day experiment was conducted to compare maize and cassava as feed for dairy cows. The experiment was carried out using the switchback method. Statistical analysis favored maize as a feed for dairy cows. During the experiment, the milk yield of maize-fed cows averaged 374 g| day more than the yield of cassava-fed cows. In view of the substantially lower price of cassava, however, a cassava diet might prove economical despite the correspondingly lower milk yield, as long as the cow's diet is fortified with a high protein supplement. The practical importance of this experiment indicates the need for further research in this direction. *(Author's summary. Trans. by N. U.)* H03

1268-0748 MAHENDRANATHAN, T. **Potential of tapioca (*Manihot utilissima* Pohl.) as a livestock feed; a review.** Malaysian Agricultural Journal 48(1):77-89. 1971. Engl., Sum. Engl., 66 Refs.

Cassava. *Manihot esculenta.* Animal nutrition. Domestic animals. Productivity. Leaves. Composition. Amino acids. Vitamin content. Toxicity. Feeds and feeding. Water content. Protein content. Fibre content. Soluble carbohydrates. Ash content. Dry matter. Malaysia.

This paper reviews work carried out on cassava roots and tops in Malaysia and elsewhere. Cassava, both as an export commodity and for local use as an animal feed, has a great potential. Increased economic returns could be derived by intercropping, mechanization, introduction of high-yielding varieties, and by the better utilization of cassava refuse and tops as livestock feeds. The crude protein content of cassava leaves is greater than m[illegible] the fodder grasses and legumes. The amino acid profile indicates high lysine content. The high HCN content has been a major deterrent to the extensive use of cassava leaves as an animal feed. The widespread use of cassava leaves, made possible by periodic cuttings to yield more than 33,000 lbs| acre| year, would enable the country to cut down its heavy dependence on imported ingredients for feeding livestock. *(Author's summary)* H03 H04.

1269-1904 HUTAGALUNG, R. I., PHUA, C. H. and HEW, V. F. **The utilization of tapioca *(Manihot utilissima)* in livestock feeding.** Kuala Lumpur, Malaysia, University of Malaya, 1973. 45p. Engl., 77 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973

Cassava. ***Manihot esculenta.*** **Tubers. Feeds and feeding. Sweet cassava. Dried tubers. Leaves. Composition. Amino acids. Chicks. Poultry. Animal nutrition. Dietary value. Food energy. Palatability. Animal physiology. Swine. Diets. Domestic animals. Dry matter. Mineral content. Malaysia.**

Experiments were conducted with pigs and chicks to compare the feeding of cassava in diets containing varying levels of protein and energy, supplemented with amino acids, molasses and palm oil, to conventional diets. Feed efficiency, weight gain, digestibility, chemical analyses, carcass quality and metabolizable energy values were used as criteria for the evaluation of all experiments. Pigs and chicks fed cassava diets containing molasses, palm oil, minerals and amino acids performed similarly to animals fed conventional diets. However, apparent digestibility of dry matter, minerals and energy in the unsupplemented diets was low compared to conventional diets, but the digestibility of protein, fiber and nitrogen-free extract was unaffected. These results indicate that cassava can be utilized to substitute other feeds if it is properly supplemented with nutrients, particularly amino acids, fats and minerals. *(Summary by D.H. and L.J.)* H03.

1270-0560 CASTILLO, L. S. *et al.* **Camote and cassava tuber silage in swine rations.** Agriculture at Los Baños 3(4):11-13. 1964. Engl.

Cassava. Sweet-potatoes. Maize. Silage. Feeds and feeding. Dried tubers. Swine. Fattening. Finishing. Processed products. Diets. Animal nutrition. Philippines.

Cassava and sweet potatoes, when used to replace corn in swine rations for fattening and finishing, produced the same weight gains as corn. Pigs fed corn made an average daily gain of 0.41 kg;those fed sweet potato silage, 0.48 kg; and those fed cassava silage, 0.46 kg. Cassava silage also has the same feed conversion efficiency as corn. Short notes for ensilage of cassava roots are included. *(Summary by J.L.S.)* H03

1271-2019 SOARES, P. R., CAMPOS, J. and CONRAD, J. H. **Farelo integral de raspa de mandioca e farelinho de trigo na alimentação de pintos.** *(Integral meal of grated cassava and fine wheat bran for feeding chicks).* Experimentiae 8(4):109-141. 1968. Port., Sum. Port., Engl., 23 Refs., Illus.

Cassava. Chicks. Swine. Feeds and feeding. Millets. Soybeans. Meals. Wheat bran. Proteins. Soluble carbohydrates. Feed constituents. Dietary value. Economics. Composition. Animal nutrition. Poultry. Cassava meal. Brazil.

A feeding trial was carried out to study the effect of substituting grated cassava meal and wheat middlings for part of the ground corn in chick rations. Fifteen treatments, each composed of 3 replicates of 10-day-old, unsexed New Hampshire chicks, were fed for 42 days on rations in which 6-42% of the corn had been replaced by an equal quantity of cassava meal and soybean meal (to equalize the protein content); or the cassava meal was partially replaced by wheat middlings. The following conclusions were reached: (1) Chicks fed the rations containing various levels of the cassava meal consumed significantly more than those receiving the rations in which a part of the cassava meal was replaced by wheat middlings. A part of this difference apparently was caused by the abnormal consumption of the ration containing the highest livel of wheat middlings. (2) Variations in the consumption of the rations were small but were slightly greater with substitutions of 36 and 42% of the ground corn. An exception was the ration containing the highest level of wheat middlings. (3) Mortality was very low and was apparently not caused by the treatment. (4) There were no statistically significant differences in weight gains between the two substitutions. (5) Analysis of the weight gain data using curvilinear regression indicated that the data fit a second degree polynomial, in which the independent variable was the percent substitution of corn by cassava meal or by cassava meal plus wheat middlings; from which it was found that a substitution of 10.36% of the corn produced the greatest gains. (6) The most economical substitution depended on the price of corn, its subtitutes and the price of broilers. (7) Feeding efficiency was best when the substitutions were between 0 and 30%. (8) There was an evident tendency to improve the ration up to 10.36% of substitution. (9) According to the economic analysis, the maximum recommended level for the substitution was 18.02%. It was concluded that in some regions and at certain times of the year in which corn is scarce, cassava meal and a mixture of cassava meal plus wheat middlings could be substituted for up to 30% of the corn in the ration for chicks if the protein, fat and mineral deficiencies of cassava meal are corrected. *(Author's summary)* H03

1272-1839 FERREIRA, J.J., SILVA, J. F. DA and GOMIDE, J. A. **Efeito do estadio de desenvolvimento, do emurchecimento e da adição de raspa de mandioca sobre o valor nutritivo da silegem do capim-elefante (*Pennisetum purpureum* Schum).** *(Effect of stage of maturity, wilting of the grass and the addition of grated cassava on the nutritive value of elephant grass silage).* Experientiae 17(5):85-108. 1974. Port., Sum. Port., Engl., 52 Refs.

Cassava. Cassava meal. Silage. Feed and feeding. Digestibility. Animal nutrition. Dietary value. Brazil.

The present experiment studied the effect of stage of maturity, wilting of the grass, and the addition of grated cassava on the nutritive value of elephant grass (*Pennisetum purpureum* Schum) silage. After a 21-day fermentation period, the silages were offered to castrated sheep kept in metabolism cages. Stage of maturity did not affect dry matter intake (g| $wt^{0.75}$) or N balance (g| day); however, the apparent digestibility of dry matter, crude protein and the intake of digestible dry matter (g| $wt^{0.75}$) declined significantly ($P<0.01$) with the stage of maturity of the grass. Wilting significantly increased the apparent digestibility of dry matter, crude protein ($P<0.05$), intake of digestible dry matter and N retention ($P<0.01$); however, it did not affect dry matter intake of the resulting silages. The addition of grated cassava to grass prior to ensiling significantly increased the dry matter intake (g| $wt^{0.75}$), apparent digestibility of dry matter, intake of digestible dry matter ($P<0.01$) and N balance ($P<0.05$), but there was a decrease in apparent crude protein digestibility. *(Author's summary)* H03

1273-0846 KOK CHOO, T. L. and HUTAGALUNG, R. I. **Nutritional value of tapioca leaf *(Manihot utilissima)* for swine.** Malaysian Agricultural Research 1:38-47. 1972. Engl., Sum. Engl., 16 Refs., Illus.

Cassava. *Manihot esculenta.* Maize meal. Leaves. Dietary value. Domestic animals. Animal nutrition. Soybean meal. Molasses. Methionine. Toxicity. HCN. Swine. Malaysia.

Two experiments were conducted using 40 Landrace-Yorkshire pigs to study the nutritional value of cassava leaves for growing-finishing pigs. The feeding of cassava leaves alone in the diet depressed ($P < 0.05$) gains and feed conversions of growing pigs. Sodium thiosulfate supplementation tended to improve the performance of growing pigs. Addition of 0.20% methionine to the diet containing 20% cassava leaves significantly ($P < 0.05$) improved gains and feed conver... as compared to those fed the cassava diet without methionine supplementation. Addition of molasses or palm oil to the cassava leaf diets appeared to improve weight gains and feed efficiency. Molasses supplementation containing methionine markedly improved ($P < 0.01$) the performance of growing-finishing pigs. Incorporation of methionine to the palm oil-cassava leaf diets tended to improve feed conversions and gains. Toxicity symptoms of cyanide were not observed throughout the experimental periods in pigs receiving cassava leaf diets. *(Author's summary)* H03 H04

1274-0739 CHICCO, C. F. *et al.* **Yuca y melaza en la utilización de la úrea en corderos.** *(Cassava and molasses in the utilization of urea by feeding lambs).* Memorias. Asociación Latinoamericana de Producción Animal 6:7-17. 1971. Span., Sum. Span., Engl., 18 Refs.

Cassava. Molasses. Cassava meal. Urea. Feeds and feeding. Diets. Lambs. Sheep. Animal nutrition. Feed constituents.

The utilization of urea with cassava meal or molasses was evaluated with yearling wethers fed low-quality hay (4.1% crude protein). The treatments were: (1) hay-basal supplement, (2) hay-cassava supplement and (3) hay-molasses supplement. Treatment 1 contained 50% ground pangola hay, 22% corn bran, 20% ground corn cobs, 2% urea, 5% molasses and 1% mineral mix. In the other treatments, the cobs were replaced by cassava meal or molasses. The rations were isoproteic. Seventy-two West African woolless wethers (36 males and 36 females) were divided in to 12 groups of 6 animals each and assigned to the treatment (2 groups of males and 2 groups of females| treatment). The rations were offered *ad libitum* for 112 days, with individual weight controls every 28 days. At the end of the feeding trial, some rumen fermentation processes were measured with 2 fistulated wethers| treatment and the digestibility of the rations with 4 wethers| treatment.

The body weight gains for the males and females in the 3 treatments were 88.3 and 59.9; 100.9 and 86.5; and 106.7 and 83.2, respectively. The differences were significant among treatments ($P < .05$) and between sexes ($P < .01$). Significant differences ($P < .01$) were obtained for bacterial protein (159.3; 193.0 and 175.5 mgN| 100 ml), blood urea (15.6; 20.7 and 19.8 mg| 100 ml), acetic acid (68.7, 59.9 and 61.9 mM| liter), propionic acid (11.7, 13.4 and 12.8 mM| liter), butyric acid (8.3, 12.8 and 13.3 mM| liter) and for digestibility ($P < .10$) of the organic matter (59.9, 66.6 and 70.7%) and cellulose (56.5, 60.4 and 64.8%) for the same order of treatments. No significant differences were obtained for voluntary intake, rumen ammonia, rate of cellulose digestion, protein digestibility and N retention. *(Author's summary)* H03.

1275-0643 RENDON, M., BENITEZ, H. and MARIN, O. **Utilización de la yuca *(Manihot esculenta)* en el engorde de pollos asaderos.** *(Utilization of cassava (Manihot esculenta) for feeding table chickens).* Revista ICA 4(3):159-171. 1969. Span., Sum. Span., 8 Refs., Illus.

Cassava. Chicks. Domestic animals. Fattening. Animal nutrition. Maize. Substitutes. Diets. Cassava meal. Feeds and feeding. Poultry. Colombia.

The Centro Nacional de Investigaciones Agropecuarias de Tibaitatá in the Savanna de Bogotá at 2,600 mt with a mean temperature of 14°C carried out an experiment to assess at what level cassava meal may replace maize in rations for Shaver broilers. Four treatments were compared according to a design of randomized blocks (0; 15; 30; and 45% cassava meal) with 4 repetitions for each. A total of 160 chicks were used for the experiment, 5 males and 5 females for each group. No significant differences were obtained at the 1% level for any treatment. The 30 and 45% levels gained significantly less weight than the control treatment. Chicks which consumed the 45% mixture were less efficient in relation to the control group, but no significant difference was found among the treatments including the cassava meal. Little weight gain was observed in those groups fed cassava meal resulting from poor feeding efficiency and low feed consumption. *(Author's summary)* H03.

1276-0994 MAUST, L. E., SCOTT, M. L. and POND, W. G. **The metabolizable energy of rice bran, cassava flour and blackeye cowpeas for growing chickens.** Poultry Science 51 (4):1397-1401. 1972. Engl., Sum. Engl., 16 Refs.

Cassava. Cassava flour. Rice bran. Feeds and feeding. Composition. Feed constituents. Poultry. Diets. Animal nutrition. Domestic animals. Food energy. Dietary values. Digestibility.

Chemical composition data, growth performance records and metabolizable energy values were used to ascertain the nutritive value of 5 tropical feedstuffs. Cassava flour was essentially without fiber and crude protein and had the highest metabolizable energy value, but appeared to contain a compound that inhibited growth. Although rice bran had the highest gross energy value, its lignocellulose and silica content was considered to be responsible for its low metabolizable energy value, which ranked below that of cassava flour and autoclaved cowpeas. Autoclaved cowpeas supported the best growth performance in both chicks and pigs, and the metabolizable energy content of the autoclaved material was considerably higher than that of either the raw or germinated cowpea diets. A heat-labile protein inhibitor substance was suspected to be responsible for the decreased performance of the raw and germinated cowpea diets. From the results obtained in this study, it appears that these feeds are satisfactory sources of metabolic energy if they are processed correctly and used in nutritionally adequate diets. *(Author's summary)* H03

1277-0415 TEMPERTON, H. and DUDLEY, F. J. **Tapioca meal as food for laying hens.** Harper Adams Utility Poultry Journal 26(3):55-56. 1941. Engl., 1 Ref.

Cassava. Feeds and feeding. Animal nutrition. Dietary value. Cassava meal. Digestibility. Poultry. Domestic animals.

This experiment was carried out to investigate the value of various uncommon poultry foods as substitutes for some ration ingredients regarded as standardized. Cassava *(Manihot utilissima)* is studied as a source of energy in the ration. Two groups of 30 Rhode Isl[illegible] Red laying hens each were used. Both groups were fed dry mash ad libitum. In the control group, the m[illegible]h consisted of (parts by weight) bran,30; middlings,30; yellow maize meal,25; fish meal,10. In the second group, the dry mash consisted of bran,13; middlings,15; yellow maize meal,11; fish meal,20; and cassava meal, 40. The ration containing 40% cassava meal gave equal results as the control ration in terms of body weight changes and mortality. The difference in egg production was not such as could be attributed to the difference in the ration without further evidence. Food consumption of the cassava meal group was lower than that of the control group and may perhaps account for the lower egg production of the former. This difference in food consumption was not sufficiently great, however, to suggest that the inclusion of 40% cassava meal resulted in an unpalatable mash. Even though the addition of 40% cassava meal resulted in a very finely divided mash, the condition of the droppings did not support the opinion that a high percentage of cassava results in constipation; and there were no indications of pasting of the mandibles, which is a predisposition to beak malformation. *(Summary by P.A.C.)* H03

1278-2382 KARUE, C. N., EVANS, J. L. and TILLMAN, A. D. **Voluntary intake of dry matter by African Zebu cattle. Quality of feed and the reference base.** Journal of Animal Science 36(8):1181-1185. 1973. Engl., Sum. Engl., 15 Refs.

Cassava. Animal nutrition. Concentrates. Feed constituents. Dry matter. Food energy. Feeds and feeding. N. Molasses. Dietary value. Domestic animals.

A study on voluntary intake of dry matter (DMI) was conducted, using 108 Zebu steers approximately 2.5 years of age as determined from their dentation. Their average weight was 271 kg with a range from 184 to 332 kg. The animals were fed poor-quality hay (7% CP, 80% CWC) ad libitum, supplemented with restricted amounts of 9 concentrates providing cassava and molasses for energy and urea for N. The concentrate supplied energy in g| $kg^{0.60}$ and urea N as a percent of total N requirement in a central-composite design as follows (N values in parentheses): 20 (70), 32 (42), 32 (98), 60 (30), 60 (70), 60 (110), 88 (42), 88 (98), and 100 (70) in diets 1 to 9, respectively. The DMI and body weight data were collected during an 84-day feeding period. Using 6 observations for each steer, the average reference base determined by regressing logarithm of DMI on the logarithm of body weight was $kg^{0.79 \pm 0.03}$, which was not different ($P > .05$) from the reference bases of $kg^{0.75}$ and $kg^{0.73}$. The DMI was 80 g| $kg^{0.79}$ and equivalent to 100 g| $kg^{0.75}$; i.e., DMI = A $(BW)^{b}$, where DMI is in grams per kilogram metabolic mass, a equals a constant, and b equals a functional power of body weight. The quality of feed influenced the functional power of body weight b. Using 6 observations from each of 12 animals per diet, an increase in caloric intake from concentrate in diets 1 to 9 resulted in a decrease ($P < .05$) in the value of b. At concentrate caloric intakes of 10, 21 and 31% of total caloric intake (cell-wall content of 71, 61 and 54%), the values of b were 0.87, 0.69 and 0.56, respectively. *(Author's summary)* H03

1279-1721 VOGT, H. and PENNER, W. **Der Einsatz von Tapioca - und Maniokamehl im Geflügelmastfutter.** *(The use of cassava and cassava meal in fattening broilers).* Archiv fur Geflugelkunde 27:431-460. 1963. Germ., Sum. Germ., Engl., 67 Refs.

Cassava. Cassava meal. Animal nutrition. Poultry. Diets. Dietary value. Tubers. Digestibility. Chicks. Feeds and feeding. Domestic animals.

According to existent literature, cassava meal is very rich in starch and can be used as energy feed stuff in feeding; unfortunately, the quality varies. A report is made of 5 test series with a total of 86 subgroups and 3,786 broiler chicks. These tests were carried out at the Lehr- und Versuchsanstalt fur Kleintierzucht in Kiel-Steenbek to find out the feeding effect of cassava meal in poultry feed. Up to 30% cassava meal was mixed into the test rations. With a level of 10% cassava meal in broiler feed, the final weights were the same as those in the group fed the control ration. On the other hand, a level of 20% and 30% cassava meal lessened weight gains; this can be traced to a depression in the first growth period whereas the higher content of cassava meal in broiler feed had no checking influence on the gain in the second growth period. Feed consumption is probably not checked through cassava meal, but rather feed conversion is debased. Because of the results of these tests, the digestibility data of Axelsson should be used when the total digestible nutrients of cassava meal are calculated. An admixture of niacin, calcium pantothenate and choline chloride improved neither gain nor feed conversion. The use of cassava flakes as a meal in poultry feed cannot be recommended, but the use of only 10% cassava meal in broiler feed can be recommended without hesitation. It is important not to forget that the low protein content of cassava meal must be compensated by higher rations of protein feedstuff. *(Author's summary)* H03

12?0-0174 PINEDA M., J. and RUBIO R., R. **Un concepto nuevo en el levante de novillas para ganadería de leche.** *(New concept in rearing heifers for dairy herds).* Revista ICA 17(4):405-413. 1972. Span., Sum. Span., Engl., 7 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Animal nutrition. Domestic animals. Dairy cattle. Feeds and feeding. Feed constituents. Colombia.**

In an experiment carried out at ICA in Palmira (Colombia), 8-month-old heifers were fed the following rations: group I (control), chopped sugar cane forage (ad libitum) and 3.0 kg daily of a concentrate based on corn; group 2, chopped sugar cane forage (ad libitum), 1.23 kg concentrate and 4.5 kg cassava containing 35% dry matter. Both concentrates contained 1.5% urea. Feed intake (dry matter basis) was similar for both groups. Between 8 and 15.5 mo of age, body weight gains of heifers in group 2 were statistically significant ($P<0.05$). Average age for first breeding was 15 and 14.5 mo, and average services per conception were 1.8 and 1.7 for groups I and II, respectively *(Summary by T.M.)* H03

1281-0808 CASTILLO, L. S. *et al.* **Camote and cassava tuber silage as replacement for corn in swine growing-fattening rations.** Philippine Agriculturist 47(9-10):460-474. 1964. Engl., 9 Refs., Illus.

Cassava. HCN content. Composition. Finishing. Sweet-potatoes. Maize. Feed constituents. pH. Proteins. Animal nutrition. Fattening. Diets. Swine. Dietary value. Feeds and feeding. Concentrates. Silage. Rice bran. Molasses. Vitamin A. Dry matter. Leaves. Philippines.

Fifteen growing-fattening pigs divided into three 60-day treatments were fed sweet potato or cassava silage and a concentrate mixture (27.26% crude protein) with no corn but with a greater amount of soybean oil and fish meal. The control lot was fed a 16.93% protein concentrate ration containing corn. The 2 silages are analyzed in detail. Multiple covariance analysis was used to adjust weight gains due to differences in initial age, weight and dry matter consumption. The adjusted weight gains did not vary significantly. The cassava-fed pigs were the most efficient in converting dry matter consumed. Feed conversion and slaughter data are given in tables. This experiment shows that corn could be entirely replaced by either sweet potato or cassava silage and that the amount of concentrates could be reduced by 40%. *(Summary by T.M.)* H03

1282-0142 CHOU, K. C. and MULLER, Z. **Complete substitution of maize by tapioca in broiler rations.** *In* Australiasian Poultry Science Convention, Auckland, 1972. Proceedings. New Zealand, World's Poultry Science Association, 1972. pp. 149-160. Engl., Sum. Engl., 12 Refs.

Cassava. Cassava meal. Animal nutrition. Poultry. Domestic animals. Chicks. Feeds and feeding. Diets. Feed mixtures. Composition. Food energy. Dietary value. Maize. Feed constituents.

Three experiments were conducted with a total of 1,700 broiler-type chicks fed on balanced pelleted diets containing 20, 30, 40, 50 and 58% cassava meal as a substitution for maize. The results of the first experiment showed that cassava can be used at relatively high levels in broiler diets; however, careful formulation is required in order to ensure a balance of all nutrients. No toxic or growth-depressing effects took place. When properly balanced in terms of nutrients, cassava diets supported growth equally as well as maize. In the second and third experiments, the addition of essential fatty acids, nicotinic acid, substitution of fish meal by additional lysine and methionine were studied. The results showed that neither essential fatty acids nor nicotinic acid were limiting in the diet as was expected. Replacement of fish meal by amino acids resulted in a statistically significant increase in body weight and feed efficiency. General patterns for practical formulation of high-cassava broiler diets are given. *(Author's summary)* H03

1283-0766 SHULTZ, E. SHULTZ, T. A. and CHICCO. C. F. **Efecto del tratamiento por calor y presión sobre la utilización de la urea en rumiantes.** *(Effect of heat and pressure treatment on the utilization of urea in ruminants.* Agronomia Tropical (Venezuela) 20(6):421-432. 1970. Span., Sum. Span., Engl., 25 Refs.

Cassava. Feeds and feeding. Diets. Cassava meal. Animal nutrition. Feed constituents. Nutritive value. Cattle. Venezuela.

Six dry, nongestating Holstein cows with ruminal fistula were used to evaluate the effect of cooking urea and cassava root meal under high temperature and pressure. The diets consisted of chopped sugar cane tops and 2 kg| day of one of the following concentrates: (1) vegetable protein,(2) urea + uncooked cassava meal, and (3) cooked cassava meal + urea. The supplement were isoproteic (25%) and isocaloric (3,100 Kcal| kg). The uncooked cassava meal + urea supplement presented significantly ($P < 0.01$) higher levels of ammonia in the rumen during the first 4 hours after consumption. Significantly ($P < 0.01$) larger amounts of microbial N was produced by the vegetable protein than the cooked urea supplement while this was superior ($P < 0.05$) to the uncooked urea supplement 6 hours after consumption. Total volatile fatty acid concentration in the rumen was greater ($P < 0.01$) in the control diet as compared to the others at 2, 3 and 4 hours after consumption, while the uncooked urea diet was highest ($P < 0.01$) at 6 hours. The cooked supplement presented superior ($P < 0\ 01$) levels at 24 hours postconsumption. In general, similar results were observed for acetic, propionic, isovaleric and valeric acids, while a reverse trend was noted for butyric acid. No significant differences were obtained in treatments for the rate of ruminal cellulose digestion. The uncooked urea + cassava meal supplement produced significantly ($P < 0.01$) greater levels of blood urea than the others and the concentration at 6 hours was larger ($P < 0.05$) than at 24 hours after consumption. Superior ($P < 0.05$) amounts of total plasma protein were obtained from the control supplement only a 3 hours postconsumption. *(Author's summary)* H03

1284-0792 GOUIN, A. and ANDOUARD, P. **La farine de manioc et la production beurriere.** *(Cassava flour and butter production).* Comptes Rendus des Séances de l'Académie d'Agriculture de France 5(1):43-44. 1919. Fr.

Cassava. Cassava flour. Animal nutrition. Dairy cattle. Milk. Production. Uses.

The authors inform the Academie of one of the causes leading to the butter crisis in France. During the years preceding the war, many cattle breeders used to skim the milk given to their calves; and in order to increase the nutritive property of the skimmed milk, cassava or other farinaceous flours were added. As these flours were not obtainable during the war, the breeders were compelled to give their calves whole milk, which had a serious effect upon butter production. If the breeders could be suplied with 1,000 tons cassava flour, they would be able to skim 17 million liters of milk, and make 750,000 kg of butter without the calves suffering in any way. In the interests of food production, French cattle breeders should be furnished with cassava from the French colonies. *(Summary by Tropical Abstracts)* H03

1285-0770 FERRER, A. **La yuca una riqueza ignorada.** *(Cassava, an ignored resource).* Agricultura Venezolana no. 97:56-58. 1970. Span.

Cassava. Maize. Wheat. Animal nutrition. Cattle. Economics. Productivity. Domestic animals. Venezuela.

Comparisons are made in using cassava, corn and wheat as animal feed in Venezuela. There is a great advantage in using cassava because of its yield, agronomic and nutritive characteristics. In addition soil and climate requirements definitely favor cassava and are unfavorable to corn and wheat in this country. *(Summary by H.J.S.)* H03

1286-0408 ALBA, J. DE. **Ensayos de engorde de cerdos con raciones a base de maíz, yuca y bananas.** *(Swine feeding trials based on corn, cassava and banana rations).* Turrialba 1(4):176-184. 1951. Span., Sum. 21 Refs., Illus.

Cassava. Bananas. Swine. Feeds and feeding. Costs. Animal nutrition. Proteins. Economics. Fattening.

On many coffee farms, banana plants are used for shade. The feasibility of using these bananas for pig rations, as an additional source of income for the coffee farmer, was studied. The substitution of cassava meal for corn in concentrates for growing-fattening pigs was also studied. Peanut cake and skim milk (fish meal is preferred but was not available) were used as protein supplements. Five treatments were used: corn; 50% cassava meal; bananas ad libitum; 50% concentrate + bananas ad libitum; 25% concentrate + bananas ad libitum. Total weight gains for each group of 5 pigs were as follows: 117.5 kg for cassava; 101.2 kg for corn; 77.2 kg for 50% concentrate + bananas and 36 kg for bananas ad libitum. Corn was the most efficient feed (3.07 kg TDN for 1 kg weight gain); 3.36 kg were required when cassava meal was substituted for the corn. Bananas with skim milk were substantially inferior; however, there were no significant differences in daily gains between the 25% and 50% concentrate + bananas. Cassava was the most expensive ration. The group fed 25% concentrates was the only one that gave returns above feed and labor costs. The proportion used was 6 parts bananas to 1 part concentrate. *(Summary by T.M.)* H03

1287-0417 OYENUGA, V. A. and OPEKE, L. K. **The value of cassava rations for pork and bacon production.** West African Journal of Biological Chemistry 1(1):3-14. 1957. Engl., Sum. Engl., 7 Refs., Illus.

Ca· ava. Feeds and feeding. Swine. Production. Costs. Animal nutrition. Finishing. Dietary value. Biochemistry. Composition.

Three groups of 8 native-bred pigs each (average age 12 wks) were fed cassava-based rations for 63 and 144 days to determine their effect on pork and bacon production. Group A was fed a standard balanced ration of Guine corn; Group B, a balanced ration of boiled cassava; and Group C, a balanced ration of raw cassava. Records were taken of the liveweights and of the amount and chemical composition of the feed consumed. From the second week of the experimental period, Group C recorded the best rate of growth; this was maintained for the first 11 weeks of the trial. All animals, however, registered satisfactory growth throughout the experimental period. Group C animals consumed the smallest amount of feed in dry matter for every pound of liveweight gained; they were followed by those in B and A, respectively. The cost of producing one pound of pork followed a similar trend. The degree of saturation of the pork (as well as bacon) fats was high, and there were no appreciable differences in fat quality of the animals in the 3 treatments. At the bacon stage, 2 Tamworth pigs in Group C went lame on the hind leg and lost weight as a result. This group, therefore, registered lower weight gains than Group B for the rest of the trial period. Group B animals, therefore, consumed the smallest amount of feed (in terms of dry matter) for every pound of bacon liveweight gained; they were followed by group A and C, respectively. The cost of producing 1 lb of bacon was still lowest for group C, followed by groups A and B, respectively. The cost of cooking cassava made it less economical for bacon production than grain. Feeding uncooked cassava at a level of about 40% of the dry matter of the ration made it considerably more economically than grain and there was no adverse effect on growth. *(Summary by T.M.)* H03
T.M.) H03

1288-0769 MONTILLA S., J. DE J., MENDEZ, C. R. and WIEDENHOFER, H. **Utilización de la harina de tubérculo de yuca, *Manihot esculenta*, en raciones iniciadoras para pollos en engorde.** *(Utilization of cassava, Manihot esculenta, root meal in starting rations for broiler-type chicks).* Archivos Latinoamericanos de Nutrición 19(4):381-388. 1969. Span., Sum. Span., Engl., 9 Refs.

Cassava. Feeds and feeding. Diets. Chicks. Cassava meal. Poultry. Fattening. Dietary value. Maize. Domestic animals.

An experiment was conducted to measure the effect upon body weight, feed efficiency and feed costs| kg of adding 0, 15 and 30% cassava root meal to broilers' rations. Broiler-type chicks housed in batteries received the experimental diets from 0 to 6 week of age. It is concluded that sun-dried cassava root meal can be used as a sustitute for corn at levels up to 30% in starting rations for broilers in relation to hody weight and feed cost per kilogram of broiler produced. *(Author's summary)* H03

1289-*0314* *MANER, J. H.* **Cassava in swine feeding.** Palmira, Colombia, Centro Internacional de Agricultuıa Tropical, 1972. 77p. Engl., 43 Refs., Illus.

Paper presented at the First Latin American Swine Seminar, 1972.

Cassava. Animal nutrition. Swine. Feeds and feeding. Tubers. Fresh products. Silage. Finishing. Composition. Cassava products. Fattening. Colombia.

This paper relates to the use of the cassava root as an energy source in life-cycle feeding of swine. It includes a brief review of the literature and a complete presentation of originaldata relatedto the chemical composition of the cassava root and to the use of fresh cassava, dried cassava meal and cassava silage as a swine feed during the growing, finishing, gestation and lactation periods. *(Author's summary)* H03

1290-0279 MONDOÑEDO, M. **A comparative study of corn and cassava as feeds for hogs. II. Ground corn versus raw chopped cassava.** Philippine Agriculturist 17(2):105-107. 1928. Engl., Sum. Engl.

Cassava. Feeds and feeding. Swine. Diets. Costs. Toxicity. Maize. Nutritive value. Animal nutrition. Philippines.

The feeding trial presented here is a continuation of a study on the comparative value of corn and cassava, which was conducted by Mondoñedo and Bayan in 1925. In the first study, peeled, cooked cassava was used; in this experiment , unpeeled, raw cassava was used. Results were as follows: (1) Raw, chopped cassava with other feeds, as used in this experiment, gave a faster, greater and more economical gain than ground corn. (2) Cassava alone or in combination with the feeds used in this experiment is just as palatable as ground corn. (3) Throughout the feeding period, there was no evidence of poisoning as a result of the cassava. The Kapo White and Angular varieties of cassava used in this experiment can therefore, be fed raw and upeeled. (4) Judging from results obtained in the two studies reported, the use of cassava may be recommended for growing breeding pigs in dry lot or on poor pasture. *(Author's summary)* H03

1291-0313 FULLERTON, J. **Tapioca meal as food for pigs.** Journal of the Ministry of Agriculture (England) 36(2):130-136. 1929. Engl., Sum. Engl., 5 Refs.

Cassava. Feeds and feeding. Swine. Cassava meal. Animal nutrition. Nutritive value. Dietary value. Composition. Domestic animals.

Barley and maize are the main sources of starch foods required for fattening pigs, especially in the later stages of bacon production. The high costs of these crops has made it necessary to look for a substitute. This trial was designed to study the suitablity of cassava meal. The main conclusions were as follows: (1) High-grade cassava meal has proved to be satisfactory as regards palatability and other dietetic properties. (2) It may be regarded as suitable to replace maize or barley meal up to at least 25% of the total ration. (3) The bacon and hams resulting from cassava-fed animals are of distinctly better quality than those from maize-fed pigs. (4) At current prices, the use of cassava meal in place of maize or barley lowers feed costs substantially. *(Author's summary)* H03

1292-0414 SHULTZ, T. A. *et al.* **Evaluación de diferentes fuentes de energía, yuca, maíz, arroz y melaza, sobre la utilización de altos niveles de úrea en bovinos.** *(Evaluation of different energy sources cassava, corn, rice, molasse —utilization of high levels of urea for bovines).* Agronomía Tropical (Venezuela) 20(3):185-194. 1970. Span., Sum. Span., Engl., 25 Refs.

Cassava. Rice. Molasses. Urea. Feeds and feeding. Diets. Cattle. Animal nutrition. Dietary value. Nutritive value. Maize. Domestic animals. Feed constituents. Digestibility.

An evaluation of cassava meal, molasses, corn meal and rice polishings, as compared to high levels of urea in supplements for young bulls, showed that urea-based diets were less efficient than the vegetable protein control diet. Significant differences were observed for body weight gains, being larger for the control (P<

0.05) than for molasses + urea. No differences were noted between treatments for apparent dry matter digestibility. more total N was retained from the control, corn + urea, or rice + urea than the other treatments ($P<0.05$). Rumen samples from diets containing urea presented near toxic levels of ammonia at 2 hours postconsumption of supplements, the difference between these and the control being highly significant ($P<0.01$). At 6 hours postconsumption, rumen microbial protein content from the control was significantly higher (P 0.01) than corn + urea, rice + urea, or cassava + urea, whereas molasses + urea was inferior to these ($P<0.01$). Significantly ($P<0.01$) higher levels of blood urea were observed at 6 hours postconsumption for corn + urea and rice + urea ($P<0.01$) as compared to cassava + urea and molasses + urea, the control being less ($P<0.01$) than the others. Volatile fatty acid concentrations in rumen samples from rations containing urea were equal to or greater than the control due to higher levels of acetic, propionic, butyric and valeric acids, whereas more P 0.01) isovaleric acid was present in control samples. No significant differences were observed for cellulose digestibility in the rumen. *(Author's summary)* H03

1293-2068 DEVENDRA, C. **A comparison of two systems of pig feeding commonly used in Malaya.** Malayan Agricultural Journal 44(1):26-41. 1963. Engl., Sum. Engl., 16 Refs.

Cassava. Feeds and feeding. Swine. Tubers. Diets. Concentrates. Feed constituents. Animal nutrition. Economics. Costs. Malaysia.

A trial comparing 2 systems of feeding pork pigs is reported. The Lehmann system included a corrected daily ration of concentrates with home-grown roughage feeds (1 part cassava and 1 part sweet potato) fed ad libitum. The system used by the Federal Experiment Station was based on concentrates only. The concentrates gave a 14% greater liveweight gain|day, which was statistically significant, with a lower (10%) dry matter consumption|lb liveweight. Production costs were significantly higher than for the Lehmann system. Closer examination of the data showed that the poor performance of the Lehmann system was not due to a general reduction of performance but rather to an increased number of pigs at the lower end of the range of liveweight increases. The fact that modal values for each treatment differed only 0.1-0.2 lb|day suggests that the system could be improved to give results as good as with the concentrates at lower costs. *(Summary by T.M.)* H03

1294-0731 OYENUGA, V. A. **Nutritive value of cereal and cassava diets for growing and fattening pigs in Nigeria.** British Journal of Nutrition 15(3):327-338. 1961. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Feeds and feeding. Cereals. Diets. Fattening. Swine. Metabolism. N. P. Ca. Digestibility. Roots. Dietary value. Minerals. Animal nutrition. Finishing. Domestic animals. Nigeria.

In Experiment 1, nine native-bred pigs were fed individually in metabolic cages on well-balanced diets having as the main source of carbohydrate guinea corn in group A, boiled cassava in group B and raw cassava in group C. Liveweight gain and efficiency of food utilization were measured. In Experiment 2 growing pigs were given a balanced diet with either raw or boiled cassava as the main source of carbohydrate. Liveweight gain and efficiency of food conversion were measured, and the metabolism of N, Ca and P was studied in balance trials lasting for 14 days. Weight gain and food utilization were better on the diets containing cassava than on that with guinea corn. With young pigs, raw cassava gave somewhat better results than boiled cassava if the amount in the diet did not exceed 42% of the dry matter content, but when the level was about 50% of the dry matter content, weight gain was not satisfactory unless the cassava was boiled. Even when boiled, 60% cassava resulted in unsatisfactory weight gain. Raw cassava at a level of 42% of the diet also tended to lead to better retention of N than did boiled cassava, which in all probability accounted for the slightly better liveweight gain of the pigs given the raw cassava diet. However, the protein of the feed was better digested when the cassava was boiled than when it was raw. The diet containing the raw cassava seemed to have led to an appreciable reduction in apparent digestibility and in the net absorption of Ca and P. It is suggested that the greater the quantity of cassava included in the diet, the lower is the availability of the dietary N, Ca and P to the pig, a fact which may be partly responsible for the poor liveweight gain of the pigs fed on a diet containing a high proportion of cassava root. *(Author's summary)* H03

1295-0714 ESTIMA, A. L. *et al.* **Melaco, mandioca e farelo de algodão como suplementos para olho de cana fresco ou ensilado.** *(Molasses, cassava and cottonseed meal as supplements to fresh and ensiled sugar cane top).* Pesquisa Agropecuaria Brasileira 2:411-420. 1967. Port., Sum. Port., Engl.,6 Refs. Illus.

Cassava. Silage. Cottonseed meal. Food energy. Dietary value. Molasses. Animal nutrition. Maize. Feed constituents. Shoots. Cattle. Feeds and feeding. Dry matter. Domestic animals. Tubers. Brazil.

A 2 x 2 x 4 experiment (112-day period) was designed to determine the effect of supplementing fresh and ensiled sugar cane tops with molasses, cassava roots and cottonseed meal on weight gain of Holstein and Zebu cattle. Initial body weight, body composition (determined by the specific gravity technique), mean shrunk weight and body fat were established. Animals were fed ad libitum in groups of three, with the fresh or ensiled cane tops; the supplements were fed at the rate of 0.5 kg| 100 kg of body weight. Those animals fed silage ate significantly less dry matter and gained significantly less than those fed fresh tops. The consumption of either molasses or cassava roots with fresh or ensiled tops caused a significant drop in dry matter consumption of cane tops. The dry matter consumed from the supplement, however, was sufficient to maintain the same daily weight gain as compared to unsupplemented diets. There was no significant difference, therefore, in the gains of the unsupplemented animals and those fed molasses or cassava roots. The consumption of cottonseed meal caused a marked increase in dry matter consumption and daily weight gains. A cottonseed meal supplement of 0.5 kg| 100 kg of body weight caused an average stimulation of weight gain of 0.78 kg| day. Although,there was no significant difference between Holsteins and Zebus in shrunk weight gain, there was a significant difference in empty body weight. This fact is due to the difference in reticulo-rumen fill, the Zebus having less fill than the Holsteins. The Zebus were also fatter and had a greater energy retention than the Holsteins. It appears that on a dry matter basis, fresh or ensiled sugar cane tops are comparable to Bermuda grass hay in energy value. The cottonseed meal used in this trial had a net energy for production comparable to barley or corn but a lower value of maintainance. *(Author's summary)* H03

1296-2072 RODRIGUES, A. J. **Mandioca na alimentação de porcos.** *(Cassava for swine feed).* Chácaras e Quintais 114(6):673-674. 1966. Port.

Cassava. Animal nutrition. Swine. Maize. Cassava flour. Production. Cassava tubers (vegetable). Brazil.

Corn and cassava are the main forages used for swine feed in Sao Paulo. Several studies have been carried out with corn, but few have been done with cassava. Research workers have recently begun to experiment with crude cassava and whole cassava flour. Swine fed cassava-based rations gave firmer bacon than those fed with millet. *(Summary by H. J. S.)* H03.

1297-0295 MANER, J. H., BUITRAGO, J. and JIMENEZ, I. **Utilization of yuca in swine feeding.** *In* International Symposium on Tropical Root Crops, Ist. St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. I. pp.62-71. Engl.

Cassava. Swine. Diets. Feeds and feeding. Animal nutrition. Feed constituents. Nutritive value. Proteins. Molasses. Tubers.

Six experiments were conducted to study the relationships of protein, vitamin and mineral supplementation, and feeding management in the diets of pigs, using cassava (*Manihot esculenta* Crantz) as the main energy source. The results indicate that fresh, chopped cassava, along with a well-fortified protein supplement, can be used as the only energy source in growing-finishing swine rations. The pigs showed a satisfactory daily feed consumption, gains and feed efficiency. Younger pigs tended to overeat protein supplement, probably to satisfy dry matter and energy needs, until their stomachs were large enough to consume larger quantities of fresh cassava. Older pigs consumed sufficient amounts of cassava to satisfy their daily energy needs and thus ate only enough supplement to meet their daily protein and vitamin requirements. The dusty, powdery nature of dry ground cassava may possibly be problematic in ration palatability although this was not a problem in present studies. *(Summary by P.A.C.)* H03

1298-0299 ALBA, M. G. **A study of different varieties of cassava for hog feeding purposes.** Philippine Agriculturist 25:782-795. 1937. Engl., Sum. Engl., 10 Refs.

Cassava. Cultivars. Animal nutrition. Swine. Domestic animals. Dietary value. Tubers. Philippines.

Four dry-lot feeding experiments using Berkjala pigs and 9 varieties of cassava (Rough Intermediate, Kapo White, Leyte Unknown, Angular, Casjave Singkong Manis, Mandioca Itaparica, Mandioca Tapicuru, Aipin Valenca and Mandioca Basiorao) were designed (1) to determine whether certain varieties of cassava had toxic effects on pigs, (2) to determine the effect of varying amounts of cassava on growth, and (3) to determine whether certain varieties of cassava are better than others for feeding swine. Three experiments lasted 70 days; the 4th was 31 days. Pigs varied in age from 3 1|2 mo to 1 yr. Basic rations consisted of 60% rice bran, 15% corn, 15% copra meal and 10% shrimp. A small amount of mineral mixture (ground charcoal, common table salt and air-slaked lime) was also added. Cassava was fed raw, chopped and unpeeled. Pigs were full fed the basic ration for the first week; the ration was replaced by cassava in percentages that increased gradually from 5 to 50%. Experiments I and IV demonstrated that the nine varieties of cassava under test, did not produce fatal or injurious effects on the pigs. Experiment II showed that from the point of view of rate of gain and feed consumed for a given unit of gain, the replacement of from 5 to 15% of the basic concentrate ration by cassava proved to be the most practical and economical. The replacement of 20% by cassava markedly reduced the rate of gain and increased the amount of feed required for a given unit of gain. If the rate of gain is used as a measure for the comparative efficiency of the varieties of cassava studied and the results are subjected to statistical treatment, there is no signficant difference between Mandioca Tapicuru, Mandioca Itaparica, Mandioca Basiorao, and Aipin Valenca. Ainin Valenca consistently gave the best results and Mandioca Basiorao was second. The results of this experiment corroborate the results in experiment II in that the replacement of a 5% part of concentrate ration by cassava roots is practical and economical, particularly in a dry-lot feeding system. *(Summary by T.M.)* H03

1299-0201 FANGAUF, R. **Tapiokamehl im futter von legehühnern.** *(Cassava meal in the rations of laying hens).* Futter und Futterung no. 53:426. 1955. Germ.

Cassava. Cassava meal. Feeds and feeding. Chicks. Poultry. Domestic animals. Eggs. Production. Animal nutrition.

This article reviews several articles on this topic. It concludes that 10-15% cassava meal can be used in chicken feed although some articles mention 20-25%. At higher percentages, egg production is reduced. The importance of the vitamin B complex is stressed. *(Summary by A. van S.)* H03

1300-2197 **CAMANIOC DU Tonkin.** *("Camanioc" from Tonkin).* **Bulletin Economique de l'Indochine** no. 132:989-990. 1918. Fr., 1 Ref.

Cassava. Animal nutrition. Viet-Nam.

The chemical composition of "camanioc" (sliced roots of sweet cassava) is compared to that of cassava tubers from different places. The nutritive value of camanioc is higher than that of potato starch due to its content of nitrogenous materials, fats and minerals. *(Summary by H.J.S.)* H03

1301-0820 ZOBY, J. L. F., *et al.* **Raspa de mandioca com suplementação de gordura e metionina, na alimentação de suinos.** *(Cassava meal fat and methionine supplemented in swine feeding).* Revista Ceres 18(97):195-209. 1971. Port., Sum. Port., Engl., 12 Refs.

Cassava. Feeds and feeding. Fattening. Methionine. Diets. Swine. Cassava meal. Proteins. Composition. Fat content. Animal nutrition. Feed constituents. Brazil.

Forty-five pigs weighing 20 kg were used to study the effects of substituting cassava meal for corn, with and without the addition of supplemental fat and or methionine in rations for growing-finishing pigs. The 5 treatments were (1) corn, (2) cassava meal, (3) cassava meal plus methionine, (4) cassava meal plus fat, (5) cassava meal plus fat and methionine. The cource of protein for all the rations was soybean meal (SBM). Prior to and after reaching 50 kg, pigs were fed 15 and 13% crude protein rations, respectively. The results indicated the following. (1) It is possible to substitute cassava meal for corn in rations for growing-finishing pigs if the crude protein and methionine levels are adequate. (2) The fat from the carcasses of pigs fed cassava-SBM rations has a lower iodine number than for those fed corn-soybean meal rations. (3) For pigs between 20 -50 kg, the addition of methionine to cassava-SBM rations improves daily gain, daily feed consumption and feed efficiency. It is not necessary to supplement cassava-SBM rations with methionine after pigs weigh 50 kg. (4) Pigs fed cassava-SBM rations with added fat were more efficient in feed conversion and had carcasses with more fat as compared to pigs fed the same ration without added fat. *(Author's summary)* H03

1302-3027 FARIAS, I. and GOMIDE, J. A. **Efeito do emurchecimento e da adição de raspa de mandioca sobre as características da silagem de capim-elefante cortado com diferentes teores de matéria seca.** *(Effect of wilting and the addition of grated cassava meal on the characteristics of elephant grass ensilage harvested at various levels of dry matter content).* Experientiae 16(7):131-149. 1973. Port., Sum. Port., Engl., 36 Refs.

Cassava. Forage. Silage. Cassava meal. Uses. Animal nutrition. Soluble carbohydrates. Brazil.

An experiment was carried out to study the effects of wilting and the addition of grated cassava meal to elephant grass silage harvested with 15.7-23.0 and 29.7% dry matter. The experiment was a 3 x 2 x 2 factorial in a split-split plot design with dry matter content as the main factor and with the wilting factor in the subplot, while the use of the additive was studied in the sub-subplot. The elephant grass was wilted by exposing the forage to the sun for 5 h; the cassava meal was used at the rate of 75 kg| ton of forage. There were 5 replications (silos) per treatment: the silos were 1 m high x 0.40 m in diameter. The forage was chopped into 2-3 cm pieces and thoroughly mixed with forks; the cassava meal was also carefully mixed into the forage. The silos were opened 21-38 days later; samples taken from the upper, medium and lower sections of each silo were analyzed for pH, dry matter, crude protein, soluble carbohydrates, lactic acid and in vitro dry matter digestibility. Percentage of dry matter loss was also evaluated. The ensilage of elephant grass with a dry matter content of 23% or higher resulted in lower dry matter loss, as well as reduction of lactic acid content and dry matter digestibility. The wilting of the grass effectively reduced dry matter loss, particularly when the herbage was ensiled with the lowest dry matter content. It also resulted in silages with higher protein content but lower pH and lactic acid values. The use of cassava meal as an additive yielded silages of higher dry matter and soluble carbohydrate contents, resulting in reduced dry matter loss and increased in vitro dry matter digestibility. The starch of cassava meal was apparently not effectively fermented to lactic acid. *(Author's summary)* H03

1303-2032 PENULIAR, S. P. **A comparative study of cassava refuse meal and rice bran as feeds for growing and fattening pigs.** Philippine Agriculturists 29(7):611-615. 1940. Engl., Sum. Engl.

Cassava. Wastes. Rice bran. Composition. Feeds and feeding. Finishing. Feed constituents. Fattening. Animal nutrition. Swine. Waste utilization. Substitutes. Philippines.

The purpose of this study was to determine the comparative feed value of cassava meal and rice bran in College standard rations for growing-fattening pigs. Two lots (16 Berkjala weanling pigs about 10 weeks old) were fed these rations for 210 days (divided into 3 equal periods). Conclusions were as follows: As regards weight gain, cassava meal was only 45% as efficient during the first 70-day feeding period, 43% during the second, and 62% during the last period. The efficiency of cassava refuse meal compared to rice bran was 52% during the whole period. As to the amount of feed required to make a kilogram gain, cassava refuse meal was only 50% as efficient as rice bran during the first period; 58% during the second; and 75% during the last period, showing that it is more suitable for older pigs than for younger ones. The average feeding efficiency of this feed as compared with rice bran in the whole 210-day feeding period was 61%. A study of feed costs per kilogram of weight gain revealed that cassava meal may be used economically instead of rice bran only during the last period. *(Summary by T.M.)* H03

1304 0476 CONNER, C. M. **Pig feeding with cassava and sweet potatoes.** Florida Agricultural Experiment Station. Bulletin no. 90. 1907. 9p. Engl.

Cassava. Sweet-potatoes. Feeds and feeding. Swine. Cottonseed meal. Feed constituents. Animal nutrition. Nutritive value. Domestic animals. USA.

The author describes experiments conducted to ascertain the feeding value of cassava and sweet potatoes for pigs. Cassava or sweet potatoes supplemented with shorts or fed alone to full-grown or to growing pigs were inadequate to support normal growth. The addition of rape slightly improved the nutritive value of cassava whereas the addition of cottonseed meal significantly improved pig performance. There are no details as to the way cassava or sweet potatoes were fed. *(Summary by G.G.)* H03

1305-0835 CARDOSO, R. M. *et al.* **Efeito da substituição gradativa do milho pela raspa de mandioca, na produção de leite.** *(Effect of the gradual substitution of corn for cassava meal on milk production).* Revista Ce 14(82):308-330. 1968. Port., Sum. Port., Engl., 26 Refs.

Cassava. *Manihot esculenta.* **Cassava meal. Maize. Concentrates. Economics. Dairy cattle. Domestic animals. Animal nutrition. Feeds and feeding. Diets. proteins. Costs. Milk. Production. Vitamin A. Brazil.**

A comparison between cassava meal (*Manihot utilissima* Pohl) and corn (*Zea mays* L.) in the concentrate for dairy cows, on a semiconfined regime was studied. A reduced switchback experimental design was used with 5 treatments and 2 animals per treatment. It was conducted for 52 days including an adjustment period of 10 days and three 14-day experimental periods. Twenty Holstein + Zebu cows were employed with a lactation period which varied from months. The average milk production was 8.7 and 10.0 kg, respectively, for the adjustment and experimental periods. In the experimental rations, the corn was gradually replaced by cassava meal. They were fed at the rate of 0.4 kg| ka milk produced above 2.5 kg. The average protein percentage of the ration was 18.6 and the calculated TDN was 73.4%. Each animal received 2.0 g of vitamin A supplement daily and had free choice of a salt and mineral mixture. The following observations were made: (1) Milk production among the treatments was statistically different. (2) Cassava meal fed as a substitute for corn gave good results since the protein and the other nutrient levels were adequate. (3) Net income, or the difference between the milk value and feed cost was greater in treatment 1, which contained 41.5% cassava meal and no corn. The lowest net income was observed in treatment 5, which contained 55% corn and no cassava meal. (4) At current prices, the use of corn was considered uneconomical. *(Author's summary)* H03.

1306-2484 MENDES, M. A. COSTA, B. M. DA. and GRAMACHO, D. D. **Efeito do feno de folhas de mandioca (*Manihot esculenta* Crantz) na alimentacao de pintos.** *(Cassava (nom. lat.) leaves in feeding chickens).* Cruz das Almas, Brazil.Universidade Federal da Bahia, Escola de Agronomia. Brascan Nordeste. Serie Pesquisa 1(1):153-159. 1973. Port., Sum. Port., Engl., 10 Refs.

Cassava. *Manihot esculenta.* **Leaves. Forage. Domestic animals. Poultry. Chicks. Animal nutrition. Feeds and feeding. Brazil.**

A one-day-old chick feeding trial using cassava (*Manihot esculenta* Crantz) leaf hay was carried out at the Escola de Agronomia, Universidade Federal da Bahia, in Cruz das Almas, Bahia (Brazil). The purpose of this study was to determine the percentage of cassava leaf hay that could be added to a commercial ration for chicks to learn the effect of cassava leaf hay on the chick feeding. The treatments used were the following: (A) Commercial ration + 3% cassava leaf hay flour; (B)Commercial ration + 6% cassava leaf hay flour; (C) Commercial ration + 9% cassava leaf hay flour; (D) Commercial ration (control). The addition of cassava leaf hay flour to the commercial ration for chicks in the levels mentioned in this trial did not present significant statistical variation in weight gains and feed efficiency. However, the ration consumption of treatments was statistically significant at 1% level of probability The Tukey test showed a significant difference at 5% level of probability but only for treatments D and C Treatment C could be recommended as its weight gain and feed efficiency were similar to treatment D but ration consumption was lower. *(Author's summary)* H03

1307-0208 ZAPATA A., O. and RUBIO R., R. **Empleo de la yuca en levante de novillas Holstein en el Valle del Cauca.** *(Use of cassava for growing Holstein heifers in the Valle del Cauca). In* Instituto Colombiano Agropecuario. Curso intensivo del cultivo de yuca. Palmira, Colombia, Centro Nacional de Investigaciones Agropecuarias, 1972. pp.43-45. Span.

Cassava. Feeds and feeding. Animal nutrition. Nutritive value. Forage. Dairy cattle. Domestic animals. Colombia.

Corn is one of the major sources of energy, but its high cost and use in human nutrition are the main factors limiting its use as an animal feed. Studies are under way to assess the nutritive value of cassava as a supplement in corn, sugar cane and molasses grass rations for young heifers. *(Summary by J.L.S.)* H03

1308-2323 PEIXOTO, R. R. **Farelo de milho e de mandioca em suinos.** *(Corn bran and cassava in swine feedings).* Revista Fir 9(6):40-47. 1967. Port., Sum. Port.

Cassava. Brans. Animal nutrition. Swine. Proteins. Cassava meal. Feed constituents. Feeds and feeding. Domestic animals. Finishing. Diets. Tubers.

An experiment was carried out at the Escola de Agronomia Eliseu Maciel to compare the behavior of cassava meal and corn bran when fed as a main source of energy to growing-fattening pigs. Sixteen pigs were distributed in 4 lots of 4 pigs each (3 males and 1 female). The rations were supplemented with fixed daily quantities of protein supplement. Pigs fed cassava meal were slower (about 30%) in reaching finishing weight; thus the convertibility of the cassava ration was approximately 15% inferior. With cassava meal, larger but fatter carcasses were obtained. *(Author's summary)* H03

1309-0199 MALLEVRE, M. **Expérience sur l'emploi de la farine de manioc dans l'alimentation des vaches laitieres.** *(Cassava meal in feeding dairy cows).* Bulletin des Séances de la Société Nationale d'Agriculture de France 74:638-644. 1914. Fr.

Cassava. Maize. Groundnut cake. Feed constituents. Gluten. Nutritive value. Dairy cattle. Domestic animals. Feeds and feeding. Animal nutrition. Cassava meal. France.

Two groups of 6 cows each were used in a feeding experiment carried out to compare the effect of replacing corn gluten by a mixture of cassava and groundnut. No significant differences were observed in the production of milk. Weight gains of animals fed cassava-groundnut were higher. The substitution was advantageous from an economic standpoint. *(Summary by J.L.S.)* H03

1310-1815 HOFMAN, P. **Schweinemastversuch mit unterschiedelichen Tapiokamehlandteilen.** *(Cassava meal for fattening swine).* Bavaria. Landesanstalt fur Tierzucht in Grub. Mitteilungen 8(1-2):32-39. 1960. Germ., Sum. Germ., Engl.

Cassava. Cassava meal. Feed constituents. Diets. Dietary value. Palatability. Nutritive value. Feeds and feeding. Animal nutrition. Swine. Fattening.

The experiment was carried out to prove the usefulness of cassava meal for swine fattening. The daily ration in all 3 groups consisted of 1 kg concentrates and a mixture of barley coarse meal and cassava meal. Group I received a mixture of 75% barley and 25% cassava meal; group II, 50% barley and 50% cassava meal; group III, 25% barley and 75% cassava meal. At first the pigs of all 3 groups showed some skin diseases; therefore, some red clover was fed until the end of the trial and the diseases soon disappeared. The fodder intake was highest in group II with 50% cassava meal and decreased remarkably in group III with 75% cassava meal. Corresponding to this was the nutritive intake, though the nutritive value (GN) of mixture III was the highest. Also the weight development in group II was the best and decreased remarkably in group III. In the diet with 75% cassava meal, the consumption of nutrients per 1 kg liveweight gain was most unfavorable, but still reached, like the weight gain, an acceptable performance. The fodder costs were the lowest for group II. For group I and III the expenses were about the same. According to the experiment, a ration consisting of

33% cassava meal showed good results for fattening of pigs and was therefore more economic. A higher percentage of tapioca meal in the ration is most likely less palatable, and results in lower food intake and growth rate. When feeding cassava meal to the animals, special attention must be paid to their mineral and vitamin supply. *(Author's summary)* H03

1311-0813 CARVALHO, J. P. DE, MONTEIRO, E. DE. S. and SOARES, L. M. **Feijão macacar e raspa de mandipoca em substituição ao farelo de trigo nas racoes de frangos de corte.** *(Cowpea and cassava meal as a substitute for wheat bran in rations for broilers).* Brasil. Instituto de Pesquisas Agronomicas de Pernambuco. Boletim Tecnico no. 39 1969. 14p. Port., Sum. Port., Engl., 11 Refs.

Cassava. Wheat bran. Feeds and feeding. Diets. Chicks. Cassava meal. Feed constituents. Poultry. Nutritive value. Animal nutrition. Brazil.

A randomized complete block experiment with 4 treatments and 5 replications was carried out to study weight gains and food conversion in 400 one-day-old chicks (males and females) cross GB-2090-Cogranjas, distributed in 20 equal plots. The treatments were (T1) check; (T2) 50% substitution of wheat bran by a mixture of toasted cowpea meal, cassava meal and corn with the same protein content; and (T3) total substitution of wheat bran by this mixture; (T4) commercial ration. It was observed that when the chicks were 77 days old, the weight gains were not statistically different for T1, T2 and T3. It was also observed that the weight gains for T2 ,T2 and T3 were significantly greater than the gains for T4. As far as food conversion is concerned, T1, T1 and T3 were not statistically different. T4 had a highly significant worse conversion than T1, T2 and T3. However, a greater incidence of perosis was observed in the treatments with higher wheat bran substitution because wheat hran has more choline than the mixture utilized. The supplementation of T2 and T3 with choline is needed to correct this deficiency and to ohtain better results. *(Author's summary)* H03

1312-0286 MODEBE, A. N. A. **Preliminary trial on the value of dried cassava, *Manihot utilissima* Pohl, for pig feeding.** West African Science Association Journal 7:127-133. 1963. Engl., Sum. Engl., 1 Ref.

Cassava. Feeds and feeding. Diets. Animal nutrition. Dried tubers. Processed products. Nutritive value. Economics. Costs. Swine.

A feeding trial was conducted to assess the value of dried cassava for pig feeding. Three groups of 5 pigs each were used. One group received the U.C.I. standard cereal meal mixture, while the second and the third groups were fed diets containing dried cassava at levels of 32-37-40% and 42-47-50%, respectively. There was no statistically significant difference between treatments in respect of liveweight gain, the mean daily liveweight gains for the control, low- and high-level cassava groups being 1.06 lb, 1.08 lb and 1.04 lb, respectively. Feed conversion efficiency was of the same order: 4.39:1 for the control, 4.39:1 for the low-level cassava group and 4.5:1 for the high- level group. Cost of feeding 1 lb of liveweight gain was lower for the cassava groups than for the control group. The practical significance of these findings is discussed. *(Author's summary)* H03

1313-2458 JUAREZ G., L. **Las hojas y tallos de yuca como forraje.** *(The utilization of cassava leaves as forage).* Lima. Estación Experimental Agrícola de "La Molina." Boletín no. 58. 1955. 66p. Span., Sum. Span., Engl., 16 Refs.

Cassava. Leaves. Toxicity. HCN. Foliage. Uses. Nutritive value. Stems. Cassava meal. Forage. Animal nutrition. Feeds and feeding. Domestic animals. Peru.

The possibility has been studied of utilizing the foliage of cassava plants as livestock feed, thus making use of waste products, especially in the tropical regions were cassava is grown. The toxicity (HCN content) of the fresh cassava leaves was determined. A practical way was also studied for its elimination to the extent where these leaves could be considered safe for forage. The production of forage from 16 varieties of cassava was ascertained at the end of the vegetative period under normal growing conditions. Another study was made of the possibility of increasing such production by means of an early harvest of the leaves and the influence that such a cutting would have on root yield. Finally the theoretical nutritive value of the cassava leaf forage was established in relationship to the comparative value of alfalfa. Based on the results of research in Costa Rica, the possibility was studied of processing the leaves, stems and whole plant into meals to be used as forage, thus taking complete advantage of the whole plant. Furthermore, the best means for processing the plants was determined, bearing in mind the availability of the material and the characteristics of cassava in respect to the undesirable glucosides. The constituents of the meal, as an indication of its nutritive value, were also determined. *(Author's summary)* H03.

1314-0859 CONNER, C. M. **Feeding horses and mules on home-grown feedstuffs.** Florida Agricultural Experiment Station. Bulletin no. 72. 1904. pp. 115-126. Engl.

Cassava. Sweet-potatoes. Dietary value. Substitutes. Animal nutrition. Feeds and feeding. Maize. Domestic animals. Food energy. Palatability. Diets. USA.

This experiment investigated the feeding value of sweet potatoes and cassava as a substitute for corn. The object was to keep the animals from losing weight, rather than gaining weight. Beggarweed hay was used to supply protein. Sweet potatoes may be substituted for one half the corn ration in feeding horses and mules doing hard work. Cassava may also be used in about the same ratio as sweet potatoes but is not as palatable to the animals. *(Summary by J.L.S.)* H03

1315-0998 GONTIJO, R.M. *et al.* **Estudo comparativo entre raspa de mandioca lavada e milho desintegrado como fontes de energia, para engorda de novilhos azebuados em confinamento.** *(Comparison between washed, ground cassava and ground corn as sources of energy in feedlot systems for crossbred Zebu steers).* Arquivos da Escola de Veterinaria (Brazil) 24(1):27-31. 1972. Port., Sum. Port., Engl., 8 Refs.

Cassava. Dried tubers. Feeds and feeding. Animal nutrition. Cattle. Maize. Feed constituents. Brazil.

The study compared the effects of supplementary addition of washed ground cassava (dried) and ground corn to the basal ration of 38 crossbred Zebu steers (aged 45 months) during a 78-day weight gain test in intensive feed of systems. The treatments were: (a) cottonseed meal, sugar cane molasses and urea (10%), silage and elephant grass *(Pennisetum purpureum)* in addition to washed, ground cassava; (b) the same as (a), except for the addition of ground corn. Mineral mixture was given ad libitum. The average weight gains of the steers in the two treatments were 0.742 and 0.685 kg, respectively. Statistical difference between the treatments was observed. The following conclusions may be drawn: Maize ears may be substituted by washed ground cassava roots (dried) as an energetic source of steer diets in feedlot systems, with the advantage of reducing weight gain cost 9%. *(Author's summary)* H03

1316-0200 OLALOKU, E. A., EGBUIWE, A. M. and OYENUGA, V. A. **The influence of cassava in the production ration on the yield and composition of milk of White Fulani cattle.** Nigerian Agricultural Journal 8(1):36-43. 1971. Engl., Sum. Engl., 17 Refs.

Cassava. Maize. Diets. Composition. Feed constituents. Feeds and feeding. Animal nutrition. Dairy cattle. Domestic animals. Milk. Production. Animal physiology. Dietary value. Digestibility. Nutritive value. Nigeria.

Two groups of lactating White Fulani cows were given either a conventional production ration (A) based on 0.42 kg maize| liter of milk or a production ration (B) based on 0.751 kg raw cassava plus 0.198 kg of a meal mixture (equal parts groundnut cake and palm kernel meal) per liter of milk. A common maintenance ration of hay was also given. The experiment lasted for a 12-week indoor feeding period. Because total milk production (4% fat corrected and solids corrected) was significantly higher ($P<0.01$) for cows on ration B, total yields of fat, protein and solids-not-fat were also significantly higher ($P<0.01$) for that group. However, the percentage of butterfat and protein in the milk, as well as body weight changes, did not differ significantly between the 2 groups ($P<0.01$). *(Author's summary)* H03

1317-2077 NEVES, J. D. *et al.* **A substituição de farelo de algodão na alimentação de bovinos.** *(The substitution of cotton seed meal in swine feeding).* Brasil. Instituto de Pesquisas Agronómicas de Pernambuco. Boletín Técnico no. 37:3-18. 1969. Port., Sum. Port., Engl., 12 Refs.

Cassava. Molasses. Urea. Animal nutrition. Cattle. Swine. Cottonseed meal. Proteins. Feed constituents. Feeds and feeding. Domestic animals. Brazil.

A trial was carried out at the Cedro Experiment Station (IPA) in Victoria de Santo Antao (Brazil) to find ways to substitute cotton seed meal with urea as a protein source for cattle fed in confinement. The weight gains and feed consumption were recorded. There were 5 treatments studying (1) partial and total substitution of cottonseed meal by urea; (2) cassava as a supplement for a molasses-urea mixture; (3) the best way to feed cattle with molasses-urea mixture, whether with limited amounts or free choice. The trial proved that it is possible to substitute cottonseed meal with urea partially or totally when cassava was used as a supplement. A big increase in weight gains was obtained when cassava was used as a supplement in the molasses-urea mixture. The free-choice process proved to be better than limited amounts when cattle were fed the molasses-urea mixture. *(Author's summary)* H03.

1318-0844 HAMID, K. and JALALUDIN, S. **Utilization of tapioca in rations for laying poultry.** Malaysian Agricultural Research 1:48-53. 1972. Engl., Sum. Engl., 4 Refs.

Cassava. *Manihot esculenta.* Cassava meal. Diets. Maize meal. Animal nutrition. Nutritive value. Feeds and feeding. Poultry. Eggs. Production. Malaysia.

Two experiments using New Hampshire laying pullets were conducted to make a preliminary study of the nutritive value of cassava meal *(Manihot utilissima)* and of the effect of methionine supplementation. Five levels of cassava at 0, 20, 40, 60 and 76% of the ration replacing maize were fed to 50 birds at the point of lay for eight weeks. Food consumption and egg production increased up to the 60% level (though not statistically significant),but at 76% cassava with no maize, food consumption declined and egg production was the lowest of any of the rations. Egg yolks became progressively whiter as cassava increased and maize decreased. In a subsidiary, short experiment, 2 levels of methionine (0.15% and 0.30%) were added to the 76% cassava ration. Egg production was low with all those rations, but with 0.3% methionine, egg production was 2 1|2 times greater (P<0.05) than with 0.15% or no methionine. *(Author's summary)* H03

1319-2125 TOLEDO, F. F. DE. **Aproveitamento das folhas e das ramas de mandioca na alimentação.** *(Use of cassava leaves and branches in nutrition).* Solo 61(1):65-69. 1969. Port., 15 Refs.

Cassava. Animal nutrition. Cassava leaves (vegetable). Fresh products. Timing. Starch productivity. Productivity. Protein content. Composition. Uses. Stems. Alfalfa. Brazil.

Literature on the nutritive value of cassava leaves and stalks is reviewed. Leaves are very rich in proteins and carotene and may be considered as a good substitute for alfalfa in animal feeds. Starch, extracted from cassava leaves more than 10 months old, usually has lower protein content than that of alfalfa, but this can be improved by collecting leaves earlier. Harvesting of cassava in the state of Sao Paulo is from May to August since starch content is higher during this period. Remarks on HCN toxicity are included. *(Summary by J.L.S.)* H03.

1320-2069 ENRIQUEZ, F. Q. and ROSS, E. **The value of cassava root meal for chicks.** Poultry Science 46:622-626. 1967. Engl., Sum. Engl.,8 Refs.

Cassava. Feeds and feeding. Nutritive value. Dietary value. Feed constituents. Animal nutrition. Cassava meal. Meals. Diets. Bone meal. Poultry. Soybeans. Molasses. Amino acids. Methionine. Domestic

Six experiments were conducted using White Leghorn cockerels to determine the nutritive value of cassava root meal in rations containing 5% tuna, 5% meat and bone meal and 23 to 32.8% soybean meal. Poorer growth and feed conversion at 3 weeks of age were observed with increasing concentrations of cassava root meal. The addition of molasses or soybean oil to a 50% cassava ration was without beneficial effect, indicating that palatability and essential fatty acid deficiency were not responsible for the poor results. Supplementation of the high cassava ration with 0.15% methionine largely overcame the depressing effects, indicating that methionine was the major limiting nutrient. When the ration was balanced with respect to protein and methionine, cassava root meal at a level of 50% of the chick ration satisfactorily replaced corn. *(Author's summary)* H03.

1321-2073 PEREIRA, A. S. **Aipim (mandioca) para vaca leiteira.** *(Aipim (cassava) for dairy cows).* Chácaras e Quintais 113(1):13-14. 1966. Port.

Cassava. Dairy cattle. Cows. Leaves. Proteins. Dietary value. Animal nutrition. Feeds and feeding. Domestic animals. Timing. Bitter cassava. Sweet cassava. Cooking. Brazil.

An answer is given to a consultation about the utilization of cassava for dairy cows. Leaves have 15-30% protein which make them advantageous for animal feeding. Optimum yields of leaves are produced 4 or 5 months after planting, but tubers need more time to reach their optimum yields; besides, in São Paulo, plants lose their leaves by harvesting time. Tubers of the bitter variety Branca de Santa Catarina are recommended for utilization in dairy cow feed styles. The material should be dried as it is poisonous even after boiling. *(Summary by H.J.S.)* H03.

1322-3456 PATEL, B. M. and YAMADAGNI, S. **Comparative effects of feeding two leguminous by-products on various nitrogen fractions of rumen liquor and blood of cows.** Indian Journal of Animal Sciences 42(3):180-184. 1972. Engl., Sum. Engl., 16 Refs.

Cassava. Feed constituents. Animal nutrition. Dairy cattle. Legume crops. Animal physiology. Toxicity. Domestic animals. India.

An experiment was carried out with lactating cows to study the comparative utilization of N from cluster-bean (CBF) and pigeon-pea fodders (PPF) as affected by the supplementation of cassava and molasses. Analysis of rumen liquor and blood samples for various N fractions showed a marked decrease of total soluble N, NH_3-N and NPN in the rumen liquor and plasma NPN on PPF feeding as compared with the cows fed CBF. *In vitro* studies also indicated PPF to be an inferior fodder; this defect could not be modified by the supplementation of carbohydrates. The total N contents of CBF and PPF were almost equal, but the nutritional quality of PPF was very poor. The probable reason for the adverse effects of PPF feeding appears to be due to its low soluble-N content. The other possibility is the presence of certain toxic principle(s), which may impair proper N metabolism in the rumen. *(Author's summary)* H03

1323-3452 NORMANHA, E. S. **Farelo de ramas e folhas de mandioca.** *(Meal from cassava leaves and branches).* Agronomico 14(5-6):16-19. 1962. Port.

Cassava. Petioles. Leaves. Cassava meal. Animal nutrition. Feeds and feeding. Varieties. Productivity. Tubers. Harvesting. Composition. Proteins. N. Cultivation. Spacing. Timing. Water requirements. Fibre content. Brazil.

The use of ground,dried cassava leaves and branches as an animal feed in the state of São Paulo (Brazil), and its nutritive value are discussed. Leaves have a higher feeding value than branches. A variety that produces many leaves should be planted. The planting distance should be less than for cassava grown for its tubers. The crop may be cut 4, 8, 16 and 20 mo after planting. The moisture content of the final product should not exceed 13%. Yields of meal may be 6 tons| ha in the first year and 4 tons| ha in the second year. After the last cutting, 30% of the normal tuber yield may still be obtained. An analysis of the meal showed the following contents: 12% moisture, 15% crude protein, 4.5% fat, 24% crude fiber, 8.3% ash and 35% nitrogen-free extract. *(Summary by Tropical Abstracts).* H03.

1324-0818 A MANDIOCA na produção leiteira. *(Cassava in dairy production).* Gleba 15(173):29. 1969. Port., Illus.

Cassava. Animal nutrition. Dairy cattle. Maize. Diets. Supplements.

An experiment was carried out to test the substitution of coarse cassava meal for ground corn in rations for dairy cows. Rations were prepared with a mineral mixture, vitamins and up to 41.5% of coarse cassava meal. Cost analysis indicated that the greater the percentage of cassava in the rations, the cheaper the milk production. *(Summary by H.J.S.)* H03.

1325-3469 GOLDFIEM, J. DE **Le manioc dans l'alimentation des veaux et du proc de laiterie.** *(Cassava as a feed for calves and shoats).* Technique Laitiére 14(270):54-55. 1959. Fr.

Cassava. Animal nutrition. Cassava flour. Cassava chips. Tapiocas. Composition. Tubers. Dried tubers. Processed products. Swine. Calves. Cattle. Feeds and feeding.

This is a short communication dealing with the use of cassava flour as a livestock feed. Cassava flour is considered a good supplement to skim milk rations in calf and shoat feeding. The chemical composition of fresh tubers, chips, flour and tapioca is given. *(Summary by J.L.S.)* H03

1326-1837 ETCHEGOYEN, F. **La yuca no es nociva en la alimentación de los cerdos.** *(Cassava is not harmful for feeding swine).* Hacienda (USA) 28:276. 1933. Engl.

Cassava. Swine. Toxicity. Palatability. Animal nutrition.

There have always been doubts as to the risk of poisoning as a result of feeding cassava to swine. In autopsies made on swine fed sweet cassava, it was found that deaths were not caused by poisoning. Even in the case of varieties with a high HCN content, the animals would have to eat large quantities of fresh, uncooked cassava before it would be harmful. *(Summary by L.C. Trans. by T.M.)* H03

1327-3250 THOMPSON, F. W. **The use of cassava in the feeding of pigs on Achimota College Farm.** Farm and Forest 7(2):84-86. 1946. Engl.

Cassava. Swine. Animal nutrition. HCN. Detoxification. Diets. Finishing.

The work at Achimota has shown that entirely satisfactory pork carcasses can be produced, using cassava as the chief source of carbohydrate in the ration after the pigs are about 18 weeks old. It should not form more than 40% dry weight of the ration. Cooked cassava is a satisfactory food for adult stock when used in the same way. It is advisable to test the cassava for HCN unless the same cassava is normally used for human food in the same area. The methods of boiling and draining need careful control. *(Author's summary)* H03.

1328-3448 JOHNSON, P. T. C., ROSE, C. J. and MILLS, W. R. **Nutritional studies with early-weaned beef calves.** Rhodesian Journal of Agricultural Research 6(1):5-11. 1968. Engl.,Sum. Engl., 9 Refs.

Cassava. Animal nutrition. Calves. Brans. Maize. Cattle. Diets. Dietary value.

Forty ranch-type Zebu calves (Angoni x Boran) were early-weaned at 9-10 weeks of age. Four groups of 10 calves each were supplemented for 150 days with one of four different diets based on bran, cassava, corn and cob and a commercial concentrate mixture. The calves fed on the commercia and cassava-based mixtures gained weight significantly ($P < 0.05$) faster than those fed on the bran-based diet; but gains were similar to a separate group of 10 calves that were suckled by their dams until they were weaned at 7 mo. Calves fed on the corn diet were significantly ($P < 0.05$) lighter than other groups. During the subsequent 9-month trial period, when all calves were treated alike and were given small amounts of supplementary feed on the veld, there was no significant difference in weight gains. *(Author's summary)* H03.

1329-2025 SERRES, H. and TILLON, J. P. **Le manioc dans l'alimentation du porc. I. Possibilités et limites d'emploi.** *(Cassava for pig feeding. I. Possibilities and limits of use).* Revue d'Elevage et de Médicine Véterinaire des Pays Tropicaux 26(2): 225-228. 1973. Fr., Sum. Fr., Engl., Span.

Cassava. Swine. Feeds and feeding. Animal nutrition. Composition. Diets. Feed constituents. Dietary value. Fattening. Finishing.

Experiments were made with large amounts of cassava for feeding of growing-finishing pigs. Good results were obtained when the diet provided sufficient minerals, vitamins and nitrogen. A well-balanced amino acid content is also necessary. *(Author's summary)* H03.

1330-3459 ZAUSCH, M., DRAUSCHKE, M. and LAUTERBACH, A. **Verdaulichkeit und einsatz von Tapiokamehl bei Schweinen.** *(Digestibility and use of cassava meal for swine).* Jahrbuch für Tierernahrung Futterung 6:256-260. 1967-68. Germ., Sum. Germ. Engl., Russ., 7 Refs.

Cassava. Cereals. Diets. Animal nutrition. Swine. Feeds and feeding. Fattening. Supplements. Digestibility. Cassava meal. Domestic animals.

Cassava meal and flakes were tested in a digestibility experiment carried out with pigs. A total digestible nutrient content of 810-820 parts per 1,000 was found in the organic substance and the nitrogen-free extract. In a feeding experiment carried out with fattening pigs, it was found that 15-20% barley can be successfully replaced by cassava meal in feed mixtures for fattening swine. *(Author's summary)* H03.

1331-2.34 TILLON, J. P. and SERRES, H. **Le manioc dans l'alimentation du porc. II. Digestibilité du manioc sous différentes présentations.** *(Cassava for swine feeding. II. Cassava digestibility in various forms).* Revue d'Elevage et de Médicine Veterinaire des Pays Tropicaus 26(2):229-233. 1973. Fr., Sum. Fr., Engl., Span., 8 Refs.

Cassava. Swine. Feeds and feeding. Digestibility. Animal nutrition. Analysis. Starch content. Dry matter. Composition. Nutritive value. Domestic animals.

Because of the high energetic value of cassava, the authors decided to determine its digestibility in 4 different forms (fresh, boiled, dry, silage) for use in swine feeding. Four castrated hogs of the same litter were selected for the experiment. The results show that the digestibility of cassava starch is very high, whatever its form. The use of silage reduced the digestibility of minerals. The energetic value of cassava reaches 3.25 Kcal|kg dry cassava (metabolizable); 1.06 F.U (Scandinavian Feed Unit System)|kg dry cassava. *(Author's summary)* H03

1332-0406 ROSS, E. and ENRIQUEZ, F. Q. **The nutritive value of cassava leaf meal.** Poultry Science 48:846-853. 1969. Engl., Sum. Engl., 9 Refs.

Cassava. Leaves. Cassava meal. Nutritive value. Deficiencies. Methionine. Cyanides. Analysis. Toxicity. Chicks. Diets. Animal nutrition. Composition. Animal physiology.

Dehydrated cassava leaf meal (*Manihot esculenta* Crantz = *M. utilissima* Pohl) depressed growth and feed efficiency of single-comb White Leghorn cockerel chicks when it comprised up to 15 or 20% of the ration. Japanese quail were similarly affected with 20% cassava leaf meal in the diet. Methionine appeared to be the first limiting factor and energy a second. A marginal methionine deficiency may have been responsible for some of the growth depression although the presence of appreciable quantities of a cyanogenetic glycoside in cassava leaves suggests that cyanide toxicity may have been responsible for a relative methionine deficiency. Since the growth effect from supplemental methionine was greater than could be explained from the methionine content of the rations, the hypothesis is advanced that cassava leaf rations increased the requirement for methionine to provide additional sulfur for the detoxification of cyanide. The addition of sodium thiosulfate to the cassava leaf ration significantly improved growth, supporting the aforementioned hypothesis. *(Author's summary)* H03

1333-0908 OLSON, D. W., SUNDE, M. L. and BIRD, H. R. **Amino acid supplementation of mandioca meal chick diets.** Poultry Science 48:1949-1953. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Poultry. Chicks. Maize meal. Diets. Feeds and feeding. Amino acids. Arginine. Cystine. Histidine. Lysine. Methionine. Tyrosine. Cassava meal. Processed products. Food energy. Tryptophane. Nutritive value. Animal nutrition. Uses. India.

When cassava meal is the major carbohydrate source in chick diets, growth and efficiency are lower than with conventional rations, which are isonitrogenous and isocaloric. This study was conducted to determine the effects of supplemented methionine or leucine (or both) to rations containing 45% cassava meal. One-day-old chicks (New Hampshire x single comb white Leghorn) were used in 2 replicates of 8 treatments (10 birds each). *(Summary by T.M.)* H03.

1334-3791 GROSKREUTZ, K. A. **Schweinemast mit Tapioka.** *(Fattening swine on cassava).* Mitteilungen der Deutschen Landwirtschaftgesellschaft 76(11):362-364. 1961. Germ., Sum. Germ.

Cassava. Feeds and feeding. Nutritive value. Digestibility. Swine. Costs. Feed constituents.

Success in swine fattening definitely depends on the type of feedstuffs, which should not only correspond to the physiological needs of the animal but should also be economical. Feedstuffs whose effects are not known by many farmers are used for fattening. This article provides information on cassava as a feedstuff. Good results were obtained at a school of agriculture in Schleswig-Holstein. Cassava not only proved to be a useful ingredient in varied mixtures but was also a very economical source of carbohydrates. *(Author's summary. Trans. by H.P.)* H03.

1335-3318 CHICO, C. F. *et al.* **La harina de yuca en el engorde de cerdos.** *(Cassava meal in swine feeding).* Agronomía Tropical (Venezuela) 22(6):599-603. 1972. Span., Sum. Span., Engl., 6 Refs.

Cassava. Animal nutrition. Feeds and feeding. Swine. Maize. Digestibility. Diets. Cassava meal. Dietary value. Fattening. Finishing. Nutritive value. N. Domestic animals. Venezuela.

The effect of substituting 25, 50, 75 and 100% cassava meal for corn in a basal diet containing 60% corn was studied. Six 43-kg pigs were used for each 7-week treatment. There were no significant differences among the treatments. The pigs gained an average of 804 g| day and needed 3.45 kg of feed| kg of liveweight gain. No differences were found for digestibility of organic matter and N retention. The average values for carcass length, dorsal fat and iodine number were 73.3 cm, 3.23 cm and 69.9 cm, respectively. *(Author's summary)* H03

1336-0823 SHIMADA, A. S., PERAZA, C. and CABELLO, F. T. **Valor alimenticio de la harina de yuca, *Manihot utilissima* Pohl, para cerdos.** *(Feeding value of cassava meal, Manihot utilissima Pohl, for growing pigs).* Técnica Pecuaria en México nos. 15-16:31-35. 1971. Span., Sum. Span., Engl., 8 Refs.

Cassava. Feeds and feeding. Diets. Swine. Cassava meal. Animal nutrition. Domestic animals. Dietary value.

Two experiments were conducted to study the feeding value of cassava meal (*Manihot utilissima* Pohl) for growing pigs. Twelve Yorkshire pigs initially averaging 30 kg were used in trial one. A progressive substitution was made of the grain of a corn-soybean meal ration for cassava meal. Rations contained 0, 22, 44 and 66% of the root meal. The 22 and 44% levels gave daily gains, feed|gain ratio and apparent digestibility coefficients similar to those of the basal ration; the 66% ration gave inferior results ($P<.05$). Twelve weanling Yorkshire pigs initially averaging 16 kg were used in trial two. Treatments were designed to study the effect of the cassava meal level (30 vs. 60%) and the addition of corn oil (0 vs. 3%). In rations without the oil, pigs gained faster and more efficiently with the low cassava ration; on the other hand, the addition of corn oil was more beneficial for the animals fed the higher percesntage of cassava. However, the differences were not statistically significant. *(Author's summary)* H03.

1337-3358 PILLAI, S. C. *et al.* **Tapioca spent pulp as an ingredient in poultry feed.** Current Science 37(21):603-605. 1968. Engl., Sum. Engl., 19 Refs.

Cassava. Animal nutrition. Feeds and feeding. Poultry. Waste utilization. Starch productivity. Animal health. Eggs. Productivity.

In the production of starch from cassava, the spent pulp presently goes to waste. The possibility of using this waste product as an ingredient in poultry feed was studied. For 7 months White Leghorn hens were fed a diet in which 50% of the ragi flour had been replaced by the spent pulp. The birds were healthy, and there was a 12% increase in the number of eggs laid. *(Summary by T.M.)* H03

1338-4387 HUTAGALUNG, R. J., JALALUDIN S., and CHANG, C. C. **Evaluation of agricultural products and by-products as animal feeds. II. Effects of levels of dietary cassava (tapioca) leaf and root on performance, digestibility and body composition of broiler chicks.** Malaysian Agricultural Research 3:49-59. 1974. Engl., Sum. Engl., Mal., 45 Refs.

Cassava. Dietary value. Tubers. Leaves. Diets. Composition. Animal nutrition. Chicks. Domestic animals. Digestibility. Feed constituents. Feeds and feeding. Food energy. Animal physiology. Malaysia.

The effects of feeding graded levels of cassava leaves and roots on the performance, body composition and the mineral composition of tissues were studied. In addition, metabolizable energy (ME) and digestibility of dry matter (DM), ether extract (EE), energy and protein of the diets were determined. In Experiment 1, the ME of cassava leaves and roots was 1590 and 3230 kcal| kg on a DM basis, respectively. Chicks fed dietary cassava leaves had lower digestion coefficients for DM, EE, energy and protein while those on the cassava root diet were not adversely affected. This suggests that chicks receiving the cassava leaf diet did not consume adequate feed to meet the nutrient requirements, particularly energy and protein. In Experiment 2, the effect of increasing the level of leaves alone in combination with graded levels of roots caused a growth depression and poorer feed conversion as compared to those on the control diet. It appears that the reduction in nutrient density and incomplete elimination of growth-depressing factors in the cassava leaf diet caused an adverse effect on growth performance and feed utilization. Birds fed diets containing a combination of leaves and roots tended to have less moisture and more fat in the whole carcassas as compared to those fed the basal diet. No consistent differences in mineral contents of the whole carcass and liver were observed for birds on either diet although there was also a slight reduction in the carcass copper and zinc content and in the liver zinc content of chicks fed a diet containing a combination of 15% leaves and 30% roots. *(Author's summary)* H03

1339-0907 ROVERSO, E. A., TUNDISI, A.G.A. and LIMA, F.P. **Melaco, mandioca e cana-de-acucar integral no arracoamento de bovinos Nelore.** *(Molasses, cassava and whole sugar cane in rations for Nelore bovines.).* Revista Medica Veterinaria 5(1):36-50. 1969. Port., Sum. Port.

Cassava. Diets. Rice. Molasses. Feeds and feeding. Cattle. Bone meal. Cottonseed flour. Cakes. Feed constituents. Feed mixtures. Dried tubers. Fattening. Finishing. Sugar cane.Domestic animals. Animal nutrition.

Molasses is generally used in bovine feeding. Because of the unavailability of molasses in certain regions, an experiment was carried out to evaluate the use of molasses ad libitum and in limited quantities and to study other sources of carbohydrates, such as whole sugar cane and cassava roots. Six randomized blocks were designed, using 24 castrated Nelore bovines (aged 21 mos and weighing 335.5 kg) that had been vaccinated against foot-and-mouth disease and given a vermifuge. The animals were confined for 112 days during the dry season. Treatment A was given 50% rice straw, 20% cottonseed meal + molasses ad libitum in separate troughs. Treatment B was fed 50% rice straw, 20% cottonseed meal + 1 kg molasses| day| steer in separate troughs. Treatment C was given 60% rice straw, 20% cottonseed meal and 20% sun-dried cassava roots. Treatment D received 65% rice straw, 15% tonseed meal and 20% whole sugar cane. In addition, all animals, except those in treatment D, were given injections of vitamin A. The mean and standard errors in weight gain in the 112 days were (A) 68.00 + 4.84 kg, (B) 65.00 + 4.84 kg, (C) 77.00 + 4.84 kg, and (D) 52.00 +

4.84 kg. Statistical analysis showed a resemblance between A and B; C and D showed the possibility of replacing molasses with sugar cane and cassava, the latter being superior. *(Author's summary)* H03.

1340-3375 PERNOT, S. **L'utilisation de la farine de manioc dans l'alimentation des jeunes veaux.** *(The use of cassava meal for calf feeding).* Le Agriculture Pratique des Pays Chauds 9:427. 1909. Fr.

Cassava. Cassava meal. Calves. Potato flour. Animal nutrition. Cattle.

Comments are made on an article by André Govin and P. Audouard, which deals with the substitution of potato flour by cassava meal in calf feeding. Flours were diluted in milk. Cassava flour gave better results than potato flour, which hardened after chilling. Cassava meal liquifies well and is easily assimilated. It is possible to prepare cassava meal rations once in 3 days during the cold season, which is not possible for potato flour. *(Summary by H.J.S.)* H03.

1341-3476 DECHAMBRE, M. **L'élevage des veaux à l'aide du lait écrémé.** *(Calf feeding with skim milk).* L'Industrie Laitiere 38(50):801-811. 1913. Fr.

Cassava. Milk. Feed constituents. Flours. Digestibility. Diets. Composition. Cassava flour. Calves. Cattle. Animal nutrition.

Notes are given on the utilization of skim milk as a feedstuff for young calves. Since the fat content of skim milk is very low, several starches and sugars were tested as possible supplements to skim-milk diets. Cassava flour was the most appropriate supplement due to its high digestibility coefficient. Methods of diet preparation and feeding aspects are included. *(Summary by J.L.S.)* H03.

1342-3242 HOWIE, G. W. **Two experiments on tapioca meal as food for pigs.** Journal of Ministry of Agriculture (London) 37:885-890. 1930. Engl.

Cassava. Swine. Maize. Animal nutrition. Economics. Costs. Cassava meal. Feeds and feeding. Diets. Dietary value. Nutritive value. Fattening. Domestic animals.

Two experiments were carried out comparing cassava meal to maize meal as a source of digestible carbohydrates in the rations for fattening pigs. Rations included middlings, barley meal, fish meal, cassava flour and maize meal, as well as palm kernel-cake meal and crushed oats. The average rate of liveweight gain was satisfactory with both the cassava and the maize treatments, and costs were reduced by the use of cassava. *(Summary by H.J.S.)* H03.

1343-3420 GADELHA, J. A., CAMPOS, J. and MAYROSE, V. **Farelo de raspa de mandioca na alimentação de pintos.** *(Cassava meal in chick feeding).* Experientiae 9(4):111-132. 1969. Port., Sum. Port., Engl., 19 Refs.

Cassava. Animal nutrition. Chicks. Cassava meal. Feeds and feeding. Diets. Methionine. Brazil.

Two 6-week experiments, using a total of 336 one-day-old Shaver Starbro chicks of both sexes, were conducted to study the nutritive and economic value of cassava meal as a source of energy in starting chick diets. The four treatments consisted of rations of 0, 15, 30 and 45% levels of cassava meal. All diets were supplemented with 0.20% dl-methionine. Chicks were maintained in metal batteries with electric heaters. A significant difference ($p < 0.01$) between treatments, and significant ($P < 0.01$) linear effects were observed in chick gain and feed efficiency. With increasing levels of cassava meal chicks gained more slowly and required more feed/kg of gain. Chicks consumed less with increasing levels of cassava meal; however, the differences were not significant. Cost/kg of gain was the same for chicks fed the diets containing 0 and 15% cassava meal; and these two diets were more economical using the same criteria than the diets containing 30 and 45% cassava meal. *(Author's summary)* H03.

1344-3430 AMILACEOS: PRINCIPAIS alimentos do porco sao de fácil producao. *(Easily produced amylaceous feedstuffs for swine).* Revista Fir 11(5):26-29. 1969. Port.

Cassava. Swine. Feeds and feeding. Animal nutrition. Nutritive value. Composition. Sweet-potatoes. Yams. Starch crops. Brazil.

Notes are given on the utilization of cassava, sweet potatoes and yams as supplements in maize diets for swine. Cassava may replace up to 8% of the maize diet. Some other food products are mentioned as optimum feed mixtures. Nutritive value and vitamin content of the principal feedstuffs for swine feeding in Brazil are given. *(Summary by J.L.S.)* H03.

1345-3417 HEW, VOON FONG and HUTAGALUNG, R. I. **The utilization of tapioca root meal *(Manihot utilissima)* in swine feeding.** Malaysian Agricultural Research 1:124-130. 1972. Engl., Sum. Engl., Mal., 16 Refs.

Cassava. *Manihot esculenta.* Cassava meal. Feeds and feeding. Swine. Diets. Costs. Animal nutrition. Economics. Processed products. Malaysia.

Two experiments using 48 Landrace x Large White crossbred pigs were conducted to study the effects of cassava meal on the performance of growing and growing-finishing pigs. Weight gains and feed conversion declined as increasing amounts of cassava were added to the diets. Supplementation of the cassava diet with methionine, palm oil and glucose improved the performance of the pigs. The economic aspects of incorporating cassava and supplements into the rations are discussed. *(Author's summary)* H03.

1346-3471 ASICO, P. M. **A comparative study of gaplek meal and corn as basal feed for growing and fattening pigs.** Philippine Agriculturist 29(8):706-712. 1941. Engl., Sum. Engl., 3 Refs.

Cassava. Gaplek meal. Maize. Feed constituents. Swine. Feeds and feeding. Diets. Fattening. Animal nutrition. Domestic animals. Gaplek. Philippines.

A trial using 14 Berkjala weanling pigs was conducted to compare gaplek meal (lot II; sliced, dried cassava roots) to corn (lot I) over three 70-day periods. For the entire 210-day period, pigs in lot I gained an average of 0.30 kg daily as compared to 0.27 kg for lot II (cassava was only 90% as efficient). The average amount of feed required 1 kg liveweight gain was 5.39 kg for lot I and 5.68 for lot II (cassava was only 95% as efficient). In terms of cost, lot II was much higher. This was because the cost of gaplek used in this experiment was much higher than that imported from Java. Gaplek meal is a good substitute for corn in rations for growing-fattening pigs if the price is 95% that of corn. *(Summary by T.M.)* H03.

1347-3337 KOK, E. A. and RIBEIRO, G. DE. **O farelo de raspas de mandioca em comparação com a quirera de milho na alimentação dos suinos.** *(Cassava meal compared with ground corn in swine feeding).* Boletim de Industria Animal 5(4):86-124. 1942. Port., Sum. Port., Engl., 6 Refs., Illus.

Cassava. Swine. Animal nutrition. Economics. Prices. Cassava meal. Diets. Cottonseed meal. Feed constituents. Maize meal. Feeds and feeding. Brazil.

Two swine feeding experiments were carried out to compare cassava meal with ground corn. The results indicated that when rations with the same protein percentage are compared, the gains obtained with cassava meal mixtures came sooner and had the same efficiency as those with ground corn. Cassava meal has a protein content 60% lower than corn; this deficiency must be balanced by including a higher percentage of feeds rich in protein. With certain precautions, cottonseed meal can be used for this purpose. The starch value of cassava meal (80.0) was slightly lower than that of ground corn (80.6). The mixture composed of 85 parts of cassava meal and 15 parts of cottonseed meal, with the same protein con[illegible] parts of ground corn, has a starch value of 79.8. Cassava meal should be given in wet ratio[illegible]ed with other concentrates; its utilization is economically profitable when its selling price is eq[illegible]er than that of corn. *(Author's summary)* H03

1348-1922 FALANGHE, O. **Substituição dos farelos de trigo por farelos de arroz e mandioca na alimentacao de poedeiras.** *(Substitution of wheat bran with rice bran and cassava meal in rations for laying hens).* Biologico 15:35-38. 1949. Port., 2 Refs.

Cassava. Cassava meal. Feeds and feeding. Diets. Poultry. Animal nutrition. Substitutes. Wheat bran. Composition. Rice bran. Brazil.

A trial was carried out to study the possibility of replacing wheat bran with cassava meal and rice bran in rations for laying hens. Forty Rhode Island Red hens were divided into 2 lots. Lot 1 was fed wheat bran. In the ration for lot 2, 44 kg wheat bran was replaced by 22 kg each of cassava meal and rice bran. An increase of 19.2% in egg production was obtained in the lot fed cassava meal and rice bran. *(Summary by J.L.S.)* H03

1349-3280 McMILLAN, A. M. and DUDLEY, F. J. **Potato meal, tapioca meal and town waste in chicken rations.** Harper Adams Utility Poultry Journal 26(9):191-194. 1941. Engl., 2 Refs.

Cassava. Animal nutrition. Poultry. Potatoes. Cassava meal. Processed products. Diets. Feeds and feeding. Chicks. Dietary value.

During the war, the possibility of feeding chickens with rations containing potato meal, cassava meal and "Town Waste" (kitchen refuse that has been converted into a dry meal for animal feed), was studied. Rations containing potato and cassava meals at a level of 20% or Town Waste at a level 30% proved satisfactory as a dry mash. Rations containing 40% of both meals diminished the amount consumed and, except for one case, caused a decrease in the final body weight. Consumptions increased but weight gain decreased when the level of Town Waste was increased to 50% of the rations. With potato and cassava meals, a higher food consumption and a consequent greater final weight might be induced by feeding the rations as a wet mash. *(Summary by H.J.S.)* H03.

1350-3332 LEITE, A. C. **Contribuição para o estudo da mandioca e da araruta na alimentação dos porcos de engorda.** *(Contribution to the study of cassava and purple arrowroot for growing-fattening swine)* Boletin de Industria Animal (n.s.) 2(2):3-26. 1939. Port., Sum. Engl., Illus.

Cassava. Animal nutrition. Feeds and feeding. Swine. Tubers. Economics. Prices. Nutritive value. Diets Fattening. Composition. *Manihot esculenta.*

A trial was carried out to compare the value of cassava (*Manihot utilissima* Pohl) and purple arrowroot (*Canna edulis* Ker Gawl) as feed for fattening shoats. Conclusions were as follows: (1) Cassava has a richer nutrient composition than arrowroot according to chemical analyses. (2) Arrowroot is not as palatable as cassava. Pigs ate no more than 3.85 kg| head| day, whereas consumption of cassava was about 5 kg. (3) Cassava proved to be a better feed than arrowroot; 1 kg had the same feeding value as 1 1| 2 kg of arrowroot (4) Cassava produces larger yields (12,700 kg| ha) of roots than arrowroot (10,000| m²). *(Author's summary)* H03

1351-4566 HENKE, L. A. **Swine feeding trials in Hawaii.** University of Hawaii Agriculture Experiment Station. Bulletin no. 99. 1949. 32p. Engl., Sum. Engl.

Cassava. Animal nutrition. Swine. Feeds and feeding. Cassava meal. Domestic animals.

Swine feedstuffs in Hawaii are based largely on garbage. Results of experiments with various feeds and the feed cost of producing pork with different combination of feeds are summarized in this bulletin. As regards cassava, all trials were based on cassava meal made from sliced, dried, shredded or ground roots because of the HCN content in the peel of some varieties. As a feed for swine, a mixture of 85% cassava meal plus 15% soybean meal was worth 95% as much as barley. Garbage from military sources had a value 40% that of a good grain ration, based on the quantity required to produce a pound of gain. In these experiments garbage alone proved an excellent feed for fattening hogs, 9-13 lb producing 1 lb of gain. Garbage proved satisfactory for weanling pigs and brood sows. Under the conditions of these experiments, comparing garbage, concentrate rations and combinations of garbaje and concentrate rations, no significant differences in size of little, at birth or mortality were found for the different methods of feeding. *(Summary by T.M.)* H03

1352-3308 KRAUSS, F. G. **Production of starch on a small commercial scale from root crops and corn.** Hawaii Agricultural Experiment Station Report 1921. pp. 55-57. Engl.

Cassava. Animal nutrition. Swine. Taro. Economics. Costs. Cassava starch. Nutritive value. Dietary value. Diets. Sweet-potatoes.

Starch production tests were made with edible canna, sweet potatoes, taro, corn and two varieties of cassava. The starch was used to conduct feeding experiments with swine and poultry. The recovery of starch was about 20% from all the crops tested except corn, which was not considered efficient. The feeding value of cassava and sweet potato residue was fully equal to that of corn when its proportion did not exceed 50%. In two 100-day feeding tests, 5 mature hogs and 10 pigs (averaging about 80 lb at the beginning of the test) gaomed 0.75-1.75 lb/day. The feed was balanced with part of its protein in animal form. Diets with more than 50% of the residue seem to cause sluggishness, a decrease in flesh firmness and distended abdomens, espescially in older animals. Figures are given for the cost of starch extraction equipment. *(Summary by H.J.S.)* H03.

1353-0625 PEIXOTO, R. R. **Estudo comparativo entre farinha de mandioca com o milho, como alimento para porcos em crescimento e engorda.** *(Comparative study of cassava meal and corn in rations for growing-fattening pigs).* Pelotas, Brasil, Universidade Federal Rural do Rio Grande do Sul, Facultade de Agronomia "Eliseu Maciel", 1965. 17p. Port., Sum. Port., 10 Refs.

Cassava. Feeds and feeding. Fattening. Swine. Cassava meal. Maize. Animal nutrition. Domestic animals. Maize meal. Brazil

Four lots of 4 Duroc pigs each (3 males and 1 female, weighing 30 kg) were fed up to 100 kg liveweight on rations based on cassava meal and corn. The rations were supplemented with a mixture of meat and soybean meals, according to Morrison's Feeding Standards. Pigs fed cassava meal required 30% more time to reach market weight; ration efficiency was also lower by approximately 15%. Cassava meal-fed pigs produced longer, but fatter carcasses (this fat was firmer than in corn-fed pigs); carcass yield was 80.2% as compared to 76.4% for corn-fed pigs. The author feels that cassava meal is advantageous but further work should be done on increasing its efficiency. *(Summary by T.M.)* H03

1354-0562 ADAMS, C. W. M., FERNAND, V. S. V. and SCHENIEDEN, H. **Histochemistry of a condition resembling kwashiorkor produced in rodents by a low-protein high-carbohydrate diet (cassava).** British Journal of Experimental Pathology 39(4):393-404. 1958. Engl., Sum. Engl., 47 Refs., Illus.

Cassava. Animal nutrition. Deficiency diseases. Protein deficiencies. Endocrine disorders. Soluble carbohydrates. Hepatic disorders. Laboratory animals. Animal physiology. Dietary value. Etiology. Malnutrition. Diets. Amino acids. Nigeria.

The effects on rodents of a cassava based diet have been investigated using histochemical and biochemical techniques. There was loss of stainable protein from the zymogen granules of the pancreatic acini, the peptic cells of the stomach, the Paneth cells of the ileum, the serous tubular cells of the submandibular gland, from the parenchymal cells of the liver and from the interstitial cells of the testis of aminals kept on such a diet. All these cells were atrophied and showed diminished eosinophilia. No loss of RNA and no change in nonspecific esterase activity were found in those exocrine glands in which these tests were done; but in certain endocrine glands (interstitial cells of the testis and thyroid), nonspecific esterase activity was diminished. In the liver, RNA and nonspecific sterase activity were both reduced. Whereas alkaline phosphatase activity was moderately reduced in the adrenal cortex, there was a substantial increase of acid phosphatase activity in the pancreatic islets. In the liver both acid and alkaline phosphatase activities were increased. The degranulation and atrophy of the serous tubules of the submandibular gland were probably related to the involution of the interstitial cells of the testis, for the serous tubules appeared nearly normal when testosterone was added to the diet. The histological changes found in animals kept on a diet of cassava could not be corrected by supplements of incomplete protein, individual amino acids, vitamins and lipotrophic factors. Only complete protein was effective. The relationship of the syndrome (seen in cassava-fed rodents) kwashiorkor has been discussed. The organs that are predominantly affected in both conditions are those with a rapid turnover in protein. Apart from species differences, it is concluded that the two conditions are essentially similar. *(Author's summary)* H03

1355-0407 MANER, J. H. and BUITRAGO A., J. **Utilización de yuca en dietas para crecimiento y acabado de cerdos.** *(The use of cassava in diets of growing-finishing pigs).* Palmira, Instituto Colombiano Agropecuarion, Centro Nacional de Investigaciones Agropecuarias. 9p. Span., 4 Refs.

Cassava. Swine. Diets. Cassava tubers (vegetable). Cassava meal. Finishing. Fattening. Diets. Proteins. Colombia.

Nutrition trials with 15 Duroc Jersey pigs (approx. 9 weeks old) were carried out. The trials lasted until the pigs reached 100 kg liveweight. The first trial was carried out in grazing corrals with coastal Bermuda grass and the second one under confinement. Three diets were used for both experiments: (1) control diet (16% protein) *ad libitum*, (2) fresh cassava *ad libitum* plus protein supplement *ad libitum* and (3) fresh cassava *ad libitum* plus protein supplement in controlled quantities based on daily needs dictated by the weight of the animal. Analysis of results was based on feed consumption, weight gains and efficiency of feed conversion. On this basis and if protein-rich sources are expensive, the most advisable ration would be diet 3. The superiority of confinement over grazing for growing-finishing swine on an *ad libitum* feeding system was also established, as well as the advantage of a mixture of soybean cake plus cottonseed cake, which produces an adequate amino acid supplementation and does not have any toxic principles. *(Summary by P.A.C.)* H03

1356-3467 ENRIQUEZ, F. Q. and ROSS, E. **Cassava root meal in grower and layer diets.** Poultry Science 51(1):228-232. 1972. Engl., Sum. Engl., 11 Refs.

Cassava. Cassava meal. Poultry. Diets. Composition. Animal nutrition. Nutritive value. *Manihot esculenta.*

The nutritive value of cassava root meal in grower and layer diets was evaluated. In one experiment, 0, 10, 25 and 50% of cassava meal was substituted in isonitrogenous grower diets and fed to single comb White Leghorn pullet chicks from 6-20 weeks of age. All groups received the same standard layer diet from 20-48 weeks of age. There was no significant difference in egg production, feed conversion, egg weight, Haugh units, shell thickness, body weight gain or mortality that could be described to level of cassava root meal feed during the growing period. In the second experiment, the same levels of cassava root meal were fed to pullets from 20-48 weeks of age. There were no significant differences in any of the parameters measured that could be ascribed to the treatment. The addition of up to 50% of cassava root meal to the layer diet did not have any adverse effects on the pullets during the 28-week experimental period. *(Author's summary)* H03

1357-4743 PHUAH, C. H. and HUTAGALUNG, R. I. **Effect on levels of dietary protein and cassava on performance and body composition of chickens.** Malayan Agricultural Research 3:99-106. Engl., Sum. Engl., Mal., 24 Refs., Illus.

Cassava. Dietary value. Proteins. Feeds and feeding. Feed mixtures. Chicks. Animal physiology. Malaysia.

A 3 x 3 factorial experiment involving 162 chicks was conducted to assess the performance and body composition of broiler chicks in response to varying protein levels (starter: 19, 22, 25%; grower: 17, 20, 23%) in combination with graded levels of cassava (0, 20, 40%). In general, protein and cassava levels in the diet gave little or no improvement in rate and efficiency of gain. With increasing levels of dietary protein, carcass protein was increased and carcass fat was decreased in a linear manner. Similarly, raising the cassava content up to 20% of the diet exerted a greater effect in increasing the protein and lowering the fat content of the carcas when supplemented up to 20% level, but further increases gave an inconsistent pattern of carcass composition. *(Author's summary)* H03

1358-2076 **MANDIOCA BARATEIA o leite.** *(Cassava makes milk cheaper).* Correio Zootecnico 9(147). 1969. Port.

Cassava. Cassava meal. Milk. Production. Animal nutrition. Brazil.

This is a brief discussion of 5 experiments carried out by R. M. Cardoso to determine the effect of using cassava meal instead of corn for feeding dairy cows. Rations consisted of cassava meal, minerals ad libitum and vitamin A. Althought cassava meal gives better results when supplemented with products rich in protein, milk production increased satisfactorily,under these conditions. *(Summary by S.S. de S.)* H03

1359-4981 NEVES, J. D. *et al.* **Uréia, melaco e raspa de mandioca, na engorda de bovinos.** *(Urea, molasses and cassava meal for fattening cattle).* Pernambuco, Brazil, Secretaría de Agricultura, Industria e Comercio, Instituto de Pesquisas Agronómicas de Pernambuco. Boletim Técnico no. 37. 1969. 18p. Port., Sum. Port., Engl., 12 Refs.

Cassava. Animal nutrition. Feeds and feeding. Cattle. Proteins. Food energy. Cassava meal. Cottonseed meal. Molasses. Urea. Diets. Brazil.

A trial was carried out at the Cedro Experiment Station (IPA) in Vitoria de Santo Antao to find ways to use urea instead of cottonseed meal as a protein source for cattle in confinement. There were 5 treatments: (1) partial and total substitution of cottonseed meal by urea, (2) cassava as a supplement for a molasses-urea mixture, (3) feeding the molasses-urea mixture in limited amounts or free choice. It was possible to replace cottonseed meal by urea, partially or totally, when cassava was used as a supplement. A big increase in weight gain was obtained when the molasses-urea mixture was supplemented with cassava; in this case the free-choice method was better. *(Author's summary)* H03

1360-5102 ARMAN, P. and HOPCRAFT, D. **Nutritional studies on East African herbivores. I. Digestibilities of dry matter, crude fibre and crude protein in antelope, cattle and sheep.** Britis Journal of Nutrition 33(2):255-264. 1975. Engl., Sum. Engl., 24 Refs.

Cassava. Pellets. Cattle. Digestibility. Proteins. Nutritive value. Dry matter. Fibre content. Animal nutrition. Animal physiology. Feed constituents. Africa.

A series of digestibility trials was conducted using 4 animals of each of the following species: Friesian cattle *(Bos taurus)*, Boran zebu cattle *(Bos indicus)*, Corriedale sheep, fatailed sheep, eland (*Taurotragus oryx* Pallas), Coke's hartebees (*(Alcelaphus buselaphus* cokei Günter),, Thomson's gazele (*Gazella thomsonii* Günther) and bush duiker (*Sylvicapra grimmia* L.). Two batches of pelleted food were prepared from ground maize cobs, cassava, wheat bran, maize bran and decorticated cottonseed cake. For each batch, 5 diets (A E) were prepared containing 65 (A) 135 (E) g crude protein (N x 6.25)| kg dry matter. The crude fibre contents of all the diets were similar (120 138 g| kg DM). The animals were given the high-protein diet (E), then given diets with decreasing protein contens, finishing with the low-protein diet (A). The antelope and half the sheep were given diets from the first batch of pelleted food; the other 4 sheep and all the cattle were given diets from the second batch of food. In sheep, there were significant differences in digestibility between the two batches. There were no significant differences in the overall mean digestibilities of al diets when given to cattle and sheep. However, with diet E, DM digestibility was higher in sheep than in cattle ($P<0.05$): the reverse was true with diet A ($P<0.001$). Crude fibre and crude protein digestibilities followed a similar pattern. The overall mean digestibility of the DM was higher ($P<0.001$) in hartebeest and duiker than in shepp; in Thomson's gazelle ($P<0.01$) and el and ($P<0.001$) it was lower than in sheep. The values for crude fibre digestibilities varied in a similar way. The mean apparent digestibility of crude protein was higher (P 0.001) in eland, hartebeest and duiker than in sheep and gazelle. *(Author's summary)* H03.

1361-5240 MANJARREZ MUÑOZ, B. *et al.* **Valor nutritivo de una combinación de harina de yuca** ***(Manihot esculenta)*** **con puliduras de arroz como substituto de maíz en la alimentación de pollos y cerdos.** *(The nutritive value of a cassava meal-rice polishings mixture to replace corn in rations for broiler chicks and swine). In* Investigaciones sobre el valor alimenticio de la yuca para los animales. México, Instituto Nacional de Investigaciones Pecuarias. Departamento de Divulgación Técnica, 1973? pp.58-63. Span., Sum. Span., Engl., 10 Refs.

Reprinted from: Técnica Pecuaria en México no. 25:58-63. 1973.

Cassava. Swine. Chicks. Cassava meal. Nutritive value. Feed constituents. Rice. Finishing. Proteins. Diets. Composition. Food energy. Mineral deficiencies. Fattening. Animal nutrition. México.

Two experiments were conducted to determine the nutritive value of a cassava meal-rice polishings (CR) mixture to replace corn in rations for broiler chicks and growing-finishing swine. In the case of broilers, the partial (50%) or total substitution of corn did not significantly affect weight gain; however, both feed consumption and feed| gain ratio were linearly ($P<0.01$) increased, probably due to the lower metabolizable energy of CR as compared to corn (3.02 vs. 3.37 Kcal| g, respectively). The pig study was divided in growing and finishing periods. In the first, the level of substitution (0, 50 or 100%) of CR for corn did not affect performance ($P<0.05$). For the finishing pig, the 50% substitution resulted in the best performance; total substitution depressed both growth and feed utilization ($P<0.01$). Carcass characteristics were not affected by the type of energy feed used. The melting point of back fat and kidney fat was not affected by the treatments ($P<0.05$). *(Author's summary)* H03

1362-2174 BORGET, M. **Alimentaction du bétail à partir d'aliments produits localement dans les D.O.M.** *(Livestock feeding based on foodstuffs native to French overseas territories).* Paris, Sous-Commision de L'Agriculture de la Pêche et des Forêts, 1965. 28p. Fr., Sum. Fr.

Cassava. Animal nutrition. Nutritive value.

A report is given on the foodstuffs, native to the French overseas territories, used for livestock feeding. There are 2 sections: (1) study of natural and cultivated pastures and their possible improvement and (2) products used for human consumption as well as for animal foodstuffs (cereals, tubers, fruit and grains). Cassava (both sweet and bitter) is one of the tubers studied. Its cultivation (for human consumption) in the West Indies is decreasing; consequently, its price is rising. Cassava's value as a forage is 0.90-0.93 FU| kg DM, corresponding to 0.17-0.20 FU| kg fresh matter. The digestible protein content is low 20-25 g| kg DM. Yields of sweet cassava range from 15-20 tons| ha in 6-8 mo in rich soils, but may be as low as 5-6 tons| ha in poor soils. Bitter cassava yields are higher, but its use in animal nutrition is quite limited. *(Summary by S.S. de S.)* H03

1363-4642 HUTAGALUNG, R. I. **Nutritive value of leaf meal, tapioca root meal, normal maize, opque-2 maize and pineapple bran for pigs and poultry.** n. i. 1972. 8p. Engl., Sum. Engl.

Paper presented at the Conference and Annual General Meeting of the Malaysian Veterinary Association, 17th, Faculty of Agriculture, University of Malaya, 1972.

Cassava. Cassava meal. Brans. Nutritive value. Maize. Food energy. Proteins. Feed constituents. Leaves. Composition. Swine. Poultry. Malaysia.

The nutritive value, proximate nutrient composition and amino acid analysis of the cassava leaf, and root, normal maize, opaque-2 and pineapple bran are given. It was found that cassava meal and pineapple bran are mainly sources of carbohydrates (energy) unless they are enriched with other essential nutrients through inexpensive processing methods. Cassava leaves provide vegetable protein that could be incorporated in livestock feeding to balance the carbohydrates contained in the cassava roots and the pineapple bran. Opaque-2 maize contains higher protein and amino acids (lysine and tryptophan) than normal maize and it supplies greater energy and more balanced proteins than normal maize, cassava roots and pineapple bran. In general, however, only small differences in the content of energy, protein and minerals of these locally grown feedstuffs were found, when compared on a qualitative rather than on a yield basis to those grown abroad. The use of local sources as feedstuffs make satisfactory diets, provided possible imbalances are recognized. Since these feeds are abundant in the tropical regions, it is felt that they can be used for poultry and pig production without competing with foods needed directly for human consumption. *(Author's summary)* H03

1364-1992 VALDIVIESO C., A. **Comparación entre la harina de yuca y el maíz en mezclas destetadoras para terneros.** *(Comparative study of cassava and corn meals as feed mixtures for weanling calves).* Tesis Mag. Agr. Turrialba, Costa Rica, IICA, 1958. 51p. Span., Sum. Span., Engl., 26 Refs.

Cassava. Cassava meal. Maize. Animal nutrition. Feeds and feeding. Domestic animals. Calves. Cattle. Dietary value. Feed mixtures. Feed constituents. Diets. Concentrates. Dry matter. Costs. Proteins. Digestibility. Economics.

The possibility of using corn and cassava meals as a basis for calf starters was studied. Ration I contained 34.5% cassava meal, 10% corn meal, and sesame oil cake as a protein supplement. Ration 2 contained 10.5% cassava meal and 36.8% corn meal. As they were born, 24 calves were assigned at random (7 females and 5 males| treatment). For statistical purposes, consumption records (from birth to 4 mo) were kept on whole milk, skim milk, calf starter, silage and concentrate. A randomized block design with sexes divided was used to analyze differences in weight; analysis for "t" was used for other comparisons. As regards consumption, differences were not statistically significant; nor were they significant for weight gains. Weight gains for heifer calves at 4 mo averaged 4 kg more than the Ragsdale standard for female Jersey cattle. Heifer calves receiving the cassava meal averaged 3.82 kg less than the Ragsdale standard. The average daily gain made by heifer calves was 0.442 kg, which was approx. equal to the Cornell standard of 0.438 kg and superior to the 0.378 kg gain of the Ragsdale standard. The average daily gain on cassava meal was 0.364 kg which was equal to the Ragsdale standard. Feed costs are given in detail. It was concluded that the starters had an equal value in calf management; the choice would depend upon the relative availability and price of corn and cassava meals. *(Summary by T.M.)* H03

1365-0599 TORRES, J. R. **Associação da raspa de mandioca e milho desintegrado no cresimento-engorda de suínos.** *(Association of cassava chips and corn in growing-finishing pigs).* Revista Ceres 10(59):392-401. 1958. Port., 9 Refs., Illus.

Cassava. Maize. Feeds and feeding. Diets. Swine. Substitutes. Animal nutrition. Fattening. Finishing. Cassava chips. Domestic animals. Brazil.

An experiment was conducted with 18 Duroc and Mundi shoats to study the value of cassava as a substitute for corn. Ration 1 consisted of 50% basic ration and 50% corn; ration 2, 50% basic ration, 35% corn, 15% ground cassava; and ration 3.50% basic ration, 20% corn, 30% ground cassava. Daily weight gains on the 3 rations were as follows: 0.533, 0.616 and 0.485 kg, respectively. Differences in feed consumption were not statistically significant. Ratios between feedstuffs consumed and weight gained were similar for all treatments. If the prices is convenient, ground cassava can replace corn partially or totally. Total substitution is recommended when the farmer wants to prolong the fattening period to obtain a higher market price later. *(Summary by S.S. de S.)* H03

1366-4465 TELENI, E. **Pig feeding studies 1968-1972.** Fiji Agricultural Journal 34:81-83. 1972. Engl., Sum. Engl., 7 Refs.

Cassava. Tubers. Swine. Digestibility. Animal nutrition. Feed constituents. Feeds and feeding. Costs. Fiji.

The profitability of a ration based on cassava and protein meal that was recommended with moderate commercial success in 1968 was reduced by increasing costs during 1969-70 so that by 1971 it was only marginally profitable even to up-country farmers with access to cheap cassava. Pork production failed to keep up with demands, causing imports to rise during this period. Variations in the protein component, chiefly methionine and lysine supplements, were studied. Results were inconclusive, but theoretical calculations suggest that the main defect of the ration was that cassava did not fill the animals' energy requirments; therefore, other high-quality energy sources will have to be used in combination with cassava. *(Author's summary)* H03

1367-0614 PEIXOTO, R. R. and ISLABAO, N. **Substituicao do milho ao nivel de 50%** farinha de mandioca na alimentação de suinos em crescimento e engorda. *(Replacement of corn at a 50%* level by cassava meal in the feeding of growing-fattening pigs). Brasil. Universidade Federal Rural do Rio Grande do Sul, Facultade de Agronomia "Eliseu Maciel". Boletim Tecnico no. 5. 1969. 20p. Port., Sum. Port., Engl., 14 Refs.

Cassava. Cassava meal. Maize. Animal nutrition. Substitutes. Fattening. Swine. Diets. Feeds and feeding. Brazil.

At the Facultade de Agronomia "Eliseu Maciel" in Pelotas (Brazil), 4 lots of Wessex Saddleback pigs (4 males and 8 females, 7-8 mo old, weighing 39 kg) were fed 2 experimental rations: A (corn + supplement) and B (50% corn + 50% cassava meal + protein supplement). At 95-100 kg, liveweight, animals were slaughtered to assess carcass quality. Group B took less time to gain 100 kg (103 vs. 113 days), consumed more ration daily (3.27 kg vs. 3.07 kg) and used the ration more efficiently (3.37:1 vs. 3.45:1). The authors think these favorable results are due to the greater quantity of meat and soybean meals consumed (100 g|day each), which modified the amino acid balance. Using cassava meal rather than corn has both nutritional and economic implications that must be taken into account since it is necessary to supplement the rations with products rich in protein. Carcass data were not considered conclusive be cause of the age of the animals at the begining of the experiment. *(Author's summary)* H03

1368-0771 MONTILLA, J. de J. **La raíz de yuca en la alimentación animal.** *(Cassava tubers for animal feeding).* Revista Protinal 18(3):120. 1971. Span.

Cassava. Cassava meal. Animal nutrition. Cattle. Chicks. Venezuela.

This article stresses the advantages of using cassava instead of corn for animal feeding. The Universidad Central de Venezuela (Maracay) has reported a local variety yielding 124.9 tons|ha of fresh roots. Young bulls fed rations containing 40% cassava meal rendered about 10 times more profit than those fed with corn meal. *(Summary by H.J.S.)* H03

1369-0059 FARELO DE RAMAS **e folhas de mandioca no alimentação animal.** *(Meal of cassava leaves and stalks in animal feeding).* Chácaras e Quintais 114(6):663-666. 1966. Port.

Cassava. Cassava meal. Leaves. Petioles. Animal nutrition. Composition. Cultivars. Protein content. Ash content. Fibre content. Fat content. Brazil.

Leaves and stalks of cassava are considered a good supplement for livestock feeding. Cassava leaves, as forage, are a good protein source (20% protein). The variety Guaxupe was analyzed at 4 months of age in 1956 and 1957 with the following results; 13.83% and 14.88% protein; 17.65% and 24.08% fiber; 5.57% and 8.63% ash; 3.17% and 4.43% fat. The drying of cassava leaves and stalks is discussed. Cultivation, size of cuttings and fertilizers are also mentioned. *(Summary by A.N.)* H03.

1370-1650 MONTILLA, J. J. **Uso de la yuca en la alimentación de aves, cerdos y vacunos.** *(The use of cassava in feeding poultry, swine and beef cattle). In* Seminario Nacional sobre Yuca, Tacarigua, Venezuela, 1973. Revista de la Facultad de Agronomía, Alcance no. 22:115-125. Span. 20 Refs.

Cassava. Animal nutrition. Feeds and feeding. Poultry. Swine. Cattle. Cassava meal. Dietary value. Venezuela.

In Venezuela it was found that the cereals used in the preparation of concentrated feedstuffs for domestic animals could be partially or totally replaced by meal made from cassava roots. A feeding trial using 3 rations containing different percentages of cereals and cassava meal was evaluated on the basis of weight gain and efficiency of feed utilization. Although the weight gains recorded were not quite as high as those obtained with the diet containing the highest percentage of cereals, the gains were more economicall at current commercial levels. The best ration is that which produces reasonably good weight gains and efficiency of feed utilization at the lowest cost. The results of the trials are given in table form. *(Summary by L.C. Trans. by T.M.)* H03

See also 0218 0369 0459 0556 1022 1376 1400 1522 1756 1773 1811 1818 1823 1825 1833 1862 1866 1867 1871 1883 H03

H04 HCN Toxicity and Detoxification (For HCN content, see C03)

1371-0753 WOOD, T. **The toxic and nutritional qualities of cassava.** West African Pharmacist 7(1):2-4. 1965. Engl., Sum. Engl., 33 Refs.

Cassava. Toxicity. HCN. Processing. Gari. Food products. Human nutrition. Nutritive value. Cyanides. Clinical manifestations. Human physiology. Africa.

Cassava is easily grown from cuttings and requires little cultivation. Since it may be left in the ground until required, it is a very convenient crop. In many parts of Africa, large quantities are consumed. It is mainly a source of carbohydrate and calories but can contribute useful amounts of calcium and vitamin C to the diet. Although toxic when raw, the traditional methods of processing usually reduce the HCN content to a safe level; however, the possibility of chronic toxic effects due to the consumption of cooked cassava and the ingestion of sublethal amounts of HCN over a long period is not to be ignored and requires further investigation. In this connection, recent work with rats has revealed that small doses of cyanide administered over a period of 22 weeks produced pathological changes in the central nervous system. The factors influencing the amount of glucoside in the tubers of the plant remain obscure. Further investigation of this problem at a more fundamental level may lead to a better understanding of these factors and closer control of the cyanogenic glucoside content. *(Author's summary)* H04 H01.

1372-4333 COUSINS, H. H. **Jamaica cassava; analysis of selected local varieties.** Bulletin of the Department of Agriculture (Jamaica) 1:130-134. 1903. Engl.

Cassava. Cultivars. Analysis. Toxicity. Sweet cassava. Bitter cassava. HCN. Jamaica.

An analysis is made of some typical varieties of cassava grown by small farmers in Jamaica. Fifteen months after planting, a laboratory analysis was made, the results of which are given in tables. It is suggested that root quality depends upon the soil and other growing conditions. The chemical analysis covers the following aspects: HCN content, moisture, total solids, glucose, sucrose, starch and glucose value. *Summary by L.C. Trans. by T.M.)* H04

1373-2362 RAZAFIMAHERY, R. **Glucosides cyanogénétiques; pois du cap, manioc et "Bononoka."** *(The cyanogentic glucosides of lima beans and cassava and the preparation of "Bononoka").* Bulletin de l'Academic Malgache 31:71-77. 1954. Fr., 10 Refs., Illus.

Cassava. Cyanogenic glycosides. Toxicity. HCN. Lima beans. Fermentation. Food products. Human nutrition. Tubers. Malagasy Republic. Detoxification processes.

This is a detailed study of the HCN content of lima beans *(Phaseolus lunatus)* and fresh cassava roots. As far as cassava is concerned, it is classified into three groups according to its degree of toxicity. It describes two methods for eliminating HCN and the preparation of "bononoka," a native food product in Madagascar, prepared from cassava root (preferably the bitter variety) by fermentation under running water, after which the roots are steamed. *(Summary by S.S. de S.)* H04

1374-0564 BECK, B. **Cassava production in West Africa.** Ibadan, 1971. 11p. Engl.

A paper presented at an Agricultural Research Seminar on Root and Tuber Crops at the Conference Centre of the University of Ibadan. February 1971.

Cassava. Cultivation. Human nutrition. HCN. Toxicity. Detoxification processes. Pressing. Detoxification. Kenya.

Notes are given on the introduction of cassava into Africa, as well as on the development of cassava food products and cassava cultivation. Repatriated slaves modified the efficient Amerindian process for the extraction of the juice by using jute bags and squeezing out the liquor with the use of heavy stones and logs. Bitter and sweet cassava are discussed. *(Summary by H.J.S.)* H04

1375-0975 BOLHUIS, G. G. **The toxicity of cassava roots.** Netherlands Journal of Agricultural Science 2(3):176-185. 1954. Engl., 15 Refs.

Cassava. Toxicity. Tubers. Linamarin. HCN. K. N. Metabolism. Planting. Colchicine. Shoots. Climatic requirements. Soil fertility. Timing. Clones.

Toxicity in cassava roots is generally agreed to be due to the presence of the glucoside linamarin which may liberate HCN. As a rule, no sharp definition is given of bitter and sweet cassava. Expression of the degree of toxicity in mg of HCN| kg of fresh root will greatly facilitate the comparison of data. It has been proved that toxicity is influenced by both internal and external factors. *(Summary by Tropical Abstracts)* H04

1376-0847 JALALUDIN, S. and YIN, O.S. **Hydrocyanic acid (HCN) tolerance of the hen.** Malayan Agricultural Research 1:2. 1972. Engl.

Cassava. Proteins. Animal nutrition. Dietary value. Animal physiology. HCN. Toxicology. Linamarin. Roots. Leaves. Poultry. Domestic animals. Feeds and feeding. Malaysia.

In an attempt to reduce production costs, cassava roots and leaves are being fed to poultry. The cassava leaf, in particular, contains a very high proportion of HCN. HCN is present in the cells of the root and leaf in a combined form (linamarin). It is released after harvesting, in the presence of the enzyme linamarase. The crude protein content of the cassava leaf is high. It is considered unlikely that all the N present is available to poultry since a substantial proportion is derived from the HCN constituent. Not only is the N from HCN unavailable but also the presence of HCN renders the diet toxic. It is estimated that the leaf contains 25% crude protein (N X 6.25) including 0.054% of HCN on a dry matter basis. This is the equivalent of 162 mg| kg fresh weight of cassava leaves. The minimum lethal dose of HCN for human adults is 60 mg; the lethal dose for poultry is yet unknown. In an experiment to study the utilization of cassava leaf protein, the authors found that hens were able to tolerate an HCN level as high as 135 mg| kg feed. Hens whose protein content in the diet was replaced with 6.25% equivalent in cassava leaves consumed, on the average, 88 mg of feed daily containing 11.9 mg of HCN. This amount is almost 20% of the lethal dose for human adults. Bearing in mind that the average weight of hens is below 2 kg, it is clear that tolerance for HCN is greater than that of human adults. The role of HCN in relation to production is unclear, judging from the present findings. *(Full text)* H04 H03

1377-2367 NORMANHA, E.S. **Toda mandioca tem veneno.** *(All cassavas contain poison).* Coopercotia 26(234):24-25. 1969. Port., Illus.

Cassava. HCN content. Toxicity. Palatability. Composition.

In Brazil, great differences were found in the toxicity of cassava (**Manihot spp.**); none of the examined varieties was totally free from poison. The variation was not only genetic but also due to growing conditions, such as soil humidity, K content of soil, altitude and planting system. Sweet cassava *(M. palmata)* does not usually contain more than 5 mg HCN|100 g of pulp, whereas bitter cassava *(M. esculenta)* contains more than 10 mg and sometimes as much as 50 mg| 100 g of pulp. The minimum lethal dose of HCN for men and animals is about 1 mg| kg of liveweight. The poison is a component of the plant's latex and is consequently found in all the plant's tissues. *(Summary by Tropical Abstracts)* H04 C03

1378-4346 QUEIER, H. **Todliche Blausaurevergiftungen durch Genuss susser Cassava** ***(Manihot aipi).*** *(Fatal hydrocyanic acid poisoning from eating sweet cassava).* Deutsche Gesundheitwesen 21:726-728. 1966. Germ., Sum. Germ., Russ., Engl., 19 Refs.

Cassava. Sweet cassava. Human nutrition. Human health. Toxicity. HCN.

From the East African Isle of Pemba, 2 lethal cases of HCN poisoning following the eating of sweet cassava *(Manihot aipi)* are reported. Both cases have been confirmed by autopsy findings and chemical tests. As has been revealed by a respective inquiry, the toxicity of the cassava tubers, a basic food for millions of people in tropical countries, is not known to the inhabitants of the above island. Such fatal accidents will not occur in the future if the population is sufficiently enlightened on this danger of intoxication and its prevention through the adequate preparation of the cassava tubers for the daily meals. *(Author's summary)* H04

1379-3395 COURSEY, D. G. **Cassava as food; toxicity and technology.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 27-36. Engl., Sum. Engl., Fr., 62 Refs.

Cassava. Toxicity. HCN. Linamarin. Linamarase. Cultivars. Cassava products. Cyanogen. Enzymes. Hydrolysis. Detoxification. Ecology. Taxonomy. Human nutrition. Processing. Human health. Cyanogenic glycosides.

The toxicity of cassava (**Manihot** spp.) is caused by the presence of the cyanogenic glycoside linamarin, together with much smaller amounts of the closely related lot-australin. These substances hydrolyze under the influence of the endogenous enzyme linamarase to liberate HCN. The quantities of toxic principle vary greatly among cultivars; and although the so-called sweet cultivars are generally of lower toxicity than the bitter ones, the correlation is not exact. Cyanide levels cannot be related to formal botanical taxa. Some variation in cyanogen content with ecological conditions of plant growth also occurs. A wide variety of traditional food preparation techniques are used for processing cassava in different parts of the world; an important element in all of these is an attempt to reduce the cyanide content by liberating the HCN, either by solution in water or by volatilization. These processes involve maceration, soaking, boiling, roasting or fermentation of the cassava roots, or a combination of these processes. The amount of analytical data available on the efficacy of these processes is limited and generally unreliable. The greater part of the cyanide is normally liberated in such processes, but there are often substantial residual quantities which may well be sufficient to produce chronic toxic symptoms and occasionally even acute poisoning in those who consume large quantities of cassava products. Little reliable information is available as to whether linamarin itself constitutes a toxic factor or whether toxicity only arises from hydrolysis of this compound to free cyanide. *(Author's summary)* H04.

1380-3396 HILL, D. C. **Chronic cyanide toxicity in domestic animals.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 105-111. Engl., Sum. Engl., Fr., 68 Refs.

Cassava. HCN. Toxicity. Forage. Animal nutrition. Human health. Ataxic neuropathy. Rats. Thiocyanates. Detoxification. Edemic goitre. Diets. Clinical manifestations. Domestic animals. Cyanides.

Cases of acute cyanide poisoning are well authenticated in animals grazing on cyanogenic forages; but chronic toxicity from continuous intake of low levels of cyanogenic plant material, including cassava, has not been clearly identified. Although chronic HCN toxicity may be influenced by concomitant nutritional deficiencies, such toxicity does not appear to be a serious practical problem in the utilization of cassava or cassava products by domestic animals. There is evidence that ataxic neuropathy in humans is associated with high cassava consumption and that continuous low-level dosage of rats with potassium cyanide will produce lesions in the central nervous system. Such observations have a parallel in the toxic effect of lathrogens and other neurotoxins contained in plants. Some goiters in humans have been attributed to cassava consumption, and experiments with animals strongly suggest that thiocyanate formed during the detoxication of ingested cyanide interferes with the utilization of iodine for thyroxin production. There are interesting similarities between cyanogenic glucosides found in cassava and other plants and the glucosinolates found in **Brassica** species. The latter however, are the more complex compounds and can yield a greater variety of hydrolytic products. *(Author's summary)* H04

T

1381-3397 OKE, O. L. **The mode of cyanide detoxication.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 97-104. Engl., Sum. Engl., Fr., 58 Refs., Illus.

Cassava. Detoxification. Toxicology. Amino acids. Cystine. Endocrine disorders. Thiocyanates. Detoxification processes. Cyanocobalamin. Vitamin B12. Protein content. HCN absorption. Composition. Cyanides.

The mode of cyanide detoxication in the body is reviewed. The high amount of thiocyanate found in the urine, saliva and blood of people who eat a lot of cassava was due to the detoxication of the cyanide by the enzyme rhodanese, which through combination with thiosulfate of colloidal sulfur forms a polysulfide chain that can react with cyanide to release sulfur in a suitable form to give thiosulfate. This enzyme represents the chief site of detoxication and occurs in all parts of the body, with the largest concentration in the liver. Cyanocobalamin (vitamin B12) occurs in the liver to some extent as the hydroxocobalamin (vitamin B12), which is capable of reacting with cyanide to give cyanocobalamin and hence another important independent pathway for cyanide detoxication. Three-mercaptopyruvic acid, arising from cysteine by transamination or deamination can provide sulfur as rapidly as thiosulfate for cyanide detoxication. Cystine reacts with cyanide to form cysteine and B-thiocyanoalanine which tautomerizes to 2-aminothidizoline-4-carboxylic acid or its equivalent 2-imino-4-thiazolidine carboxylic acid, which is excreted. Finally the thyroid gland shows some detoxicating effect. In the presence of powdered sheep thyroid, the lethal dose of acetonitrite for mice was 1.4 mg|g whereas it was 0.32 mg|g for those not fed the powdered sheep thyroid. *(Author's summary)* H04 H02.

1382-3394 COCK, J. H. **Cyanide toxicity in relation to the cassava research program of CIAT in Colombia.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 37-40. Engl., Sum. Engl., Fr., 23 Refs.

Cassava. HCN. Toxicity. Research. Germplasm. Human nutrition. Animal nutrition. Cyanides. Cassava programs. Colombia.

Despite the fact that an estimated 8-10% of the global daily caloric needs of man are supplied by cassava, the crop has not been subjected to any concentrated research effort to advance the technology of its production. A serious shortage of calories in the tropics is noted; and in response to this need, CIAT has undertaken a full-scale program to develop cassava as an efficient producer of calories for human consumption, as well as for the growing animal feed and industrial starch markets. CIAT research concentrates on increasing yields, lowering production costs and developing simple storage and processing methods. The importance of cyanide toxicity is noted as it is CIAT's intention to screen its large germplasm collection for a cultivar with a zero or very low cyanide level. However, CIAT does not intend to carry out research to develop methods of detoxification. Relationships between cassava cyanide content and nitrogen fertilization are discussed, as well as the affinity of certain insect pests to secondary chemicals associated with the cyanide. *(Author's summary)* H04.

1383-0667 HORII, S., ABE, A. and MOTIMOTO, H. **Hydrocyanic acid content in cassava meal and its quantitative determination method.** Bulletin of the National Institute of Animal Industry 19:63-67. 1969. Jap., Sum. Jap., Engl., 9 Refs., Illus.

Cassava. Cassava meal. Processed products. Composition. HCN content. Analysis. Laboratory experiments.

An analysis was made of the HCN content of cassava meal produced in Thailand, which might be utilized as an energy source. Of the 9 samples of cassava meal tested the HCN contents were widely variable (14-107 ppm). A trend was observed that the HCN content of meal was lower than that of chips (14-65 ppm vs. 69-108 ppm). In the quantitative determination of HCN in cassava meal, the proper amount of a sample for testing was from 10 to 15 g since upon distilling the HCN, a large sample was apt to get remarkably pasty. It is recommended that hydrolysis should be conducted before distillation, adding 200 ml of distilled water of citrate buffer solution at 25° - 30°C for 2 hours. The detection method using Na picrate test paper for the rough screening of HCN content in cassava meal was tested; it wasfound that the sample, which developed reddish-brown color within 2 hours, might well be judged as containing 50 ppm or more of HCN. The methods of determination and the screening test are presented. *(Author's summary)* H04

1384-3393 SADKI and SANG, KI HAHN. **Cyanide toxicity and cassava research at the International Institute of Tropical Agriculture, Ibadan, Nigeria.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 41-42. Engl., Sum. Engl., Fr., 4 Refs.

Cassava. HCN. Toxicity. Entomology. Research. Cyanogenic glycosides.Injurious insects. Resistance.

Because of IITA's interest in cassava for human and livestock consumption, selection for acyanogenesis will be an important objective of the cassava breeding program. Selection for acyanogenesis will be based on finding cassava lines that lack the glucoside, glucosidase, and|or the glucoside and glucosidase. While stressing the importance of acyanogenesis, other important objectives of the program will be the retention of features such as resistance to insects and diseases in acyanogenic cassava plants. *(Author's summary)* H04

1385-0671 OKE, O. L. **The role of hydrocyanic acid in nutrition.** *In* Bourne, G. H., ed. World review of nutrition and dietetics. Basel, Switzerland, S. Karger, 1969. v.2. pp. 170-198. Engl., 167 Refs., Illus.

Cassava. Toxicology. HCN. Human nutrition. Human physiology. Toxicity. Detoxification.

Chemical characteristics of HCN are given. An ample review of literature on cyanogenesis in plants is presented. So far, only 12 cyanogenetic glucosides have been isolated. Methods for determining HCN by qualitative or quantitative analysis are discussed. Symptoms of toxicity in man and animals are described. Detoxification of cyanides was also studied; it was found that not all cyanide compounds are poisons. *(Summary by T.M.)* H04

1386-2387 MONTGOMERY, R.D. **The medical significance of cyanogen in plant foodstuffs.** American Journal of Clinical Nutrition 17:103-113. 1965. Engl., Sum. Engl., 93 Refs.

Cassava. Cyanides. Toxicity. Animal health. Human health. Detoxification. Human nutrition. Lima beans. HCN. Bitter cassava. Cyanogenic glycosides.

Several plant foodstuffs in common use, particularly in the tropics, contain cyanide, either in the form of glycosides or nitriles. Acute poisoning can occur, especially in conditions of economic stress; and there are cogent reasons for continuing to control the cyanide content of cultivated lima beans and to take precautions in the preparation of yams and cassava. Chronic ill effects from cyanogenic glycosides have not been demonstrated in man; but serious liver disease has been induced experimentally by glycosides of cycads, which have also been reported to cause hindquarter paralysis in livestock. Although there is little doubt that hydroxocobalamin plays a part in the detoxication of cyanide, suggestions that cobalamin deficiency and ingested cyanide may be related factors in the pathogenesis of tropical neurologic or ophthalmic disorders remain only plausible theories. For a more complete understanding of this subject, more work is needed in fields which involve the biochemist, agriculturalist and veterinary surgeon, as well as the epidemiologist and clinician. Such work is desirable in view of the increasing development of pulses as a source of dietary proteins. *(Author's summary)* H04

1387-0469 CHARAVANAPAVAN, C. **Studies in manioc and lima beans with special reference to their utilization as harmless food.** Tropical Agriculturist 100(3):164-168. 1944. Engl., Sum. Engl., 7 Refs.

Cassava. Lima-beans. Analysis. Cyanogenic glycosides.

The cyanogenetic glucoside in cassava and lima beans has been isolated and proven to be poisonous. Suitable methods have been worked out to reduce the cyanogenetic glucoside content to a safe limit. Methods are described for their utilization as harmless foods. *(Author's summary)* H04.

1388-3264 NORMANHA, E. S. **Analise de HCN em mandioca.** *(HCN analysis in cassava).* Ciencia e Cultura 17(2):197. 1965. Port., 1 Ref.

Cassava. Tubers. HCN. Detoxification processes. Boiling. Analysis.

HCN extraction from fresh cassava tubers increases as the maceration period increases. The bitter cassava variety, Branca de Santa Catarina, was tested; it was concluded that after 24 h of maceration and a satisfactory period of boiling, tubers can be used for cattle feed without danger of toxicity. *(Summary by H.J.S.)* H04.

1389-1722 FERNANDES, N. S., NAZARIO, W. and CAMARGO, W. V. DE A. *Manihot tripartita,* **nova espécie de mandioca tóxica para bovinos. Ocorrência clínica no município de Luciara (MT).** *(Manihot tripartita, a new species of cassava toxic to cattle; clinical occurrence in the municipality of Luciara (State of Mato Grosso).* Biológico 38(6):163-167. 1972. Port., Sum. Port., Engl., 10 Refs. Illus.

Manihot tripartita. **Toxicology. Animal physiology. Animal nutrition. Brazil.**

The authors reported bovine mortality in Luciara, state of Mato Grosso (Brazil), caused by ingestion of the native plant, *Manihot tripartita,* known as "mandioquinha do mato." This is the first time that this species is described as toxic, being responsible for bovine poisoning. The authors identified the active principle of the plant as cyanide and confirmed its nature by chemical and toxicological tests with the plant. They reproduced the poisoning in bovine experimentally and also performed the histopathological and differential diagnosis. *(Author's summary)* H04.

1390-0426 CLARK, A. **A preliminary note on the inhibitory effects of chronic poisoning by foods containing cyanic substances.** Journal of Tropical Medicine and Hygiene 42(5):65-72. 1939. Engl., 24 Refs., Illus.

Cassava. Feeds and feeding. Metabolism. Diets. Amino acids. Cystine. Laboratory animals. Swine. Human nutrition. Maize. Toxicology. Hepatic disorders. Clinical manifestations. Thiocyanates. Laboratory Experiments. Animal physiology. Human physiology. Cyanides. Animal nutrition. Nigeria. Egypt. Ghana. Africa.

This study attempts to clarify the more significant findings in cases of chronic poisoning by cyanogenic foods (cassava and maize) and to show their relationship to certain problems of tropical medicine, based on facts ascertained in Nigeria (1934-36), in Egypt (1937) and in the Gold Coast (1938). Human diets containing large quantities of cassava or maize produce a fatty, destructive degeneration, especially of the liver and the adrenals; the kidneys are affected to a lesser extent; in many cases a degeneration of the optic nerve especially in the temporal half, occurs. In Africans, steady diets of cassava and maize resulted in depigmentation, reduced cystine content in hair and nails, high thiocyanate content of the urine, and low blood glutathione. In experiments with rats fed cassava or fermented maize, crystals (apparently of amino acids) were almost constantly present in the serum of the blood. In a very severe case of human cassava poisoning with all the symptoms of pellagra, 220 mg| 100 g of amino acid N was found in the liver; and in two other cases 170 mg| 100 g was found. These amounts are comparable to those found in acute toxic necrosis of the liver. In omnivores, liver degeneration and the resultant metabolic disturbances, combined with adrenal damage and the effects of cyanic poisoning on the blood and nervous system, produced all the symptoms of pellagra. In rumiants, the liver is not injured to the same extent; the dermal and nervous structures are most affected. The digestive system is affected to a lesser degree (secondarily). Results of autopsies on pigs fed cassava and dry pea diets are presented. *(Summary by P.A.C.)* H04

1391-0457 ADRIAENS, E. L. **Note sur la toxicité et la préparation du manioc du Congo Belge.** *(Notes on the toxicity and preparation of cassava in the Belgian Congo).* Bulletin Agricole du Congo Belge 33(3):332-251. 1942. Fr., Sum. Fr., Dutch.

Cassava. Toxicity. HCN. Glucose. Gaplek. Processing. Molasses. Human nutrition. Detoxification. Detoxification processes. Food products. Dried tubers. Cassava meal. Cassava chips. Processed products. Marketing. Economics. Analysis. Biochemistry. Zaire.

The best methods of eliminating any serious danger due to the liberation of HCN from cassava are considered. Tests show that the best antidote to HCN is glucose. It is thought that difficulties will be avoided by treating the raw product properly before its arrival on the European market.A suitable method of preparing the roots in the form of chips or slices is described. *(Author's summary)* H04.

1392-0403 PANDEYA, R. S. **Cyanide toxicity in cassava, a review.** International Development Research Center, Cassava| Swine Advisory Committee. Working Paper no. 6. 1972. 16p. Engl.

Cassava. Toxicity. Linamarin. Lotaustralin. HCN. Detoxification. Cyanogenic glycosides. Cyanogenesis. Human physiology. Animal physiology. Plant physiology. Human nutrition. Animal nutrition.

A review of the literature on cyanide toxicity in cassava (*Manihot esculenta* Crantz) is presented. Topics include presence of cyanogenetic glucosides in crop plants including cassava; linamarin and lotaustralin in cassava; chemistry and biosynthesis of linamarin and lotaustralin; possible biosynthetic role of HCN liberated from linamarase action; distribution of glucoside throughout the plant organs and factors affecting the glucoside concentration; toxicity of HCN; cassava toxicity in man and in livestock. *(Summary by P.A.C.)* H04

1393-0435 PEREIRA, A. S., NERY, J. P. and IGUE, T. **Seleção de novos clones de mandioca para mesa, pela toxicidade e paladar de suas raizes "in natura".** *(Determination of new clones of edible cassava according to their toxicity and by tasting fresh roots).* Bragantia 24(10):55-58. 1965. Port., Sum. Engl., Illus.

Cassava. Selection. Clones. Toxicity. Tubers. Composition. HCN content. Human nutrition. Brazil.

Toxicity in cassava roots is caused by their HCN content. It is generally considered that 40 mg of this compound is enough to kill an adult human being. Before new or introduced cassava varieties are distributed to growers, it is necessary to determine whether or not they have a high HCN content. This determination is also of importance in the breeding program when it is necessary to select edible varieties of cassava. Results from flavor tests and chemical analyses indicated a strong correlation between bitter flavor of the fresh root and HCN content. Conversely, roots without the bitter taste had a low content of this toxic substance. The fresh root sampling test has been used successfully in the selection of new cassava varieties. *(Author's summary)* H04 C03

1394-3287 RIEDERS, F. **Noxious gases and vapors: carbon monoxide, cyanides, methemoglobin, and sulfhemoglobin.** *In* Drill's Pharmacology in Medicine. New York, McGraw-Hill, 1965. pp. 932-956. Engl., 294 Refs., Illus.

Cassava. HCN. HCN absorption. Detoxification. Toxicity.

Nearly 400 varieties of plants, encompassing some 150 species in over 40 families, contain cyanogenetic glucosides; cassava is included. In mammals, cyanide is also present, both as an intermediate of one-carbon metabolism and as a constituent of cyanocobalamin (vitamin B12) coordinated to the central cobalt atom. The concentrations in man are so low that they are not detected in normal toxicological analysis for forensic purposes. Data are given concerning physicochemical properties, mechanism of action, absorption and fate, toxic effects and treatment. *(Summary by H.J.S.)* H04

1395-3458 BETHLEM, M. L. B. **Sobre a suposta toxicidade da farinha de mesa e da farinha dágua.** *(On the presumed toxicity of cassava flours "farinha de mesa" and "farinha dágua").* Revista da Sociedade Brasileira de Quimica 19:141-144. 1950. Port., 15 Refs.

Cassava. Human nutrition. Processing. HCN. Cassava flour. Analysis. Toxicity. Brazil.

In drawing up an official list of toxic foods in Brazil, the different cassava flours were submitted to laboratory analyses to test the presence of cyanogenic glucosides. Results were negative for all methods used; therefore, the different flours are considered safe for human consumption. *(Summary by T.M.)* H04.

1396-3289 CLARK, A. **Report on the effects of certain poisons contained in food-plants of West Africa upon the health of the native races.** The Journal of Tropical Medicine and Hygiene 39(32):269-276; 39(24):285-292. 1936. Engl., Sum. Engl.

Cassava. Cocoyams. Human nutrition. Toxicity. HCN. Hepatic disorders. Human health. Nigeria.

The food plants commonly containing cyanic glucosides are enumerated, and the effects of these poisons on man and on experimental animals are described. The suggestion is made that pellagra and the pellagroid diseases are commonly produced by inhibition of the respiratory mechanism of the body through the action of cyanic substances. The association of albuminuria in southern Nigeria with the consumption of cocoyam and cassava is examined. The relationship of such foods to the occurrence of fatty liver is considered. Measures that might possibly ameliorate the conditions arising from the widespread intoxication by these foods are suggested. *(Author's summary)* H04 H02

1397-3199 VELDEN, M. VAN DER. *et al.* **A preliminary study on the action of cassava on thyroid iodine metabolism in rats.** British Journal of Nutrition 30(3):511-517. 1973. Engl., Sum. Engl., 20 Refs.

Cassava. ***Manihot esculenta.*** **Thiocyanates. Cyanides. Analysis. Iodine. Deficiency diseases. Diets. Rats. Animal health.**

The ingestion of cassava (*Manihot esculenta* Crantz) by rats increased the plasma thiocyanate concentration and reduced the thyroid iodine content and the plasma protein-bound iodine. Increasing doses intensified these effects. In producing these effects, the daily ingestion of 10 g cassava root containing 1.6 mg cyanide was approximately equivalent to a daily intake of about 1-2 mg thiocyanate. These results suggest that the antithyroid action of cassava is the result of the production of thiocyanate by the rat from cyanide arising from the cyanogenic glucosides present in this food. *(Author's summary)* H04

1398-5328 CLARK, A. **On the individual resistance of animals to the effects of poisonous food plants.** Journal of Tropical Medicine and hygiene 43:276-279. 1940.

Cassava. HCN. Toxicity. Animal physiology. Laboratory experiments.

Experiments studying poisons found in cassava, fermented maize, legumes and aroid tubers were carried ou on rats. Duration of life cycle on the toxic diet was taken as an index of resistance to the effects of chroni poisoning. Rats fed 7 varieties of cassavai failed to live their normal life span although "idiosyncratic' resistance was found in some individuals. *(Summary by T.M.)* H04

1399-4672 PIERIS, N., JANSZ, E. R. and KANDAGE, R. **Cyanogenic glucoside content of manioc. I An enzymic method of determination applied to processed manioc.** Journal of the National Scienc Council of Sri Lanka 2(1):67-76. 1974. Engl., Sum. Engl., 14 Refs.

Cassava. HCN content. Cyanogenic glycosides. Cyanides. Linamarase. Linamarin. Cassava chips. Cassav flour. Cassava starch. Analysis. Laboratory experiments. Biochemistry. Sri Lanka.

A method is described for determining the total cyanide content of cassava products. Exogenous linamaras has been used to hydrolyze the linamarin in the plant material. Enzyme activity, incubation time and volum of distillate have been varied so that maximum recovery of total cyanide was obtained. Recovery of addec HCN and linamarin from cassava substrate was found to be satisfactory. The method was applied tc determine the total cyanide content of boiled cassava, cassava flour and starch. On boiling raw cassava wa found to lose 2|3 to ½ of its total cyanide. Steeping with leaves prior to boiling did not alter these value significantly. It was found that while cassava starch contained only small quantities of total cyanide, cassav flour-unless specially processed to reduce cyanide content -contained 50-250 ppm total cyanide. *(Author's summary)* H04

1400-3412 MANER, J. H. and GOMEZ, G. **Implications of cyanide toxicity in animal feeding studies using high cassava rations.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Center, 1973. pp. 113-120. Engl., Sum. Engl., Fr., 15 Refs. Illus.

Cassava. Animal nutrition. Diets. Toxicity. HCN. Rats, Swine. Thiocyanates. Proteins. Endemic goitre. Feeds and feeding. Methionine. Cyanides

Studies on the chronic toxicity of cassava and| or added cyanide have been performed with rats and pigs. Methionine supplementation significantly improved body growth and feed conversion of animals fed cassava-based diets, with or without added cyanide, and led to an increased urinary excretion of thiocyanate. The improvement of the protein quality and the utilization of the methionine-sulfur in the detoxification processes appear to be the main reasons for the response to methionine supplementation. No gross thyroid lesions (goiter) have been observed on any of the rats fed either the control diet or cassava containing 150 mg| HCN| kg. A study on methionine and iodine interaction is under progress and partial results are presented. *(Author's summary)* H04 H03.

1401-2442 PHAM, H. D. **Contribution á l'étude de la valeur alimentaire et de la toxicité du manioc.** *(Contribution to the study of the food value and toxicity of cassava).* These. Doc. Vet. Lyon, France. Faculté de Médine et de Pharmacie de Lyon, 1962. 57p. (Ecole Nationale Véterinaire de Lyon, 1962 no. 1). Fr., Sum. Fr., 23 Refs.. Illus.

Cassava. ***Manihot esculenta.*** **Cassava flour. Composition. Cooking. Cassava tubers (vegetable). Gari. Cassava leaves (vegetable). Nutrient loss. Nutritive value. Digestibility. Toxicity. HCN content. Cyanogenesis. Detoxification processes. Drying. Storage. Protein content. Amino acids**

This thesis is divided into 3 parts: The first part deals with the botanical characteristics of the cassava plant, as well as brief notes on its cultivation and uses for animal and human nutrition. The second part deals with the chemical composition and the nutritive value of cassava tubers. The third part is devoted to HCN content and detoxification of the tubers. The author concludes that cassava is good for animal and human nutrition, provided it is not used as a unique source of food and that its toxicity can be controlled. *(Summary by H.J.S.)* H01 H04.

1402-3271 SHANK, R. C., WOUGAU, G. N. and GIBSON, J. B. **Dietary aflatoxins and human liver cancer. I. Toxigenic moulds in foods and foodstuffs of tropical South-east Asia.** Food and Cosmetics Toxicology 10(1):51-60. 1972. Engl., Sum. Engl., 16 Refs.

Cassava. Tubers. Cassava starch. Rice. Groundnut. Maize. Cereals. Moulds. Human nutrition. Storage. Aspergillus. Rhizopus. Deterioration.

As the initial phase of a survey to evaluate the relationship between dietary loads of aflatoxin and the incidence of liver cancer in Southeast Asia, this study demonstrated the distribution of molds in foods from Thailand and Hong Kong and distinguished those capable of mycotoxin production. Mycological studies of more than 3,000 food samples (including fresh cassava tubers can cassava starch) showed **Aspergillus** to be the commonest contaminating fungus, *Aspergillus flavus* being the predominating species. Other fungi included species of **Penicillium, Fusarium** and **Rhizopus.** Bioassays evaluating acute and subacute toxicity in rats identified the infecting agents capable of producing mycotoxins other than aflatoxins. Among 162 isolates, 49 proved to be toxigenic; these included species of all the general commonly identified in food samples. *(Author's summary)* H04

1403-1681 CANELLA, C.F.C., DÖBEREINER, J. and TOKARNIA, C.H. **Intoxicação experimental pela "maniçobá", *Manihot glaziovii* Muell. Arg., em bovinos.** *(Experiment to determine the toxic effects of the "manicoba" tree, Manihot glaziovii Muell Arg., in cattle).* Pesquisa Agropecuaria Brasileira. Série Veterinária 3:347-350. 1968. Port., Sum. Port., Engl., 3 Refs., Illus.

***Manihot glaziovii.* Toxicity. HCN absorption. Animal physiology. Cattle. Brazil**

Experiments were carried out in Campo Maior, state of Piauí, in which 125, 250 and 500 g of fresh shoots of the "maniçoba" tree (*Manihot glaziovii* Muell. Arg.) were fed to bovines weighing about 100 kg each. These shoots gave a strong positive reaction in tests for HCN. The animal that received the smallest amount of shoots did not show any symptoms, but the other 2 died from acute poisoning. Cattle mortalities occur in this area after the first rains at the beginning of the rainy season (Oct-Dec); these are said to be due to ingestion of "wilted leaves" from this tree. A dry period lasting days or weeks often follows, during which time most of the vegetation wilts. Based on the history of the disease and on their own experiments, the authors conclude that the shoots of *M. glaziovii* are indeed responsible for these mortalities among cattle. *(Author's summary)* H04.

1404 0425 GONSALVES, P. E., GRINBERG, M. and SOUZA E SILVA, O.R. DE. **Intoxicação por cianeto, mandioca brava, em pediatria.** *(Cyanide intoxication due to wild cassava, in pediatrics).* Revista do Hospital das Clinicas 11(4): 265-271. 1956. Port., Sum. Port., Engl., 15 Refs.

Cassava. Toxicity. Human nutrition. Toxicology. HCN. Cyanides. Human physiology. Human health. Clinical manifestations. Brazil.

The authors carried out a study of cyanide intoxication in children; in Brazil this is mostly due to intake of wild cassava (*Manihot utilissima* Pohl). The paucity of papers on the subject in Brazilian medical literature is stressed. Pharmacological effects of cassava and cyanides in general are discussed in addition to the symptons of 3 types of intoxication (highly acute, acute and chronic) and treatment recommended. Six cases are reported which had been admitted to the Pediatric Clinic (emergency ward) during a five-month period. *(Author's summary)* H04

See also 0145 0179 0184 0205 0330 1035 1054 1125 1167 1168 1195 1232 1259 1268 1273 1401 1766 1788 H04

1405-0010 MEYER, K. H. and SETTELE, W. **Amidon. LII. sur L'inhomogénéité des amylopectines de tapioca et de waxy maize.** *(Starch. LII. The nonhomogeneity of the amylopectins of tapioca and waxy maize).* Helvetica Chimica Acta 46(25-26):197-204. 1953. Fr., Sum. Engl., 32 Refs.

Cassava. Cassava starch. Analysis. Maize. Laboratory experiments. Viscosity.

Low molecular weight fractions have been obtained from waxy maize and tapioca amylopectins. By B-amylolytic degradation and periodate oxidation, the mean length of inner and outer chains of the different amylopectins have been determined. In the case of waxy maize, the outer chain length increases (from 9 to 17 residues of glucose) with the molecular weight of the fraction, whereas the length of the inner chains remains more or less constant (7.5 ± 1.5). Viscosimetric curves of the triacetates of waxy maize amylopectins of low fractions are quite similar to those obtained with amylose-triacetates. *(Author's summary)* 101

1406-0033 HELLMAN, N.N. and MELVIN, E. H. **Surface area of starch and its role in water absortion.** Journal of the American Chemical Society 72(11): 5186-5188. 1950. Engl., Sum. Engl.

Cassava. Cassava starch. Water absorption. Absorption. N. Analysis. USA.

The surface area of dasheen, corn, tapioca and potato starches available to N at —195° was found to be 2.62, 0.70, 0.28 and 0.11 m²| g, respectively. Interpretation of the water-sorption isotherms of these 4 starches by the BET equation requires surface areas of 330, 334, 348 and 442 m²| g, respectively. It was concluded that the nitrogen-available surface area of starch does not give a quantitative explanation of the water-sorptive capacity of starches of different botanical origins. The apparent external surface area of these starches was also determined photomicrographically and found to be in close agreement with the nitrogen-available surface area. *(Author's summary)* 101

1407-0031 VISWANATHAN, P.N. and KRISHNAN, P.S. **Metabolic activity of starch granules from the tapioca plant. II. Functional activity of starch granules from tuber.** Indian Journal of Biochemistry 2 (2): 69-72. 1965. Engl., Sum. Engl., 10 Refs.

Cassava. Cassava starch. Tubers. Analysis. Biochemistry. Metabolism. Laboratory experiments. Research. Proteins. India.

Starch granules from the cassava tuber isolated in a mannitol (or sucrose) medium, permits the study of endogenous reactions leading to starch formation. In addition to starch, the granules contain protein and considerable quantities of sucrose and reducing sugar, part of which is fructose. Orthophosphorus and esterified phosphorus are also present but in much smaller quantities. Starch formation in the granules occurs in the absence of external supplements; however, the amount is considerably increased in the presence of certain nucleotide derivatives and sucrose or fructose. The transformation of externally added UDPG exceeds 100% under some conditions, pointing to a recycling. During the formation of starch, there is utilization of endogenous sucrose and partial accumulation of fructose. *(Author's summary)* 101

1408-2370 MERLINI, A. **L'agar tapioca per la coltura di alcuni microrganismi patogeni.** *(Cassava agar for the culture of some pathogenic microorganisms).* Pathologica 18(416):321-322. 1926. Ital., 12 Refs.

Cassava. Composition. Laboratory experiments. Uses. Culture media. Cassava starch.

This briefly describes a culture medium based on agar (2 parts), cassava starch (1 part) and broth (100 c c). The medium is good for the culture of some microorganisms, which showed need for special media. *(Summary by H.J.S.)* 101

1409-0001 WURZBURG, O. B. **Root starches other than those of white and sweet potato.** Economic Botany 6(3):211-215. 1952. Engl., Sum. Engl.

Cassava. Cassava starch. Processing. Uses. Dextrins. Marketing. Trade. Economics. U S A.

The root starches discussed are not produced in the United States, but are imported. Tapioca, from cassava roots, constitutes about 86% of these and is particularly valued in the food and adhesive industries. Sago, from the pith of palm trees and cycads, is used primarily as an adhesive; arrowroot, from a rhizome, is used as a food starch. *(Author's summary)* 101 102.

1410-0140 JARAMILLO M., G. **La yuca como materia prima en la pequeña industria.** *(Cassava as a raw material in small industry).* Revista Nacional de Agricultura (Colombia) 38(479):29-30. 1944. Span.

Cassava. Cassava starch. Dextrins. Glucose. Processing. Colombia.

This gives brief information on the production of starch, dextrins and glucose. *(Summary by A. N.)* 101 102.

1411-2327 MARAVALHAS, N. **Alteração na estructura do amido das farinhas de mandioca.** *(Alteration in the structure of starch from cassava meals). In* ———— Cinco estudios sôbre a farinha de mandioca. Brasil. Instituto Nacional de Pesquisas da Amazonia. Publicação no. 6. 1964. pp. 15-22. Port., Sum. Port., Engl., 9 Refs.

Cassava. Analysis. Cassava starch. Brazil.

Studying the degree of polymerization (DP) by Meyer's method and determining the yields of amylose in cassava products (meal from the Amazon Valley), the author arrives at the conclusion that in the empirical process of its preparation, a substantial alteration in the structure of the original starch occurs. Both amylopectin and amylose are modified substantially. In comparing data from Diemair and Hufnagel on studies of dried potato products, he concludes that the amylopectin fraction from cassava is more resistant to thermal treatment than a respective fraction from potatoes. Cassava amylose appears to be more susceptible. *(Autor's summary) 101*

1412-2381 RESENTHAL, F. R. T. *et al.* **Amidos da mandioca. I. Características dos grânulos de 11 variedades procedentes do estado de Minas Gerais.** *(Cassava starch. I. Characteristics of granules of 11 varieties from the state of Minas Gerais).* Anais da Academia Brasileira de Ciencias 44(1):55-60. 1972. Port., Sum. Port., Engl., 9 Refs.

Cassava. Cassava starch. Cultivars. Analysis. Gelatinization. Temperature. Processing. Composition. Laboratory experiments. Particle size. Brazil.

The starches of the 11 varieties of cassava present granules of several shapes; the most common and found in all varieties were the **cupuliform**, the **biconcave-convex** and the **rounded** ones. The **mitriform**, **sacciform**, **polygonal** and **faceted** granules appeared irregularly and were not characteristic. The greatest diversification in shape was observed in the CN-15: Riqueza variety. Striation was light and the polarization crosses were very clear, some centered and others excentric; some granules were fissured. The largest granules were between 18-26μ in length and 16-22μ in width whereas the smallest ones were between 3-10μ in length and 3-10μ in width. All starches were weakly anionic, and the values found for the gelatinization temperature were very similar. Initial temperature ranged from 53°C to 56°C and final temperatures, from 61°C to 63°C. The ash, fat, phosphorus and protein contents were within the normal range. The iodine affinity in these starches varied from 3.1 to 3.5, which corresponds to an amylose content of approximately 15.3 and 17.5%. *(Author's summay)* 101

1413-2138 EVERINGTON, E. **Cassava starch and its uses.** West Indian bulletin 12:527-529. 1912. Engl.

Cassava. Uses. Dextrins. Industrialization. Processing. Factories. Cassava starch. Glucose.

A brief review of cassava growing is given. Average yields were 8 ton|ha. Cassava starch has a great advantage in the entire manufacturing process for the complete extraction of starch. From the time roots are placed in the factory, it takes only three days for the products to reach the market. The process for the manufacture of cassava starch, dextrin and glucose is discussed including examples of their use. *(Summary by J.L.S.) 101*

1414-0893 SCHALLER, R. VON. **Entwicklung und derzeitiger Stand der tapioca Starke-Industrie in Thailand.** *(The present and future of the cassava starch industry in Thailand).* Starke 9(7):132-133. 1957. Germ., Sum. Germ., Engl., Illus.

Cassava. Processing. Cassava starch. Industrialization. Trade. Marketing. Economics. Factories. Thailand.

Cassava starch production in Thailand has developed from tiny, handmade, manual makeshifts into a well-established industry, which apart from domestic consumption exported about 40,000 tons in 1956. The industry is at present in a critical situation. Changes for the better depend on the introduction of better, more economical equipment and processing methods, as well as the use of fertilizers and methods for general improvement of soils. *(Author's summary)* 101 J00

1415-0462 CHIRIFE, J. and CACHERO, R.A. **Through-circulation drying of tapioca root.** Journal of Food Science 35(4):364-368. 1970. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Tubers. Drying. Industrial machinery. Research. Laboratory experiments. Analysis. Industrialization. Argentina.

The drying characteristics of freshly harvested cassava root (*Manihot utilissima* Pohl) from Posadas (Argentina) have been investigated in a laboratory through-circulation dryer. Variables studied were bed depth (2-12 cm), air velocity (2,300-5,200 kg| h | m²), and air temperature (55-100°C). Static pressure drops of air passing through beds of dried and wet slices were also investigated. Straight lines are obtained by plotting the nondimensional moisture content (W-We)|(Wo-We) against time on semilogarithmic paper. This indicated that a diffusional mechanism controls the drying rate. Factors to be considered in the design of a continuous, through-circulation dryer are given. *(Author's summary)* 101.
Tarj. Nº 193

1416-0921 SUBRAHMANYAN, V. *et al.* **Variation in the chemical composition of sago prepared commercially out of tapioca starch and proposed specification for the product.** Bulletin. Central Food Technological Research Institute (India) 5(4):77-80. 1956. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. pH. Cassava starch. Composition. Analysis. Water content. Ash content. N. Fiber content. Tapiocas. Nutrient loss. India.

Twenty-one samples of sago prepared from cassava starch were obtained from different sago factories at Salem, Madras State, and were analyzed for the following constituents: moisture, total and acid-insoluble ash, nitrogen, colored impurities, pulp and fibrous material, and acidity. Based on the data obtained, the following standards have been suggested for this product: moisture (max. 12.5%), total ash (max. 0.35%);

acid-insoluble ash (max. 0.10%); nitrogen (max. 0.025%); colored impurities (color of sago powder gelatinized with dilute NaOH (max. 1 R + 3 Y Lovibond units); pulp and fibrous material (max. 5%); pH of aqueous extract range (4.0-7.0); loss of solids during cooking (max. 25%). *(Author's summary)* 101

1417-0788 SOLIVEN, F. A. and BONECILIO, E. **A preliminary report on the effect of pH on the rate of settling of cassava starch in aqueous suspension.** Philippine Journal of Science 88(1):103-117. 1959. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. pH. Cassava starch. Water requirements (processing). Silting. Laboratory experiments. Timing. Processing. Philippines.

The results provide evidence of the influence of the hydrogen ion concentration of the medium in which the starch granules are suspended on the rate of settling of cassava starch. The conclusions are as follows: (1) At a pH range of 1.9-2.1, the starch in a slurry containing 0.0366 g| cm³ may be completely settled in 12-14 min, and the rate of settling decreases as the pH is increased or decreased. (2) At a constant pH (2.0), the rate of settling of cassava starch is also influenced by the amount of starch per unit volume, the more concentrated it is, the slower is the rate of settling. The concentration of cassava starch for rapid settling should be no greater than 0.06. *(Author's summary)* 101

1418-0874 SUBBRAHMANYAN, V. *et al.* **Recovery of starch from tapioca "fibre".** Bulletin. Central Food Technological Research Institute (India) 1956:80-81. Engl., 4 Refs.

Cassava. Wastes. Industrialization. Uses. Animal nutrition. Cassava starch. Waste utilization. Composition. India.

The fiber, considered a waste product in the process of starch manufacture, is presently used for cattle feed or fuel. A sample of cassava fiber obtained from a sago factory in Salem (southern India) was analyzed for its constituents according to the methods of the AOAC. Results show that cassava fiber, as obtained during the manufacture of starch from fresh roots, contains a high percentage of starch which is presumably present in the intact cells not ruptured in the rasping process. A short description of the process of starch recovery from these fibers is included. The average yield of starch as determined by 4 experiments was about 25% of the weight of the fiber; yields ranged from 22 to 28%. Results showed that fiber starch is sufficiently pure for use in the manufacture of sago and other industrial uses. *(Summary by J.L.S.)* 101 102

1419-0973 FAVIER, J. C. **Les amylaces du Cameroun; I. etude de la digestibilité "in vitro" de l'amidon de diverses plantes alimentaires du Sud-Cameroun. Influence des transformations technologiques sur l'amidon de manioc.** *(The starch crops of Cameroon. I. Digestibility in vitro of the starch of several food plants in southern Cameroon. Effect of processing on cassava starch).* Industries Alimentaires et Agricoles 86(1):9-13. 1969. Fr., 7 Refs., Illus.

Cassava. Processing. Food products. Gari. Fermentation. Hydrolysis. Sugars. Maltose. Glucose. Drying. Temperature. Leaves. Tubers. *Solanum tuberosum.* **Colocasia. Cassava starch. Animal nutrition. Cassava pastes. Human nutrition. Maize. Sweet-potatoes. Yams. Bananas. Banana-Plantains. Soluble carbohydrates. Digestibility. Africa. Cameroon.**

Digestibility of raw starch from food plants in southern Cameroon was estimated with bacterial amylase. From graphs, maize gave nearly 200 mg reducing sugars as maltose| g starch at 17 h incubation; cassava 150 mg at 24 h; breadfruit *(Artocarpus communis apyrena)* about 60 mg, though its valu were scattered: sweet potatoes, potatoes, Xantosoma, Colocasia and yam gave less and plantain the least (about 10 mg at 24 h). For cassava, starch from the fresh tuber gave nearly 150 mg, from the sun-dried or smoke-dried flour 75, from the rasped pulp rolled into sticks inside a banana leaf and cooked, 400 or 650, from pulp fermented for making gari 100 and from gari dried on metal sheets 600 or 700 mg at about 24 h. Heating increased digestibility of the starch; fermentation did not. It might be better to cook the plantains and tubers that are given to animals. *(Summary by Nutrition Abstracts and Reviews)* 101 H01

1420-0992 SAMSON, G. D. **Liquid glucose from cassava starch.** Acta Médica Philippina 8:43-48. 1951 Engl., 10 Refs.

Cassava. Industrial starches. Uses. Glucose. Industrialization. Glucose industry. Philippines.

The product obtained was a thick straw-colored, syrup with a sweet taste, conforming to the requirements of the United States Pharmacopoeia for liquid glucose. A description is given of the methods followed and characteristics of the product. *(Summary by H.J.S.)* 101

1421-3808 CAMPBELL, H. A., HOLLIS JUNIOR, F. and MacALLISTER, R. V. **Improved method for evaluating starch for specific uses.** Food Technology (USA) 4(12):492-496. 1950. Engl., Sum. Engl. Illus.

Cassava. Cassava starch. Enzymes. Analysis. Industrial starches. Viscosity. USA.

Procedures for the evaluation of starches intended for specific industrial processes are outlined. These procedures are based upon the flow characteristics of slurries of ungelatinized starch, changes which take place in the viscosity and microscopic appearance of starch slurries during a heating cycle, and the susceptibility of starches to amylase action at relatively low temperatures. The interpretation of these measurements and observations, as applied to starches intended for specific uses, is discussed. *(Author's summary)* 101

1422-3434 TO-TAM, N., MASLOVA, G. M. and TREGUBOV, N. N. **O nekotorykh fiziko-khimicheskikh svoistvakh krakhmala is manioka.** *(Some physicochemical properties of cassava starch).* Izvestiya Visshikh Uchebnykh Zavedenii Pischevaya Tekhnologiya no. 5:35-38. 1969. Russ., Sum. Russ., Refs., Illus.

Cassava. Cassava starch. Particle size. Gelatinization. Temperature. Analysis.

The size of cassava starch grains varies from 1.5-30 μ; most of them are 6-12 μ and are similar in shape to potato starch grains. Large manioc starch grains differ from large potato starch grains in the density of the grains in the center and along the edges. The temperature interval of the gelatinizing of cassava starch, obtained during a study of its individual fractions, was 51-79°C. This can be explained by the wide range of variation in the size and shape of cassava starch grains. *(Summary by Biological Abstracts).* 101
Tarj. Nº 370

1423-1672 BANZON, J., FULMER, E. I. and UNDERKOFLER, L. A. **Fermentative utilization of cassava. The production of ethanol.** Iowa State College Journal of Science 23:219-235. 1949. Engl., 29 Refs., Illus

Cassava. Ethanol. Alcohol. Fermented products. Cassava starch. Analysis. Processing. Fermentation. Moulds. Temperature. Industrial microbiology. Philippines.

Cassava roots contain 20-30% starch and should be a cheap source of alcohol. Acid hydrolysis produces as high as 98.8% of the theoretical amount of reducing sugars, calculated as dextrose. When mashed and fermented with yeast, the highest yield of EtOH, was 69% of the theoretical amount; there was no correlation between the amount of sugars present and the alcohol produced. Substitution of mold bran for yeast raised the yield of alcohol to 76.4-79.2%. Cooked cassava pastes set to almost solid gels on cooling. It is almost impossible to mix amylolytic agents into the cooled cooked starch, and retrogradation occurs. Satisfactory thinning can be accomplished by means of H_2SO_4 using (g of sample): (cc of acid) = 1:3 for 0.1 N; 1:2 for 0.2 N; 1:5 for 0.4 N; and 1:1 for 0.8 N. The acid must be neutralized subsequently in acid-resistant equipment. Liquefaction may be secured by mold bran, malt, or an enzyme preparation (Rapidase 10X). Part of the amylolytic material is added for liquefaction at 70° and the remainder at 30°. For malt and mold bran, the best division is 3% (of the weight of cassava flour) for thinner and 7% for saccharification. Rapidase 0.1% was also satisfactory for thinning. Ground cassava and presumably the undried roots are a promising source of starch for conversion to alcohol with ordinary equipment. *(Summary by Chemical Abstracts).* *101 103*

1424-3790 GLICKSMAN, M., WANKIER, B. N. and SILVERMAN, J. E. **Frozen pudding composition.** United States Patent 3,754,935. 1973. 3p. Engl., Sum. Engl.

Cassava. Food products. Uses. Patents. USA.

The patent describes a formulation for making frozen puddings, based on raw, unmodified tapioca starch, which can withstand several freeze-thaw cycles, including cycles through the +15°F temperature area. *(Author's summary)* 101

1425-1612 SEIDEMANN, J. and NEUDERT, B. **Bestimmung der korngrobenverteilung von Starke mit dem Granulometer "TuR" ZG 2.** *(Determination of particle size distribution of starch with the aid of a granulometer "TuR" ZG 2).* Nahrung 16(5):533-542. 1972. Germ., Sum. Germ., Engl., Russ., 16 Refs. Illus.

Cassava. Cassava starch. Particle size. Laboratory experiments. Analysis. Potatoes. Maize. Wheat.

After dealing briefly with the common methods for determining particle size distribution, the authors give results of studies on potato, cassava, maize and wheat starches by means of the impulse technique, using the granulometer "TuR" ZG 2. The results obtained were evaluated according to E. Heidenreich's method with the aid of a special slide rule. The time needed for the entire analysis, including calculations, was reduced considerably. *(Author's summary)* 101

1426-3726 ARDARY, Z. L., STURGIS, D. H. and REYNOLDS, C. D. **Thermal insulation.** United States Patent 3,793,204. 1974. 5p. Engl., Sum. Engl., Illus.

Cassava. Cassava starch. Uses. Patents. USA.

The thermal insulating properties of fibrous thermal insulation for high-temperature applications are improved by incorporating graphite flakes in the insulation to reduce radiant heat transfer substantially. This comprises randomly oriented fibers joined by a binder of previously gelatinized carbonized starch. The improvement lies in the incorporation of thin graphite flakes in the composite with the maximum dimension of each being disposed orthogonal to the expected direction of heat flow through said composite. Satisfactory results have been achieved by using starches such as cassava, potato and arrowroot, with particles of about 10 µm. A figure and 6 claims regarding the significant improvement in the thermal insulating composite are given. *(Summary by T.M.)* 101.

1427-3928 RASPER, B. **Functional properties of non-wheat flour substitutes in composite flours. II. Amylolytic susceptibility of non-wheat starches.** Canadian Institute of Food Science and Technology. Journal. 7(3):166-174. 1974. Engl., Sum. Engl., Fr., 23 Refs., Illus.

Cassava. Cassava starch. Analysis. Laboratory experiments. Wheat flour. Composite flours.

Starches from tubers of some species of the genus **Dioscorea** *(D. rotundata* Poir*), D. alta.* L; *D. cayenensis* Lam., *D. esculenta* (Lour.) Birk., roots of cassava (*Manihot utilissima* Pohl.), cormels of cocoyam (*Xanthomonas sagittifolium* Schott.), fruits of plantain (*Musa paradisiaca* L.), together with starches from sorghum (Sorgho ROF) and millet (SOUNA II), were tested for the susceptibility of the ungelatinized granules to the action of bacterial α-amylase, fungal glucoamylase and malt diastase. Although all starches were more resistant to enzymatic degradation as compared with starch extracted from the Canadian hard red spring wheat, considerable differences were observed among individual starches. Among noncereal starches, cassava starch was the most susceptible, whereas large-granule yam and plantain starches did not show any significant degree of digestion even after a 48-hour treatment with the enzymes. Scanning electron microscopy revealed that the mode of the enzymatic attack on the granules of cassava and cocoyam starch (both being composed starches), differed from that on cereal starch granules. The reduction of the diastatic activity of composite flours, in which wheat flour was replaced by less susceptible starches, was reflected in a lower CO_2 production in sucrose-free doughs during fermentation. *(Author's summary)* 101

1428-0962 CASSAVA STARCH for textile industry. *In* Nigeria. Federal Institute of Industrial Research. Quarterly Progress Report. 1967. p.13. Engl.

Cassava. Industrial Starches. Textiles. Industrialization. Cassava starch. Analysis. Viscosity. Nigeria.

A test on viscosity of some cassava starch samples prepared at the Institute was carried out, the object being to determine their suitability for application in the textile industry. The test is continuing and detailed information on the result obtained will be given in a future report. Trade Sample Tests: (a) Cassava chips prepared in Nigeria for export to West Germany were tested for moisture, and crude fiber and starch, and these conformed to the Trade Specifications. (b) Three sets of cotton drills comprised of 7 specimens were submitted by the Permanent Secretary, Federal Ministry of Trade for testing and comparison of quality. The specimens were made up of 3 white drills, 2 khaki drills and 2 blue drills. The tests carried out included weave, ends and picks per inch, count of warp and weft, breaking load of 2-inch strip specimen, proportion of added matter, color resistance to mild alkali and acids, cold and hot. *(Full text)* 101 102

1429-0187 CHADHA, Y. R. **Sources of starch in Commonwealth Territories. III. Cassava.** Tropical Science 3(3):101-113. 1961. Engl., Sum. Engl., 25 Refs.

Cassava. Cultivation. Diseases and pathogens. Pests. Productivity. Nutritive value. HCN content. Composition. Leaves. Cassava starch. Starch productivity. Industrialization. Uses. Processing. Gari. Processed products. Food products. Production. Trade. Economics. Africa.

Throughout tropical areas of the world, the cassava plant is widely cultivated for its starchy tubers which serve as a staple food in many countries. Of the total world acreage of this crop, more than half is concentrated in tropical Africa. The chief industrial outlet for the tubers is the manufacture of cassava starch, which is in great demand in the food, textile and paper industries; principal starch suppliers in the world market are Brazil and Indonesia. African Commonwealth territories produce large quantities of cassava, but almost the entire crop is consumed as food and the production of commercial starch has remained negligible. Extraction of cassava starch is a simple operation requiring no complicated machinery, and there is ample scope to establish it as a village industry in these territories. *(Author's summary)* 101 D00

1430-0969 ETORMA, S. B. **Chemical studies on cassava products: I. The critical moisture-molding content of cassava starch.** Philippine Journal of Agriculture 7(4):409-412. 1936. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Storage. Cassava starch. Moulds. Deterioration. Water content. Composition. Analysis. Water absorption. Philippines.

The curves representing the rates of absorption or loss of moisture show that the modified atmosphere where the moisture content of the starch and that of the former come to an equilibrium is attained at the end of 15 days, after which period such behaviour proceeds slowly. The rate of absorption by or loss of moisture in cassava starch under different atmospheres is highly variable, as shown by straight-lined curves in air, parabolic in water and in less concentrated solutions of sodium hydroxide and concentrated solution of sodium chloride, and asymptotic in more concentrated solutions of sodium hydroxide. The critical moisture-molding conten of cassava starch was found to be 19%; therefore, to keep cassava starch free from old growth, it should be dried to well below 19% moisture. *(Author's summary)* 101 102

1431-0111 HIGGINBOTHAM, R. S. and MORRISON, G. A. **The fractioning of starch. I. The estimation of amylose in the presence of amylopectin.** Journal of the Textile Institute 40:201-207. 1949. Engl., 18 Refs., Illus.

Cassava. Cassava starch. Analysis.

The amyloses and amylopectins are sharply differentiated in their reactions with I; the practicable methods of estimating amylose by potentiometric determination of I absorbed under specified conditions or by colorimetric measurement of the I complex were investigated. The former method appears more accurate and conditions can be chosen under which the pure, unfractionated amyloses of the common starches absorb 21% I while amylopectins absorb < 0.5%. A simple apparatus has been devised, which uses the method of Bates et al.; actual measurement of potential differences is avoided by use of 2 similar resistance glass vessels of ~ 150-ml capacity, provided with Pt wire electrodes, glass mechanical strirrers, and burets and joined by a glass bridge filled with saturated KCl solution. The whole apparatus is placed in a thermostat at 25°, and the electrodes are connected to a sensitive galvanometer through a tapping key. The procedure and details of the method are given. *(Summary by Chemical Abstracts)* I01

1432-2222 ROBIN, J. P. and GUILBOT, A. **Effet de divers amidons et produits dérivés sur la floculation des proteines du lait de vache.** *(Effect of various starches and derived products on the flocculation of proteins in cows' milk).* Cahiers de Nutrition et de Dietetique 6:29-34. 1971. Fr., 6 Refs., Illus.

Cassava. Cassava starch. Food products. Milk. Biochemistry. Analysis. Laboratory experiments. Proteins. Human nutrition.

Partly separated milk, diluted 5 X with distilled water, was mixed with a 1% suspension of various starches at pH 4.5-4.7 (using dilute HCl) and the turbidity of this mixture was measured at intervals. Visual examination was carried out using amido black dye on this mixture directly or after diluting 5 X; and electron microscope pictures were made. Polished maize starch was found to have maximum antiflocculant effect. cassava and pregelatinized cassava starches had a medium effect, followed by finely divided tapioca starch products, which had slightly more effect than larger particle-size tapioca and corn, potato or normal maize starches. Amylose was found to have little effect on antiflocculant activity, unlike amylopectin; β dextrin would appear to have a limiting effect on antiflocculant activity. *(Summary by Food Science and Technological Abstracts).* I01 H01

1433-3800 HODGE, J. E., MONTGOMERY, E. M. and HILBERT, G. T. **Hydrolysis of the amylopectins from various starches with beta-amylase.** Cereal Chemistry 25(1):19-30. 1948. Engl., Sum. Engl., 32 Refs.

Cassava. Cassava starch. Laboratory experiments. Analysis. Enzymes. Hydrolysis. pH.

The amylopectin or branched-chain fractions of corn, wheat, white potato, sweet potato, and tapioca starches were isolated by removal of the amylose or linear fraction after its precipitation with n-butanol, then degraded by β-amylase to the limit dextrins. The extent of conversion to maltose, yields of limit dextrins and crystalline maltose hydrate, phosphorus contents, alkali labilities, iodine sorptions, specific optical rotations, and properties of the triacetyl derivates were determined. The branched-chain fractions from the different starches were alike in extent of conversion by β-amylase, alkali lability, specific optical rotation, and in some properties of the acetates. They differed in phosphorus content, the nature of the phosphorus present, and iodine sorption. The root and tuber limit dextrins retained phosphorus, whereas the cereal limit dextrins did not. Evidence was found which was interpreted as indicating the existence in some starches, particularly corn and sweet potato, of a fraction intermediate in the extent of branching between linear amylose and the average for branched amylopectin. *(Author's summary)* I01

1434-1876 BHADRA, R., GOSWAMI, S. K. and MAJUMDAR, S. K. **Effect of different complex nutrients on neomycin production by *Streptomyces fradiae* H.** Acta microbiológica 18:300-303. 1973. Engl., Sum. Engl., 7 Refs.

Cassava. Cassava starch. Uses. Culture media. Analysis.

Studies of the nutritional requirements of a neomycin-producing mutant *Streptomyces fradiae* H. developed by the authors show that cassava starch (at a concentration of 5%) is an excellent carbon source for antibiotic production while soy flour and yeast powder are superior nitrogen sources for neomycin production. A mixture of 1% soy flour and 1% yeast powder gives maximal antibiotic titer. *(Author's summary)* I01

1435-2139 COUSINS, H. H. **The industrial prospects of cassava starch.** Bulletin of the Department of Agriculture, Jamaica 1:53-57. 1909.

Also in West Indian Bulletin 8:260-263. 1907.

Cassava. Cultivars. Tubers. Productivity. Developmental research. Starch productivity. Timing. Costs. Cassava starch. Production. Prices. Industrialization. Processing. Economics. Jamaica.

Cassava is a plant that has survived from the earliest occupation of the island by mankind and is capable of yielding returns of starch under suitable conditions. These encouraging facts place it ahead of any other plant grown for purposes of starch production. Furthermore the intrinsic qualities of cassava starch that can be produced in Jamaica are favorable, and a well-made product can command a high price. It would appear that this industry offers a field for investment and development, whereby large areas of land (at present of small productive power) could be made to yield good profits. *(Author's summary)* 101 J00

1436-1874 VISWANATHAN, P. N. and KRISHNAN, P. S. **Metabolic activity of starch granules from the tapioca plant. I. UDPG-starch-glucosyl transferase.** Indian Journal of Biochemistry 2(1):16-21. 1965. Engl., Sum. Engl., 11 Refs.

Cassava. *Manihot esculenta.* Cassava starch. Biochemistry. Analysis. Enzymes. Tubers. Laboratory experiments. Metabolism. Stems. India.

Starch granules from the tuber of the cassava plant, *Manihot utilissima,* possess very high UDPG-starch-glucosyl transferase activity. The isolated granules are characterized by a high order of endogenous activity; this is revealed when the assay conditions are modified to include a heat-treated control. Some properties of the enzyme in the form of granules and the relation between the enzymic activity and the starch content have been studied over a 6-month period of maturation of the tuber. It has been possible to effect a partial enrichment of the activity in the granules without actual solubilization. Appreciable activity of the enzyme is also observed in preparations from the pith tissue obtained from the stem. *(Author's summary)* 101

1437-0419 VELIKAYA, E. I. and NGUEN DIN THYONG. **O fiziko-khimicheskikh svoistvakh krakhmala manioka.** *(Physicochemical properties of cassava starch).* Izvestiya Vysshikh Uchebnykh Zavedenii. Pishchevaya Tekhnologiya no. 3:57-59. 1971. Russ., 11 Refs., Illus.

Cassava. Cassava starch. Analysis. Composition. Biochemistry.

In addition to polysaccharides, cassava starch contains small quantities of proteins, fat and mineral salts, including those of phosphoric acid. It has a comparatively high amylose content (30%) and relatively low molecular weight amylopectin, which resembles amylose. The reaction of the starch is weakly acid. *(Summary by Biological Abstracts)* 101
T-773

1438-0687 RASPER, V. **Investigations on starches from some West African root crops.** *In* International Symposium on Tropical Root Crops, Ist, St. Agustine, Trinidad, 1967. Proceedings. St. Agustine, University of West Indies, 1969. v.2, pp. 48-61. Engl., 13 Refs.

Cassava. Yams. Cocoyams. Potatoes. Maize. Gelatinization. Viscosity. Human nutrition. Cassava starch. Analysis.

Traditionally fufu is prepared by pounding peeled and boiled yam, cassava or cocoyam tubers or plantain fruits either alone or as a mixture in a wooden mortar until an elastic and somewhat glutinous dough is formed. Yams are preferred for making fufu, but cassava has recently become their most serious competitor. This paper describes an examination of some rheological properties of the starches prepared from some West African yam species, several cocoyams and plantains. The amylose content of these starches has also been investigated. The study has been completed by microscopic examination of individual samples. Starch from corn, white potatoes and cassava was used as a standard for the comparison. *(Summary by H.J.S.)* 101

1439-1639 MICHAUD, M. R. **Diagrammes de riz et de tapiocas.** *(X-ray diagrams of tapioca and rice). In* Congrés du Manioc et de Plantes Féculentes Tropicales, Marseille. 1949. Marseille, Institut Colonial, 1949. pp. 84-85. Fr.

Cassava. Tapiocas. Analysis. Legal aspects.

X-ray diagrams of tapioca are entirely different from those obtained with rice. Therefore, it is possible to detect when rice is used instead of cassava in making tapioca. *(Summary by Chemical Abstracts)* 101

1440-0904 QUDRAT-I—KHUDA, M. *et al.* **Cereals and cereal products; properties of certain starch varieties and their sources in East Pakistan.** Pakistan Journal of Scientific and Industrial Research 3(3):159-162. 1960. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Cereals. Particle size. Cassava starch. Mineral content. Colocasia. Dioscorea. Starch content. Analysis. Composition. Protein content. Soluble carbohydrates. Fat content. Fibre content. Pakistan.

The properties and other data of 14 sources of starch have been described. The starch content and particle size for each type of the isolated starch have been found to be quite satisfactory for commercial exploitation. *(Author's summary)* 101

1441-2268 FURLONG, J. R. **Nigerian cassava starch.** Bulletin of the Imperial Institute 40(4):257-271. 1942. Engl., 5 Refs.

Cassava. Cassava starch. Cultivars. Analysis. Industrialization. Production. Nigeria.

The possibility of producing cassava starch has been studied by the Nigerian Department of Agriculture in collaboration with the Imperial Institute, which gave advice on methods of evaluating the starch and examining and reporting on samples prepared by the Department. A report on two batches of starch submitted for examination is given, as well as a discussion on bases for judging the commercial quality of starch. The main object of this investigation was to ascertain whether the different local varieties of cassava root yielded starches of varying quality. The process for the manufacture of starch as a village industry is briefly reviewed. *(Summary by J.L.S.)* 101

1442-1675 HOOD, L. F., SEIFRIED, A. S. and MEYER, R. **Microstructure of modified tapioca starch-milk gels.** Journal of Food Science 39(1):117-120. 1974. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Modified starches. Particle size. Cassava starch. Food products. Food thickeners. Analysis.

The ultrastructure of hydroxypropyl distarch phosphate-skim milk gels was evaluated with light, scanning (SEM) and transmission (TEM) electron microscopy. SEM of the ungelatinized granules showed that chemical modification did not affect the surface or the size of the granule. Two types of gelatinized granules were observed with the TEM. One had a homogeneous granular texture throughout while the other had a granular coat and a dispersed, less dense core. The coat-core type granule may be the result of chemical modification. Casein micelle subunits were evident. Micelles were not aggregated, nor was there any evidence of a continuous network among the micelles and the starch granules. *(Author's summary)* 101

1443-3798 HSIEH, P.T. **[Studies on the physical and chemical properties of the starches produced in Taiwan. I. Some physical properies of cassava and sweet potato starches].** Chemistry (Taiwan) 4:231-237. 1961. Chin., Sum. Engl., 6 Refs. Illus.

Cassava. Cassava starch. Particle size. Gelatinization. Viscosity. Temperature. Analysis. Taiwan.

In order obtain fundamental knowledge relating to the practical utilization of the starches produced in Taiwan and to investigate molecular characteristics, a study was made of physical properties of the starches prepared from cassava (Wu-Chih-CHUNG) and sweet potato (Hsin-TaidNung No. 31) produced in Taiwan. The granular size of the starches was microscopically measured with a micrometer. The results were as follows: cassava starch: range of granular size, 2-32μ; main range of granular size 11-14μ; average size 13μ; sweet potato starch: range of granular size, 5-40 u; main range of granular size, 13-15μ; average size, 14μ. The determination of the gelatinization temperature of each starch was carried out hy measuring the refractive index or the transmittance during heating 6% or 1% aqueous starch solution. The range of gelatinization temperature of cassava starch was found to be hetween 58° and 68°C; that of sweet potato starch was in the range of 68° to 76°C. The following results were ohtained by measuring the viscosity of the solutions of cassava and sweet potato starches with Stomer's viscometer: At the same temperature, the viscosity of the cassava starch solution was slightly higher than that of the sweet potato starch solution with the same concentration. By prolonged cooking at 90°C, the viscosity of the starch solutions remarkably decreased with time and hecame nearly constant after 20 minutes. When the temperature of each of the starch solutions (cooked for 20 minutes at 90°C) was slowly reduced to 60°C, the viscosity of the starch solutions having the concentration of more than 9% markedly increased to about twice that before the cooling. *(Author's summary)* 101

1444-2439 SUTRA, R. **Classement des différentes varietés d'amidons au moyen des spectres de diffraction de rayons x. Possibilité de reconnaître un tapioca fraude avec la fécule de pomme de terre** *(Classification of the different starch varieties by means of X-ray diffraction spectrum. Possibilities of detecting cassava starch in potato starch).* Annales des Falsifications et des Fraudes 45:195-199. 1952. Fr., Sum. Fr., 3 Refs., Illus.

Cassava. Cassava starch. Potatoes. Tapiocas. Legal aspects. Analysis.

The diffraction spectra by X-ray of the different starch varieties are classified hy corn type (cereals, legumes, rice, cassava, arrowroot, taro) and potato type ("tolomane," yam, bread fruit). During the transformation of cassava into tapioca, a disorganization of the crystalline region is produced; only the properties of the high intensity rings remain. This permits one to discover when cassava starch has been used instead of potato starch. *(Author's summary)* 101

1445-2292 GUILBOT, A. and DRAPRON, R. **Caractères physico-chimiques distinctifs de divers tapiocas et de produits similaires obtenus à partir de la fécule de pomme de terre.** *(Distinctive physicochemical characteristics of several tapiocas and similar products obtained from potato starch). In* Congrés International de Chimie Industrielle, 31°, Liége, 1958. v. 2, pp. 679-682. Fr., 6 Refs., Illus.

Cassava. Composition. Industrial starches. Viscosity. Organoleptic examination. Tapiocas. Potatoes. Analysis.

The physicochemical behavior of the suspension of cassava tapioca is quite different from the suspension of potato "tapioca," particularly after hoiling. In the case of cassava, a limited swelling of grains is observed. These grains, which are very viscous, may remain individualized. A very significant fraction of the suspension dispersed completely in the liquid to constitute a medium of certain viscosity which serves as a binding agent. In the case of potato "tapioca," grains absorhed more water, consquently being less viscous. The excess liquid of the medium contains less dispersed amylaceous substances and its viscosity becomes weak. Consequently, the replacement of cassava tapioca by the so-called "indigenous tapioca," prepared from potato starch, does not result in foods with identical physicochemical characteristics. In addition, these may be interpreted as important organoleptic differences. *(Author's summary)* 101

1446-3659 KNIGHT, J. W. **Speciality of food starches.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.77-78. Engl., Sum. Engl., Fr., Illus.

Cassava. Cassava starch. Analysis. Modified starches. Laboratory experiments. Breads. Australia.

The purpose of this paper is to show where properties of cassava starch can best be employed to produce food products. The pasting qualities of corn, sorghum, wheat and cassava starches are compared. Work has been done showing that bread and bread-type products can be made from formulas in which cassava starch or flour replaces wheat flour. Recently, a wide variety of convenience foods that contain a starch-derived base has been produced. The necessary properties of these starch products are discussed. The amylopectin starches, which are commercially available as waxy maize or waxy sorghum starch, are being used in these convenience foods in increasing quantities. The properties of these starches are discussed and the manner in which these properties can be modified, by chemical treatment is explained. It is shown that cassava starch is eminently suitable for producing the same type of products as those derived from the waxy starches. It is recommended that more effort be made to produce these highly priced food products from cassava starch. *(Author's summary)* 101

1447-0177 PARK, Y. K., BAR, W. H. and PAPINI, R. S. **Relação entre intumescimento, gelatinização e suscetibilidade dos amilos de mandioca e de milho a alfa-amilase bacteriana.** *(Relation between gelatinization and suceptibility of cassava and corn starches to bacterial alpha-amylase.)* Revista Brasileira de Tecnologia 2:95-99. 1971. Port., Sum. Engl., 5 Refs. Illus.

Cassava. Cassava starch. Viscosity. Gelatinization. Temperature. Enzymes. Analysis. Particle size. Biochemistry. Maize. Processing. Brazil.

Comparative pasting temperatures and viscosities of 10% aqueous suspensions of cassava and corn starches were compared on the amylograph. The pasting temperature of cassava starch was much lower than that of corn starch, but the pasting viscosities of cassava starch were much higher than those of corn starch. Starch susceptibility to bacterial α-amylase was studied on the amylograph by preparing a 30% aqueous suspension of starch with 5 SKB units of bacterial α-amylase per gram of starch. The decrease in the pasting viscosity of cassava starch was tremendous as compared to corn starch. The swelling and gelatinization of the starches due to temperature changes and the dissolution of the starches by bacterial α-amylase were studied microscopically. The cassava starch consisted of small and large granules. All large granules were swollen and gelatinized at 57 - 60°C; small granules were swollen at 65°C. All large granules of corn starch were swollen and gelatinized at about 70°C. The swollen large granules were immediately destroyed by the bacterial α-amylase, while the small, nongelatinized granules were not hydrolized. These facts lead to the conclusion that α-amylase susceptibility of cassava starch was very high when compared to corn starch because cassava starch has a lower swelling and gelatinizing temperature and because the starch granules are weakly bonded. *(Author's summary)* 101

1448-3144 EMMONS, D. B., BECKETT, D. C. and LARMOND, E. **Physical properties and storage stability of milk-based puddings made with various starches and stabilizers.** Canadian Institute of Food Science and Technology Journal 5(2):72-76. 1972. Engl., Sum. Engl., Fr., 10 Refs., Illus.

Cassava. Food products. Food stabilizers. Viscosity. Modified starches. Cooked starches. Uses.

Viscosity, firmness and sensory evaluation tests were used to evaluate various starches and stabilizers for their effect on the physical properties and stability of milk-based puddings during frozen and refrigerated storage. Measuring both firmness and viscosity described the body and texture better than either alone; measuring elasticity would probably have improved the description. Two modified starches (cross-linked, acetylated and waxy maize) produced similar physical properties, but freezing destabilized the pudding. Added calcium or nonfat dry milk increased pudding firmness and viscosity. When small amounts of carrageenan replaced some of the modified starch, the predominant characteristics changed from a viscous body to a soft gel and spoonability improved. Freezing completely destabilized the puddings. With higher levels of carrageenan, free whey appeared if the body was broken during storage. Corn starch produced a gelled, elastic pudding that was relatively difficult to spoon; the pudding retrograded during storage; freezing destabilized this gel completely. Untreated waxy maize produced a very viscous, stringy body which destabilized during freezing. Increased stirring during cooking of corn starch puddings resulted in increased firmness and less syneresis during refrigerated storage *(Author's summary)* 101

1449-0470 STARCH AND **glucose from tapioca roots.** Journal of Industry and Trade 3(11):1639. 1953. Engl.

Cassava. Roots. Cassava starch. Glucose. India.

The Central Food Technological Research Institute at Mysore, has developed processes for the preparation of starch from cassava roots. Glucose and sweet syrup are then made from this starch. *(Summary by Tropical Abstracts)* 101

1450-1711 WESTSTEIJN, G. and OKAFOR, N. **Comparison of cassava, yam and potato dextrose agars as fungal culture media.** Netherlands Journal of Plant Pathology 77: 134-139. 1971. Engl., Sum. Engl., Dutch., 9 Refs.

Cassava. Dextrose. Cassava starch. Uses. Laboratory experiments. Culture media.

In the experiments in vitro at 20 and 30°C, the fungi *Phytophthora palmivora, Aspergillus melleus, Thielaviopsis paradoxa, Pestalotiopsis versicolor* and *Curvularia pallescens* showed a better mycelial growth on cassava dextrose agar than on potato dextrose agar and yam dextrose agar. This also applied to sporulation, except for the last two fungi at 20°C, which sporulated best on potato dextrose agar. *(Author's summary)* 101.

1451-1846 HELLMAN, N. N., BOESCH, T. F. and MELVIN, E. H. **Starch granule swelling in water vapor sorption.** Journal of the American Chemical Society 74:348-350. 1952.Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Cassava starch. Analysis. Water absorption.

Microscopic measurements of the swelling of individual starch granules occurring with the sorption of water vapor at various relative pressures are reported for corn, potato, cassava and waxy corn starch. The linear granule swelling in a water-saturated atmosphere over the vacuum-dry dimension is as follows: corn, 9.1%; potato, 12.7%; cassava, 28.4%; and waxy corn, 22.7%. For all except cassava starch, there is practically no hysteresis in the function of swelling vs. relative humidity of the atmosphere with which the starch is equilibrated. For all starches, the function of swelling vs. moisture content shows an absorption-desorption loop with the desorption leg giving smaller granule dimensions for equal water content. *(Author's summary)* 101

1452-0191 HIGGINBOTHAM, R. S. and MORRISON, G. A. **The fractioning of starch. II. The separation of amylose and amylopectin.** Journal of the Textile Institute 40:208-219. 1949. Engl., 16 Refs.

Cassava. Cassava starch. Analysis.

Experiments were carried out to see whether sago, cassava, potato and maize starches could be separated quantitatively into 2 fractions consisting solely of amylose and amylopectin. By repeated crystallization of impure amyloses from a very diluted solution in H20 saturated with butanol, a limiting value of 21.0% I2 absorption was obtained for products containing 80-95% of the total amylose in the starches examined. This figure was assumed to represent the value for pure unfractionated amylose. Too high a concentration during crystallization markedly reduced the efficiency of the process. The I2 absorption of pure amylopectins ranged from 0.1% to 0.5%, according to the parent starch. No means of purifying amylopectin has been discovered so the conditions of initial precipitation must be chosen to keep the amount of amylose in the nonprecipitated fraction as small as possible. Butanol, pyridine and iso-AmOH were used as precipitants for amylose. Hot aqueous solutions of pyridine are better solvents for starch than hot H20, even if saturated with butanol. AmOH will sometimes precipitate larger proportion of the amylose, but it is not so specific and the precipitation is difficult to purify. To detect any chemical modification of the starches that might have occurred during the separation, the intrinsic viscosities were determined of the triacetates of the pure amyloses and amylopectins and of the parent starches. Of the starches examined, sago is the most easily separated into its components, 96-98% of the total amylose being precipitated and purified with little loss. With cassava and potato starches, the mild method of dispersion used with sago did not give complete separation of the components, 95 and 85% of the starches being dissolved. A striking feature is that although the proportion of the total amylose precipitated is not much lower than under conditions giving complete dispersion, losses by recrystallization are considerable. Maize starch exhibited these results to a much greater degree, 80% of the starch being dissolved, 83% of amylose being precipitated on cooling, but only 72% being recoverable to 98% purity on recrystallization. It is suggested that aggregates containing both amylose and amylopectin are formed. The nature of the binding is at present obscure, but probably ordinary valency bonds are involved as H bonding, or van der Waal's attractions would presumably be broken by the dispersing agent used. Full experimental details and results are given. *(Summary by Chemical Abstracts)* 101

1453-5337 BATES, F.L. FRENCH, D. and RUNDLE, R. E. **Amylose and amylopectin content of starches determined by their iodine complex formation.** Journal of the American Chemical Society 65:142-148. 1943. Engl., Sum. Engl., 23 Refs., Illus.

Cassava. Cassava starch. Analysis.

Starch possesses 2 components that are quite distinct in their reactions with iodine to form iodine complexes. A potentiometric method was developed for the rapid quantitative determination of the amylose components of starch. Cassava starch contains 17% amylose, as compared to 21% for corn and 22% for potato. The amount of iodine bound by the amylose component of starch varies inversely with the iodide concentration. Preliminary results indicate that afinity for iodine varies inversely with the degree of branching of the starch chains and directly with chain length. The amylose component of any one starch appears fairly homogenous in chain length. The synthetic starch of Hassid, in agreement with methylation studies and iodine titration, appears to be essentially amylose. *(Author's summary)* 101

1454-0456 RASPER, V. **Investigations on starches from major starch crops grown in Ghana. II. Sweling and solubility patterns: amyloclastic susceptibility.** Journal of the Science of Food and Agriculture 20(11):642-646. 1969. Engl., Sum. Engl., 22 Refs.

Cassava. Yams. Cocoyams. Maize. Starch crops. Cassava starch. Sweet-potatoes. Viscosity. Gelatinization. Enzymes. Biochemistry. Analysis.

The patterns of progressive swelling and solubilization of various starches from major Ghanaian starch crops have been evaluated over the range of pasting temperatures to provide evidence of the associative bonding (i.e., hydrogen bonding) within the granules. The swelling patterns were greatly influenced by the species of the starch tested; but all the starches, except those of maize and cocoyam *(Xanthosoma sagittifolium)*, exhibited single-stage swelling, reflecting the presence of one set of internal bonding forces. The dissolving action of amylases on granular starches, which provides another means for studying granule structure, was examined by measuring the starch degradation at different enzyme concentration levels and a fixed amount of substrate. There was considerable variation in resistance to enzyme action among the starches. With root starches, the increase in resistance was parallel to the increasing size of the granules. *(Author's summary)* 101

1455-0434 RASPER, V. **Investigations of starches from major starch crops grown in Ghana. I. Hot paste viscosity and gel-forming power.** Journal of the Science of Food and Agriculture 20(3):165-171. 1969. Engl., Sum. Engl., 22 Refs.

Cassava. pH. Viscosity. Gelatinization. Cassava starch. Analysis. Ghana.

The most important rheological properties of starches from several major starch crops grown in Ghana were examined. The changes in consistency during the whole pasting cycle and the gel-forming power were tested with starches of several species of yams (**Dioscorea**),plantain *(Musa paradisiaca)* cultivars, cocoyams (both *Xanthosoma sagittifolium* and *Colacasia antiquorum*) and several local varieties of cassava *(Manihot utilissima).* Most of the yam starches gave very high viscous pastes yielding very strong, short gels on cooling, some of them with a very high retrogradation tendency. The rheological properties of plantain starches were similar to those of yam starches; cocoyam starches produced pastes which had lower viscosity and exhibited some breakdown on prolonged heating and stirring and poorer setback on cooling. With new cocoyam *(Xanthosoma sagittifolium)*, the gel-forming power, however, was higher than that of cassava and sweet potato starches. *(Author's summary)* 101

1456-2315 DAS GUPTA, H. P. **Studies on starches from indigenous grains and tubers. IV. Cassava starch.** Journal of the Indian Institute of Science 19A(4):31-34. 1936. Engl., Sum. Engl., 2 Refs.

Cassava. Cassava starch. Potatoes. Productivity. Processing. Maize. Viscosity. Sago. Analysis.

A simple method for the preparation of cassava starch has been outlined. The starch has a viscosity approaching that of potato starch and can be utilized as a substitute for the latter. *(Author's summary)* 101

1457-2316 PIERSON, G. G. **Determination of viscosity of dilute solutions of cassava flour and other starches.** Industrial and Engineering Chemistry 6:183-187. 1934. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Cassava starch. Viscosity. Processing. Sago. Wheat. Rice. Cereals. Analysis. Potatoes. Silting. Sorghums.

After describing certain characteristics of the viscosity of some of the widely used brands of cassava flour and other starches, various methods of testing viscosity are discussed. A new method where heat and agitation are definitely controlled by a constant flow of dry steam, is proposed as being suitable for determining the viscosity curve because it permits a continuous testing of the solution. A modified Perkins viscometer is an important feature of this method. A diagram and detailed instructions are included. *(Summary by T.M.)* 101

1458-2198 PACHECO, J. A. DE C. **Viscosidade de fécula de variedades de mandioca. II. Curvas viscosimétricas das variedades Branca de Santa Catarina, Brava de Itu e Cafelha, determinadas em amostras preparadas em laboratorio.** *(Viscosity of the starch of cassava varieties. II. Viscosimetric curves of Branca de Santa Catarina, Brava de Itu and Cafelha varieties determined from samples prepared in the laboratory).* Bragantia 11(4-6):133-139. 1951. Port., Sum. Port., Engl., 3 Refs., Illus.

Cassava. Viscosity. Uses. Textiles. Cassava starch. Analyses. Cultivars. Industrialization. Industrial starches. Paper industry. Research. Laboratory experiments. Brazil.

Samples of 3 commercial varieties of cassava starch (*Manihot utilissima* Pohl) were prepared in the laboratory to find out if they differed in viscosity. These varieties were Branca de Santa Catarina, Brava de Itu and Cafelha, considered to be very promising in relation to root yield.Viscosity measurements were mede using a Brabender amylgraph viscograph, and the data obtained were submitted to statistical analysis. The results indicated that these varieties differed substantially in their starch viscosity. *(Author's summary)* 101 102

1459-2314 HIXON, R. M. and SPRAGUE, G. F. **Waxy starch of maize and other cereals; a possible competitor for tapioca.** Industrial and Engineering Chemistry 34(8):959-962. 1942. Engl., Sum. Engl., 24 Refs., Illus.

Cassava. Rice. Sorghums. Cereals. Cassava starch. Analysis. Maize. Industrial starches. Viscosity. Uses.

The properties of starch from waxy corn are discussed. This starch has high viscosity, low gelling characteristics, and a slight tendency to retrograde. These qualities suggest the utilization of this starch as a replacement for cassava in many commercial products. Indicated uses are as a remoistening glue, in paper sizes and as a substitute for minute tapioca. Starch has been milled from waxy rice, waxy sorghum and waxy barley. Starch from waxy barley differs from the others in having both red- and blue-staining granules. *(Author's summary)* 101

1460-5322 KERR, R.W. and TRUBELL, O.R. **On the multiple-amylose concept of starch. I. Gamma-amylose.** Cereal chemistry 18:530-548. 1941. Engl., 28 Refs., Illus.

Cassava. Cassava starch. Analysis.

Methods are given for the isolation and characterization of an amylose fraction of corn starch,provisionally called -amylose. Cassava gives only 1| 10 of the yield given by corn starch; potato starch yields almost none. Proof is given that -amylose is different from -amylose or physical modifications of it, such as would be formed by reversion or retrogradation. The mol wt of -amylose acetate is given as 4,890 + 390, which for a triacetate indicates a chain length of 17 + 2 dextrose units. This is not a higher polymer of units that make up -amylose. -amilyse is not a product of synthesis from intermediate degradation products of starch but exists preformed in the corn starch granule. *(Summary by Chemical Abstracts)* 101

1461-3450 SRIVASTAVA, H. C. and PATEL, M. M. **Viscosity stabilization of tapioca starch.** Stärke 25(1):17-21. 1973. Engl., Sum. Engl., Dutch, Fr., 15 Refs., Illus.

Cassava. Viscosity. Analysis. Composition. Laboratory experiments. Food products. Industrial starches. Uses. Cassava starch.

Two samples of cassava starch of different viscosities have been crosslinked with sodium trimetaphosphate, epichlorohydrin and phosphorus oxychloride. Of these crosslinking agents, epichlorohydrin was the most efficient, requiring only 0.01 to 0.15% of the reagent on the weight of starch. As cassava starch has a high viscosity initially, it requires less of the crosslinking agent for stabilization of its paste viscosity than the starch sample having a low initial viscosity. *(Author's summary)* 101.

1462-0786NOTES SUR **le manioc séché et la farine de manioc.***(Notes on dry cassava and cassava flour).* Bulletin Agricole du Nongo Belge 15:175-181. 1924. Fr.

Cassava. Processed products. Tubers. Productivity. Cassava flour. Zaire.

Research carried out by several members of the Agricultural Service is briefly described. Information deals with yields of some dried cassava products related to the fresh tubers; prices of cassava on the local market; composition of dried products and flour. *(Summary by H.J.S.)* 1001

1463-5340 SECK, W. and FISHER, G. **Uber der Verhalten von Starkelosungen bei extrem hohen Verschiebungsgeschwindigkeiten.** *(The condition of starch solutions at extremely high shear velocities).* Kolloid-Zeitschrift 90(1):51-58. 1940. Germ., Sum. Germ., Illus.

Cassava. Cassava starch. Analysis. Viscosity.

The Hurrell colloid mill was used to obtain extremely high shear or displacement velocities; a theoretical discussion of its operation is given. Various starches (potato, arrowroot, cassava, corn, wheat, rice and sago) were used in these experiments. Mechanical treatment of all the starches resulted in greatly reduced viscosities (losses were up to 98% of the original viscosity). These high losses can be correlated with the swelling properties of the various starches; the starch kernels showing the highest degree of swelling without disintegration suffer the greatest reduction in viscosity. The viscosity differences of the individual starches disappear to a large extent when the starches undergo mechanical treatment. This viscometric equalization can be assumed to be due to the natural viscosity of the starch, uninfluenced by swelling phenomena. *(Summary by Chemical Abstracts)* 101

1464-2482 ALBUQUERQUE, M. **Molestias e pragas que atacam a mandioca.** *(Diseases and pests of cassava).* Revista Brasileira de Fertilizantes, Insecticidás e Raçöes 5(8):32-36. 1963. Port.

Cassava. *Xanthomonas manihotis.* Cultivars. Resistance. Injurious insects. Brazil.

Bacteriosis (*Xanthomonas manihotis* Arthaud-Berthet) is the only cassava disease of great economic importance in the state of Bahia (Brazil). The damage is really serious only when the crop is grown in poor, leached soils. Caterpillars of *Laphygma frugiperda* caused serious damage, but they were effectively controlled. Acarids sometimes affect cassava severely when it is grown in poor soils. Cassava varieties are classified according to the degree of resistance. *(Summary by A.N.)* I01 F01

1465-0912 HONSCH, W. M. **Production and properties of yuca starch.** Stärke 18(1):20-22. 1966. Engl., Sum. Engl., Germ., Fr., Illus.

Cassava. Production. Viscosity. Gelatinization. HCN. Cassava starch. Industrialization. Processing. Venezuela.

Planting and harvesting of cassava and production of cassava starch in two modern German-built factories are dealt with. Conversion of cassava starch into modified starches and dextrins presented no severe difficulties except for a darkening in color with acid conversion. Different viscosities of the native starches made in the two factories can possibly be explained by differences in the age of the cassava. *(Author's summary)* I01.

1466-3407 ITO, K. A., SEEGER, M. L. and LEE, W. H. **The destruction of *Byssochlamys fulva* asci by low concentrations of gaseous methyl bromide and by aqueous solutions of chlorine, and iodophor and peracetic acid.** Journal of Applied Bacteriology 35(3): 479-483. 1972. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Cassava starch. Uses. Pest control.

Byssochlamys fulva asci are resistant to high concentrations of aqueous chlorine and idophor solutions but are sensitive to peracetic acid. Concentrations of 2% and 4% peracetic acid gave 99.9% reductions in 2.5 and 1.3 min, respectively. The asci were also sensitive to methyl bromide gas (MeBr); large numbers of asci (5 x 10^4|g) inoculated into tapioca starch powder (a_w=0.69) were killed in 30 days by 90 mg of MeBr| kg of starch. About 180 asci|g were killed by adding 60 mg of starch. *(Author's summary)* I01

1467-3262 TEIXEIRA, C. G. **Produção de alcool de mandioca.** *(Alcohol processed from cassava).* Agronomico 15(11|12):5. 1963. Port.

Cassava. Alcohol. Processing. Economics. Costs. Fermentation.

Amylaceous substances from cassava must be saccharified artificially. Saccharification is expensive, thus the author does not recommend using cassava as a source of alcohol. *(Summary by H.J.S.)* I01.

1468-5350 MEYER, K.H. and HEINRICH, P. **La composition de quelques espécies d'amidon.** *(Composition of several kinds of starch).* Helvetica Chimica Acta 25:1639-1650. 1942. Fr.

Cassava. Cassava starch. Composition. Laboratory experiments. Hydrolysis. Analysis.

Investigations of the composition of the starch of potato leaves, seeds and tubers have shown marked differences in the proportions of amylose and amylopectin. These studies were extended to a study of the composition of the starches from sago, cassava, peas and waxy maize. The starches were isolated from the ground material by repeated levigation in water. Suspensions of 3 g starch in 25 cc of water were poured into 250 cc of water, rinsed with a further 25 cc and agitated for 30 min at a definite temperature. After cooling to

40°, centrifuging and decanting, a portion of the measured clear solution was degraded with β-amylase. The extraction was repeated at a lower temperature if any residual dextrin was formed. The glucose formed by hydrolysis of a sample of the clear solution was used to estimate the polysaccharide concentration. Degradation of the starches by treatment with 35% calcium chloride, precipitation with alcohol and electrodialysis of 0.2 to 1% samples gave solutions containing crude amylose which were analyzed by hydrolysis according to Bertrand. The gel content in the crude amylopectin was similarly detected. The total content of the starches was estimated by addition of the value found for amylose and amylopectin and are tabulated. *(Summary by Chemical Abstracts)* 101

1469-0570 **COOKED STARCH texture without cooking.** Food Processing 33(5):34. 1972. Engl.

Cassava. Cooked starches. Food products. Uses. Cassava starch. Food thickeners. Food stabilizers.

Cassava starch has been modified to ensure ease of dispersion and complete rapid hydration in cold water; it can be used as a thickener, suspension agent, stabilizer and whipping aid. The texture produced is that of cooked starches. The bland flavor is particularly suited for use in dairy or simulated dairy foods and light cream sauces. Other suggested applications are as a thickene in dry instant puddings, a suspension agent for flavored powders, a whipping aid in marshmallows and meringues, etc. Savings may be achieved as the starch is less costly than gums, requires no heating and cooling, requires a lower use level for a given viscosity than pregelatinized starches and requires no premixing with other ingredients to prevent lumping. *(Summary by Food Science and Technology Abstracts)* 101 102.

1470-3121 BASTOS, J. A. M. **Substancias orgánicas como atraentes para a postura do gorgulho,** *Callosobruchus analis* **Fabr., no feijao de corda,** *Vigna sinensis* **Endil.** *(Organic substances as attractions for the weevil, Callosobruchus analis Fabr., which lays its eggs on the cowpea, Vigna sinensis Endl.).* Pesquisas Agropecuarias Brasileiras 4:127-128. 1969. Port., Sum. Port., Engl., 3 Refs., Illus.

Cassava. Entomology. Laboratory experiments. Cassava starch. Uses.

The power of attraction for egg laying *C. analis* of the following organic substances were tested: cowpea seed meal *(Vigna sinensis* Endl.), bean seed meal *(Phaseolus vulgaris* L.), corn starch, cassava starch, wheat meal, corn oil, peanut oil, cane sugar and corn meal. No attraction was evident. The laying capacity of 100 insects was tested by placing them in confinement with some cowpea meal. In 24 hours, 380 eggs were deposited. The organic substances did not attract egg laying. *(Author's summary)* 101

1471-4779 ROSENTHAL, F. R. T. *et al.* **Amidos de mandioca. III. Algumas propiedades uteis em variedades de Minas Gerais.** *(Cassava starches. III. Some useful properties in varieties from Minas Gerais).* Revista Brasileira de Tecnologia 5:173-184. 1974. Port., Sum. Engl., 6 Refs., Illus.

Cassava. Cultivars. Cassava starch. Analysis. Viscosity. Enzymes. Biochemistry. Brazil.

A comparative study was made of the useful properties of starches extracted from cassava grown in Minas Gerais and to observe the correlation of these properties with botanical variety. The Brabender viscosity curves of the starch pastes were observed during heating and cooling, under stirring at several concentrations; some varieties of starch presented high viscosities. The pastes of all starches under study were quite stable under slightly alkaline, neutral and slightly acid conditions. By the action of α-amylase, some pastes were more easily hydrolyzed than the others. The solubilities of the starch films in hot or cold water were quite different. A comparison of the data obtained for the tensile strengths and elongation of starch films showed that they were very similar. The "cooked" color of the starches and the characteristics of the gel after cooking, molding and cooling were also studied. It was concluded that some of the useful properties of the starches varied much more than the others and that they varied even in those starches of cassava resulting from mutations of the same variety, such as the 2 cultivars from Vassourinha, or the 3 from Riqueza. Based on the data obtained some of these starches could have different uses than the other. *(Author's summary)* 101

1472-5321 FOSTER, J.F. and HIXON, R.M. **Relationship between solution viscosity and molecular weight in the amylose series.** Journal of the American Chemical Society 66:557-560. 1944. Engl., Sum. Engl., Illus.

Cassava. Cassava starch. Analysis. Viscosity.

Osmotic pressure values for corn and cassava amylose are given and molecular weights of other members of this series estimated from other considerations. A dependence of intrinsic viscosity on a power of molecular wt greater than unity is indicated, confirming expectations from the comparative rigidity of Fischer-Hirschfelder models of amylose. The rigidity of acetylated amylose molecules in chloroform appears to be the same as that of amylose in ethylenediamine. *(Author's summary)* 101

1473-5325 KERR, R.W., TRUBELL, O.R. and SEVERSON, G.M. **On the multiple amylose concept of starch. II. Amylopectin and amylose.** Cereal Chemistry 19:64-81. 1942. Engl., 17 Refs., Illus.

Cassava. Cassava starch. Analysis.

Refinements in procedures are given for the estimation of amylopectin in corn, cassava and potato starches; it was found that the percentages calculated from diastatic conversion are not as constant for these 3 types of starch as reported by earlier investigators. The material not saccharified by diastase cannot be accounted for solely as γ -amylose, from which it is concluded that the latter is not identical to amylopectin. The more common procedures for separating amylose are reviewed, but in no case was a product obtained which could be converted straightforwardly and quantitatively to maltose with β -amylase. The products from 2 newer methods of fractionating starch are reported, but none of these fractions answers the requirements for either amylopectin or amylose. The concept of amylopectin and amylose, given by Maquenne is still apparently hypothetical; and until it can be demonstrated, caution is advised in the use of these terms for designating various fractions of starch. *(Summary by Chemical Abstracts)* 101

1474-3239 ARMITAGE, F. D. **Starches from roots and other sources; identification by the microscope.** Industrial Chemist 19:267-272. 1943. Engl., Illus.

Cassava. Cassava starch. Particle size. Analysis.

An attempt has been made to identify starch grains according to their geometrical form. In general there are two types of starch grains; i.e., circular and polygonal. Data given deal with buckwheat *(Fagopyrum esculentum)*, cassava, sago palm, yams, ginger, sweet potatoes, horse chestnuts and acorns. For cassava there are 2 types of grains: the smaller ones range from 4-8 µm and are mostly circular or roughly polygonal; the larger grains may vary from 12-30 µm and are shaped like the capital letter D. *(Summary by H.J.S.)* 101

1475-5341 POTTER, A.L. and HASSID, W.Z. **Starch. V. The uniformity of the degree of branching in amylopectin.** Journal of the American Chemical Society 73:997-998. 1951. Engl., Sum. Engl., 7 Refs.

Cassava. Cassava starch. Analysis.

Cassava and corn amylopectins were subfractionated by fractional precipitation with methyl alcohol into 3 and 4 subfractions, respectively. End-group determinations by the periodate oxidation method showed that each of the 3 cassava and each of the 4 corn subfractions possessed approx the same degree of branching as its original parent amylopectin material. These data indicate that all the amylopectin molecules of a particular starch possess the same average number of glucose residues per terminal glucose unit. *(Author's summary)* 101

1476-5323 CROSSLAND, L.B. and FAVOR, H.H. **Starch gelatinization studies. II. A method for showing the stages in swelling of starch during heating in the amylograph.** Cereal Chemistry 25:213-220. 1948. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Cassava starch. Viscosity. Gelatinization. Analysis.

The stages of swelling occurring during gelatinization of certain starches may be shown by viscosity measurements in the amylograph if a viscous water-binding dispersion medium with proper temperature-viscosity characteristics is employed. This fact is demonstrated herein by utilization of sodium alginate and high viscosity type carboxymethyl cellulose. Starches studied include those of corn, wheat, potatoes, waxy maize, cassava and wrinkled peas. Since there was only one stage of gelatinization for cassava, curves were selected in which the peak viscosity was about 850 Brabender Units. *(Author's summary)* 101

1477-5342 FOSTER, J.F. and LEPOW, I. H. **An investigation of the streaming birefringence of amylose solutions.** Journal of the American Chemical Society 70:4169-4173. 1948. Engl., Sum. Engl.,

Cassava. Cassava starch. Laboratory experiments. Analysis.

The amylose component of starch is readily orientable in streaming gradient. A study was made of the effect of temperature, solute concentration and solvent composition using mixtures of glycerol and ethylenediamine as solvent. Comparison of amyloses from corn, cassava,potato and lily bulb starches give results in qualitative agreement with their relative intrinsic viscosities. Results are discussed on the basis of the orientation theory. It was concludedthat the effect in the case of the amyloses in predominantly due to elongation of coiled molecules rather than to simple orientation. *(Author's summary)* 101

1478-3258 MEIKLE, R. A. **The use of cassava starches as a flocculant in the aluminia industry.** Jamaica, ALCAN, 1973. 2p. Engl.

Cassava. Industrial starches.

This is a letter from ALCAN Jamaica Limited to CIAT concerning the use of cassava starch as flocculant in the alumina industry. In Jamaica they use wheat starch and have tested cassava starch. They have been able to obtain satisfactory settling rates but filterability has been very poor. The trend throughout the alumina industry is to move away from the use of natural starches and to adopt synthetic flocculants. The Guyanese Bauxite Company has been using cassava starch for their operation with apparently satisfactory results. *(Summary by H.J.S.)* 101.

1479-3216 BANKS, W. *et al.* **Physiochemical studies on starches; the molecular size and shape of amylopectin.** Starke 24(8):245-251. 1972. Engl., Sum. Engl., Germ., Fr., 38 Refs.

Cassava. Cassava starch. Analysis. Biochemistry.

Light-scattering, viscosity and ultracentrifugal techniques have been applied to a number of amylopectin samples, These measurements have confirmed the very large size of the macromolecule and have shown that such values are not due to aggregation resulting from hydrogen bonding. The hydrodynamic behavior of amylopectin has been compared to that of the closely related glycogen. The difference between the two is due to the much more flexible, coil-like nature of the amylopectin. An examination has been made of the factors governing the extension of amylopectin as the pH is varied; under appropriate solvent conditions, a "coil-tohelix" transformation may be observed. The conformation of the amylopectin molecule is discussed, and the concept that the macromolecule is a two-dimensional entity is proposed. *(Author's summary)* 101

1480-4781 ROSENTHAL, F. R. T. *et. al.* **Amidos de mandioca. II. Estudos de estructura, em variedades de Minas Gerais.** *(Cassava starches. II. Structural studies in varieties from Minas Gerais).* Revista Brasileira de Tecnologia 4(1-2):7-18. 1973. Port., Sum. Engl., 15 Refs., Illus.

Cassava. Cassava starch. Analysis. Viscosity. Cultivars. Enzymes. Biochemistry. Brazil.

Starches of 10 varieties of cassava from Minas Gerais, were studied. According to the Brabender viscosity curves in low concentrations, the starches were divided into 2 groups: those that presented viscosity peaks with the shape of a slanting plateau and those that presented sharp vertical peaks. While being heated in higher concentrations, the plateaus disappear, and all kinds of cassava present high viscosity peaks and little tendency to retrogradation above 8%. Diagrams of swelling and solubility in water show that all these starches present moderate solubility. When submitted to enzymatic action, these starches do not present striking differences in the degree of solubilization. This does not occur when they are solubilized by DMSO. X-ray diffraction patterns show only slight structural differences among some of the starches, not confirming those results obtained by DMSO. The observation of the granules digested, either by DMSO or the enzyme, on the optical microscope showed that way of attack is practically the same for all, the only difference lying in the rates of digestion. The results obtained in the different determinations showed that starches of cassava, some of them resulting from mutations of one same variety, such as the 2 cultivars of Vassourinha or the 3 from Riqueza, present slight structural modifications that show up through the loosening of the associative forces during swelling, through the rupture conditions during solubilization, or the degradation through the action of different agents. *(Author's summary)* 101

1481-3738 FERNANDEZ, O. and ARRANS, A. **Estudio químico de la fécula de *Manihot utilissima*.** *(Chemical study of Manihot utilissima starch).* Revista de la Academia de Ciencias Exactas Físico-Químicas Naturales (España) 43:167-178. 1949. Span.

Cassava. Cassava starch. Composition. Analysis.

Since cassava is being used increasingly for its glucose and starch content (to replace potato starch), a detailed analysis was made of its composition. In general, starch is composed of amylose soluble in water and insoluble amylopectin. Soluble amylose in the cassava starch is higher than in other starches (23%). P is only found in the amylopectin(0.021 g of P_2O_5/100 g of starch).Several analyses were made to determine the presence of silicon, pentosans, uronic acids, acetylic derivatives, and the presence of P in acetylic esters. An enzymatic hydrolysis of starch and amylopectin and a starch and amylopectin hydrolysis with pancreatin were made. *(Summary by S.S. de S.)* 101

1482-1705 NARA, S. *et al.* **Sorption water of starch granules.** Journal of the Agricultural Chemical Society of Japan 43(8):570-574. Jap., Sum. Engl., 19 Refs.

Cassava. Cassava starch. Water absorption. Analysis. Temperature.

Equilibrium levels of sorption water in various starches were determined at 25° and 40°C under varying relative humidities. Sorption levels were higher at 25° than at 40°C, with potatoes and waxy rice having the highest levels, followed by sweet potatoes, cassava and rice. Hysteresis loop areas of adsorption and desorption waters at 25°C were 11.2, 8.0, 8.8, 8.1, 6.4, and 6.0%, respectively. Loop areas were also larger at 25° than at 40°C. Monomolecular sorption water was about 7.7% at 25°C (by Brunauer, Emmet and Teller's formula) and did not differ significantly among the starches. Isothermic sorption heat was constant (by Clausius-Clepeyron's formula) with all starches when sorption water was higher than 20%. *(Author's summary)* 101

1483-5333 BALDWIN, R.R., BEAR, R.S. and RUNDLE, R.E. **The relation of starch-iodine absorption spectra to the structure of starch and starch components.** Journal of the American Chemical Society 66:111-115. 1944. Engl., Sum. Engl., Illus.

Cassava. Cassava starch. Analysis.

Study of absorption spectra confirms the great difference in behavior of amylose and amylopectin with I found by the potentiometric I titration and provides another means of analyzing the 2 components in whole starch. The differences in individual amylose and amylopectin from different starches make a simple colorimetric analysis for the 2 components unreliable. The amount of I bound in complex formation with amylose increases as the concentration of iodide decreases, becoming 1 I molecule for 6 glucose residues for infinitely dilute iodide solutions. The wave length of maximum absorption of an amylose solution shifts toward the red as the chain length of amylose is increased. The shift is in the same direction when the lengths of the unbranched portions of amylopectin are increased. An increase in the molecule extinction coefficient accompanies an increase in the length of amylose or an increase in the lengths of the unbranched portions of amylopectin. Both these properties permit the relative evaluation of mol wt of amylose and degree of branching of amylopectin. The change in the molecule extinction coefficient is the more sensitive. The relative mol wt of a few amylose and the degree of branching of some amylopectin have been examined. Results are in agreement with other determinations. The molecule size, maximum wave length of absorption, extinction coefficient and characteristic potential of cassava amylose are 450; 6,250; 41,600; and 0.200, respectively *(Summary by Chemical Abstracts)* 101

1484-5335, MULLEN II, J.W. and PACSU, E. **Starch studies. Gelatinization of starch in water and in aqueous pyridine.** Industrial and Engineering Chemistry 34(7):807-812. 1942. Engl., Sum. Engl., 13 Refs., Illus.

Cassava. Cassava starch. Gelatinization. Analysis. Particle size.

Gelatinization of potato, cassava, wheat, corn and rice starches was studied in water-pyridine mixtures. Gelatinization of these starches was followed by consistometric methods furnishing data relative to the temperatures, consistencies and heats involved in the process. Correlation was established between these factors and the granule sizes of the different starches. The disaggregation of the starch granules appears to reach a more advanced stage in a mixture containing 30% pyridine. It was also found that the heat absorbed during gelatinization is more than ample to furnish energy for breaking 1 to 2 hydrogen bonds| glucose anhydride unit. Results are given in tables and figures. *(Author's summary)* 101

1485-0593 RASPER, V. **Investigations on starches from major starch crops grown in Ghana. III. Particle size and particle size distribution.** Journal of the Science of Food and Agriculture 22(11):572-580. 1970. Engl., Sum. Engl., 33 Refs., Illus.

Cassava. Particle size. Yams. Starch crops. Maize. Cassava starch. Silting. Analysis. Processing.

Two procedures (sedimentation and Coulter counter) were used for the particle size analysis of starches from major West African starch crops. Data obtained by both methods appears to be in good agreement for large-granule starches. Deviations of average diameters obtained by the sedimentation method from those obtained by the Coulter counter method increased as particle size decreased (below 20μm) the latter method giving higher results. This was confirmed by microscopic examination accompanying the size analysis of all tested samples. Good agreement was found between the size analysis results on **Dioscorea** starches and some of their physical properties that were affected by granule size. To some extent, size and shape of **Dioscorea** starches can be used as a basis for differentiation even between cultivars; starches from different cultivars of plantain (*Musa paradisiaca* L.) and cassava (*Manihot utilissima* Pohl) did not show any significant differences. *(Author's summary)* 101 102

1486-5320 COX, M.J. and McMASTERS, M.M. **Micromanipulative studies on gelatinized starch granules.** Plant Physiology 21:459-466. 1946. Engl., Sum. Engl., 11 Refs.. Illus.

Cassava. Cassava starch. Analysis. Gelatinization. Viscosity.

A micromanipulative study was made of corn, glutinous corn, cassava and potato starches to determine whether length of paste might be correlated with ability of the individual granules to stretch without breaking. There was no apparent correlation between these phenomena. Starch granules pasted at 100°C can be stretched to a greater extent than at 80°C. When identical corn starch samples were pasted at a given temperature for 10, 30 and 60 min and 72 h, a significantly greater stretch was exhibited by the samples pasted for 30 min than for the others all of which were essentially a like in their ability to stretch. Pretreatment of starch granules with 0.2% sulfur dioxide or sodium hydroxide did not affect the percentage of strech. These treatments respectively decreased and increased paste viscosity. Stretching the gelatinized granules did not bring about sufficient realignment of molecules to cause a return of birefringence. Individual granules could be pulled away from the main body of a 3% corn starch paste with ease. Potato starch granules stretched more before separating, but they too came away easily. It was difficult, however, to separate single granules from a 4-5% corn or potato starch gel. Cassava starch has a high paste viscosity. Glutinous corn or cassava starches pasted for 10 min in a boiling water bath could be stretched to about 3 times (200%) in the original granule length, as compared with 157% for corn and 145% for potato starches. *(Author's summary)* 101

1487-5334 LANSKY, S., KOOI, M. and SCHOCH, T.J. **Properties of the fractions and linear subfractions from various starches.** Journal of the American Chemical Society 71:4066-4075. 1949. Engl., Sum. Engl., Illus.

Cassava. Cassava starch. Analysis. Viscosity.

As a preferred mode of fractionation, starch is gelatinized in a buffered Pentasol-water mixture, gently boiled under reflux for several hours, then cooled and refrigerated to precipitate the linear A-fraction. Improved methods have been developed for characterizing the starch fractions in terms of (a) intrinsic viscosity in 1 N potassium hydroxide solution, (b) I affinity by potentiometric titration, (c) reducing value toward alkaline 3,5-dinitrosalicylate reagent, and (d) retrogradation tendency of the linear component. These methods have been employed to describe and differentiate the linear A-fraction and branched B-fractions from corn, wheat, sago, Easter lily, potato and cassava starches. These criteria are also useful in detecting minor hydrolytic changes in the starch substance, in evaluating various modified starches and elucidating the fraction of B-amylase on the starch fractions. A study of the reducing values of the A-fraction toward hypoiodite, bromine, alkaline, copper, ferricyanide and alkaline dinitrosalicylate indicates that none of these reagents is specific for terminal aldehyde groups. A technique has been devised for subfractionating the A-fraction by successive partial precipitations with octyl alcohol. Indirect evidence from I affinities suggests the presence of a material intermediate between strictly linear and highly branched. Some conclusions as to the character of the A-fraction are given. *(Summary by Chemical Abstracts)* 101

1488-5338 CAESAR, G.V. and MOORE, E.E. **Consistency changes in starch pastes. Tapioca, corn, wheat, potato and sweet potato.** Industrial and Engineering Chemistry 27(12):1447-1451. 1935. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Cassava starch. Gelatinization. Analysis.

A new and improved consistometer and technique for studying the pasting phenomena of starches are described. Figures show the consistency record of pastes of cassava flour, heavy- and thin-boiling corn, potato and wheat starches. The usual concentration is 20%; but for cassava, concentrations of 10, 20 and 30% are given. The temperature range extends from the zone where starch and water constitute a milk to boiling and back to room temperature. Therefore, the whole paste history of a starch from cooking to cooling is covered. The degree of degeneration of a starch is sensitively revealed by the form of the curves, where paste temperature is plotted against the net power in watts required to maintain a constant speed of agitation. Each starch thus assumes a characteristic curve form, and a classification into types exhibiting similar characteristics may readily be made. *(Author's summary)* 101

1489-5332 HIGGINBOTHAM, R. S. **The fractioning of starch. V. The determination of the molecular weights of the triacetates of amylose and amylose fractions by osmotic pressure measurements.** Journal of the Textile Institute 42:235-248. 1951. Engl., Sum. Engl., 16 Refs.

Cassava. Cassava starch. Analysis.

The essential requirements for accurate osmometry are discussed, and an improved osmometer is described. The results of measurements on solutions of the triacetates of samples of pure amylose and 2 series of fractions from sago and cassava amylose, respectively, are reported. For most of the work the solvent was nitroethane, but in a few cases, chloroform or l-nitropropane was used well. Nitroethane and l-nitropropane gave the same value of $(\pi | C_2)\ c_2 \rightarrow o$; the values obtained with chloroform different from those with nitroethane, but at 25ºC, the ratio of the value of $(\pi | C_2)\ c_2 \rightarrow o$ in chloroform to that in nitroethane was constant over a wide range of molecular weights and equal to l-25. Possible causes of the discrepancy are discussed. *(Author's summary)* 101

1490-5339 SECK, W. and FISCHER, G. **Zur Kenntnis der Starkegallerten.** *(Starch gels).* Kolloid-Zeitschrift 93(2):207-224. 1940. Germ., Sum. Germ., 24 Refs., Illus.

Cassava. Cassava starch. Analysis. Gelatinization. Viscosity. Hydrolysis.

The relation between gelation properties and swelling behavior of starch is discussed. Only those systems exhibiting elasticity of form as well as elasticity of volume are considered gel-forming systems. The starches (corn, rice, wheat, potato, sago, arrowroot, cassava) were treated as follows: (1) They were swollen in water; (2) some of the swollen starch was boiled with water; and (3) some of the swollen material was passed through a colloid mill. Viscosity and modulus of elasticity (with an elastometer) were determined on these products. The effects of oxidation and hydrolysis were studied. The seed starches are gel-forming while the stem and root starches are not. Gel-forming starches have a low viscosity while the nongel-forming types are highly viscous. No correlation between viscosity and the degree of gel formation was observed. However, there is a relationship between viscosity and the degree of swelling of the starch; i.e., the formation of a form-elastic gel is bound up with the degree of hydration of the starch. Oxidation increases the tendency of the starch to form gels. Hydrolysis with acid decreases viscosity. Amylopectin, the coarsely dispersed constituent of the starch grain, is considered as the main structural element of the form-elastic starch gels. *(Summary by Chemical Abstracts)* 101

1491-2418 WURZBURG, O.B. and SZYMANSKI, C.D. **Modified starches for the food industry.** Journal of Agricultural and Food Chemistry 18(6):997-1001. 1970. Engl., Sum. Engl., 4 Refs. Illus.

Cassava. Maize. Industrial starches. Human nutrition. Food thickeners. Food stabilizers. Food products. Modified starches. Uses.

Within the past few decades, modified starches have broadened the scope of usefulness of starch. Modified food starches provide improved viscosity control over a broad range of processing variables; e.g., pH, temperature and shear. These products have also provided additives which lengthen the cold-storage stability of products, while contributing to their organoleptic properties. Two techniques of modification, crosslinking and stabilizing groups, and the effects of both on starch properties are discussed. Modified starches provide the food processor with an adaptable tool to meet specific requirements of a variety of food systems. *(Author's summary)* 101

See also 1633 1737 1831 101

1492-2350 ADEYINKA, D. and AKRAN, C. D. **Improvements on the 1 ton| day gari plant.** Nigeria. Federal Institute of Industrial Research. Research Report no. 24. 1964. 14p. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Cassava starch. Industrialization. Processing. Water requirements (Processing). Washing. Peeling. Rasping. Screening. Silting. Silting agents. Drying. Solar drying. Steeping. Industrial machinery. Nigeria.

Cassava roots contain between 15 and 30% starch and have been commercially exploited in various parts of the world for the manufacture of starch. Recently, interest has been shown —both by government organizations and private enterprise— in the manufacture of tapioca starch from cassava roots in Nigeria. This technical memorandum gives a comprehensive survey of the various methods of manufacturing tapioca starch in different parts of the world. An analysis of a sample of tapioca starch prepared at the Institute on an experimental basis, as carried out by the Royal Tropical Institute in the Netherlands, is also included. *(Author's summary)* 102

1493-1867 RUIZ, J. F. **Stand und Entwicklung der Starkeindustrie in Venezuela.** *(The starch industry in Venezuela).* Starke 15(1)31-32. 1963. Germ.

Cassava. Cassava starch. Factories. Glucose industry. Dextrins. Trade. Venezuela.

Two developmental stages of starch production in Venezuela are described: (a) The small, labor-intensive units. A brief description is given of a small, hand-operated "rajadero," in which the starch is precipitated by placing cassava chips on a concrete pad, where they are sun dried. Because of this small-scale industry, the country's starch requirements were not met. Tables are given on starch imports in Venezuela until 1958, at which time the Government taxed starch imports to promote domestic production. (b) Modern plants in El Pao and Caracas were built to meet domestic demands for the paper and textile industries. In 1963 production was further increased, and a glucose syrup processing plant was added. The main problem was the insufficient supply of raw material; therefore, private industry, in cooperation with government agencies, is involved in fertilizer trials, developing better varieties and better cultivation techniques. *(Summary by A. van S.)* 102

1494-0131 BOOTH, R. H. **Post-harvest deterioration of tropical root crops: losses and their control.** Tropical Science 16(2):49-63. 1974. Engl., Sum. Engl., Fr., Span., 48 Refs.

Cassava. Storage. deterioration. Harvesting. Tubers.

This reviews work done on postharvest problems of tropical root crops: cassava, yams, sweet potatoes, potatoes and aroids. These have been estimated as providing the staple food for about 400 million people. With the possible exception of sweet potatoes and potatoes postharvest losses of these crops have been little studied. For example, about half the total root crop production in the tropics is provided by cassava, and little is known as to why this crop cannot normally be kept in the fresh state for more than 2 to 5 days after harvest. Deterioration, manifested in loss of quality or quantity, results from pathological, physiological or mechanical damage. Reduction in mechanical damage is considered of paramount importance by the author. Whereas gross mechanical damage can only be reduced by improved methods of harvesting and handling, smaller wounds that may promote physiological and pathological losses may be healed by a process known as "curing." Curing reduces storage losses of sweet potatoes, potatoes and yams and is now reported to prevent rapid posharvest deterioration of cassava. Whilst physiological and pathological losses may also be reduced by the use of chemicals and refrigeration, such techniques are limited in application in the tropics by economic and organizational factors. The author emphasizes the need for a greater understanding of the postharvest losses that occur in this important group of crops so that simple control measures can be sought. *(Author's summary)* 102

1495-2377 COHENCA, J.M. **La industria de la mandioca en el Paraguay.** *(Cassava industry in Paraguay).* Paraguay, Universidad Nacional de Asunción, 1966. 29p. Span., Sum. Span., 9 Refs.

Cassava. Processing. Cassava flour. Food products. Bakery products. Composition. Factories. Industrialization. Production. Industrial machinery. Development. HCN content. Nutritive value. Legal aspects. Paraguay.

This study describes various aspects of cassava technology and production capacity in Paraguay. There is also a discussion of prices, production costs, and other factors affecting this industry. Note is made of the views and observations of cassava farmers and manufacturers alike, and recommendations are duly made. Also included are data on cassava's HCN content, both in roots and in processed flour. There are data on cassava's chemical composition and nutritional value, and there is a discussion on the production of cassava flour and the various legal aspects governing this activity. *(Author's summary. Trans. by N. U.)* 102

1496-0139 EDWARDS, D. **The industrial manufacturing of cassava products: an economic analysis.** Tropical Products Institute. Report no. G88. 1974. 42p. Engl., Sum. Engl., Fr., Span., 30 Refs.

Cassava. Cassava products. Economics. Marketing. Trade. Consumption. Distribution. Prices. Processing. Cassava starch. Pellets. Cassava chips. Animal nutrition. Industrial machinery. Production. Costs. Factories. Legal aspects. Industrialization. Development costs. Packing. Tubers. Development. Income.

This is one of a series of economic studies designed to facilitate investment decisions within developing countries. The basis of the report is a set of financial and physical cost models in which processing methods and modes of operation are compared. Although the financial analysis is based on factor costs in a Southeast Asian country, the physical requirements are presented so that by appropriate adjustments for local yields and other factors, the factor costs can be readily applied to other areas. A description of the manufacturing processes is given. As well as details of manufacturing requirements, the supply of cassava tubers is considered. The interaction of supply to an industrial enterprise with subsistence farming and other food uses necessitates careful planning of supplies if the enterprise is to operate successfully. Accordingly, a simple costing has been made of a plantation from which part of a factory's supply of cassava tubers can be drawn. This has been used as the basis of supply for one of the cost models. The cost models can be divided into two sections: four for the production of chips and pellets and four for the production of starch. A detailed analysis of these models is given, and working assumptions and results are discussed. A comparison is made of the relative profitability of the models. Commercial requirements and official standards for cassava products are outlined in an appendix. *(Summary by T.M.)* 102 J00

1497-0004 RONALD, K.S. **Crystal gum made from tapioca, a low viscosity product with good textural properties; improves sauces, confections and coatings.** Food Processing (England) 24(12):101-106. 1963. Engl.. Illus.

Cassava. Tapiocas. Uses. Food products. Confectionaries.

Crystal gum, a new tapioca product that combines low viscosity with good color, clarity and flavor properties, is used as a component to improve the quality of a wide range of foods. This product is designed to meet the need for a textural ingredient in food that will impart desirable end properties at comparatively high application levels. Unlike conventional low-viscosity starches, it is light in color, has good clarity and a bland taste: Viscosity of crystal gum is 7,000 to 20,000 centipoises in a 55% solids dispersion and is comparable to gum arabic at the same concentration. This product has been used as a dispersing agent for fats, as a constituent in gum candies, and as a coating and glazing agent. A detailed description of the application of this product is presented. *(Summary by J.L.S.)*102 H01

1498-0320 INGRAM, J.S. **Some traditional food products from tubers of cassava (*Manihot esculenta* Crantz).** n.d. 6 p. Engl., 11 Refs.

Cassava. Gari. Kpokpo gari. Kakayake. Agbeli kaklo. Farinha. Casave. Processing. Food products. Human nutrition. FooFoo. Bakery products. Cassava flour. Dried tubers. Cassava bread. Venezuela. Nigeria. Ghana. Brazil. Trinidad and Tobago.

The author describes local methods and utensils used in the preparation of native foods made from cassava in the following countries: Nigeria, Ghana, Brazil, the West Indies and Venezuela. *(Summary by P.A.C.)* 102

1499-0148 MOREIRA, N. **Novos alimentos de mandioca e sua industrialização.** *(A new cassava food and its industrialization).* Lavoura no. 71:35-36. 1968. Port.

Cassava. Cassava products. Cassava flour. Processing. Industrialization. Brazil.

The paper deals briefly with traditional cassava flour processing, and discusses a new homemade cassava machine, which was tested to obtain a cassava flour with a higher starch content and lower fiber content than current processing. This type of cassava flour is known as "farinha de cagé," costs NCR$0.60 per kg, and has many home uses. *(Summary by A. N.)* 102

1500-2152 GEORGI, C. D. V. **Notes on the fertilizing value of tapioca refuse.** Malayan Agricultural Journal 10:218. 1922. Engl.

Cassava. Wastes. Composition. Industrialization. Manures. Waste utilization. Malaysia.

An inquiry has been made as to the utilization of refuse from tapioca factories as a fertilizer. This refuse is a grayish white powder containing a proportion of short fibers. The results of analysis are as follows: moisture 11.6, ash 28.7, organic and volatile matter (by difference) 59.7, N 0.61, potash 0.58, phosphoric acid 0.56%. Although the use of refuse is uneconomical because of transportation costs, it could however be utilized to advantage in situ. *(Summary by Chemical Abastracts)* 102

1501-0013 JOHNSON, M. O. **Drying as a method of food preservation in Hawaii.** Hawaii, Agricultural Experiment Station. Bulletin no. 7. 1918. 31p. Engl., Sum. Engl., Illus.

Cassava. Drying. Cassava flour. Processed products. Roots. Composition. Water content. Protein content. Fat content. Fibre content. Ash content. Starch content. Cortex. Bakery products. Food products. Composite flours. Substitutes. Taro. Sweet potatoes. Potatoes. Wheat. Costs. Economics. Production. USA.

The principles and methods of drying are discussed with relation to Hawaiian conditions. The construction and use of a homemade air drier with a capacity of about 150-200 lbs wet material, is given in detail. This drier has given good results in experimental work. Results are given of experiments in drying the banana, taro, cassava, sweet potato, edible canna and Irish potato. A detailed discussion is given of various Hawaiian food products as sources for substitutes for wheat flour. Of the various wheat flour substitutes, flour made from the cassava root appeared the most promising, being the finest, whitest flour with the lowest cost of production. *(Author's summary)* 102

1502-0878 SPECIFICATION FOR **tapioca flour for use in the cotton textile industry.** **New Delhi, India. Indian Standard IS:2033. 1962. 9p. Engl., Illus.**

Cassava. Industrialization. Textiles. Legal aspects. Cassava flour. Industrial starches. Uses. India.

These specifications prescribe the requirements for cassava flour for use as a sizing material in the cotton textile industry. Methods of testing for various characteristics of cassava flour are also given. *(Summary by H.J.S.)*102

1503-0192 NEW WAYS OF **preparing tapioca as a substitute for rice.** Malayan Agricultural Journal 30(2):91-92. 1947. Engl.

Cassava. Cassava flour. Processing. Malaysia.

This is a brief commentary on the preparation of cassava flour and its use as a possible substitute for rice. *(Summary by J.L.S.)* 102

1504 0144 LIMA, U. DE A. **Sôbre farinha de mandioca.** *(Cassava flour).* Suplemento Agricola (Brasil) 13(617):12. 1967. Port.

Cassava. Cassava flour. Processing. Brazil.

Comments are given on how to prepare cassava flour in Brazil's rudimentary mills. The roots are washed, peeled, ground, squeezed and screened; the resulting wet mass is toasted and packaged. *(Summary by A. N.)* 102

1505-0897 CHECCHI AND COMPANY, WASHINGTON. **Prospects for a tapioca starch industry in Guinea.** Washington. 1964. 57p. Engl., Sum. Engl., Illus.

Cassava. Uses. Industrial machinery. Processing. Drying. Storage. Costs. Planting. Harvesting. Cassava starch. Industrialization. Marketing. Economics. Production. Cultivation. Development. Factories. Developmental research. Tubers. Prices.Guinea.

Cassava grows very well in Guinea, and conditions for its expanded cultivation are excellent from the point of view of soil and climate. The sweet variety is chiefly grown for domestic use on an individual farmer basis. It was apparent that there was no surplus of roots grown; thus there is no raw material for industrial purposes. The team recommended that an industry should be built up, starting on a small manageable scale over a period of years. The rate of buildup would depend upon how quickly a cheap supply of better variety roots could be developed. Only then can manufacture be justified with a view to supplying the highly competitive world markets. At present the price level of roots is so high that this is out of the question; therefore, a small industry should be started with a view to supplying local needs only. It is also recommended that together with the first plantations of bitter cassava, which is more suited to an industrial process than the sweet variety, a small factory should be erected in the same area to produce starch from roots harvested from these plantations. Part of the production of this factory can be sold to the textile factory, which should be in production in early 1965 and requires 250 tons per year. The remainder can be sold on the local market for starching clothes and for food purposes. There is also a possibility that adhesive may be required by the chipboard factory and plywood factory now under construction at Seredou and Nezerekore, respectively. A further substantial outlet could certainly be developed if the Government decides (as in Brazil) to mix cassava flour with wheat flour. This might well provide an offtake for several thousand tons per year. When this stage is in sight and provided that the operations of the first pilot plant are going well, it will then be possible to extend the operations by opening up new plantation areas and developing further factories within the new growing areas. When roots can be produced at a factory-delivered price of $7.50 to $9.00| ton and in sufficient volume, it will be time to consider setting up of a larger factory to produce a higher grade of flour suitable for export to the world markets. It may be five years or more before conditions can develop sufficiently to start an export industry. *(Author's summary)* 102

1506-0752 NORMANHA, E.S. **Mandioca tem variada aplicação.** *(Cassava has several uses).* Guia Rural (Brazil) 1966-67:240-244. 1966-1967. Port., Illus.

Cassava. Industrialization. Farinha. Alcohol. Factories. Processing. Cassava starch. Cassava meal. Production. Brazil.

Small- and large-scale production of cassava starch and flour in Brazil are described, in addition to the production of ethyl alcohol. *(Summary by H.J.S.)* 102

1507-0155 MENDES, C.T. **A mandioca e o alcool motor.** *(Cassava and power alcohol).* Notas agricolas (Brazil) 6:55-59. 1949. Port.

Cassava. Alcohol. Production. Uses. Brazil.

This paper presents a general overview of the uses of absolute alcohol mixed with gasoline or as its substitute in motors. Sugar cane, potatoes and maize were considered as raw materials. Comparing cassava as a raw material for industrial alcohol, it was shown that 1 ton of cassava roots produced 1 liter of absolute alcohol, being a cheaper source than sugar cane. *(Summary by A. N.)* 102

1508-0121 GOVEA, V. DE S. **Alcool de mandioca por fermentação continua.** *(Cassava alcohol by continuous fermentation).* Revista Latinoamericana de Microbiología. 15(3):147-150. 1973. Port., Sum. Port., Engl., 20 Refs.

Cassava. Alcohol. Ethanol. Production. Industrial microbiology. Processing. Fermentation. Analysis. Brazil.

Through continuous fermentation, a process of converting cassava into ethyl alcohol was tried in order to obtain competitive results when compared with the current industrialization of alcohol from sugar cane. The saccharification of cassava slurries by enzyme-enzyme method yields 96.2% dextrose. The enzymes used for this purpose (amylase and amyloglucosidase) were obtained from *Bacillus subtilis* NRRL B941 and *Aspergillus awameri* NRRL 3112, respectively, cultivated in a cassava medium. The alcoholic fermentation on a semi-industrial scale was carried out in a "continuous culture apparatus," model CF 500, using *Saccharomyces cerevisiae* ATCC 1133 as the fermentation agent. The glucose medium obtained by this all-enzyme system has proven to be excellent for alcoholic fermentation without the addition of artificial nutrients, yielding 90.87% in the conversion of glucose to ethyl alcohol. *(Author's summary)* 102 103

1509-2193 PACHECO J. A. DE C. Observações preliminares sobre a influencia da variedade de mandioca na viscosidade do polvilho. *(Preliminary observations on the influence of cassava variety on starch viscosity).* Revista de Agricultura (Brasil) 31:337-366. 1956. Port., Sum. Port., Engl., 5 Refs., Illus.

Cassava. Cultivars. Industrialization. Analysis. Viscosity. Marketing. Processing. Cassava starch. Brazil.

In order to maintain a solid position on the consumer market, Brazilian starch must maintain high, uniform standards, with as little variation as possible from one factory to another. Inadequate industrial operations are often responsible for variations in the finished product. Other factors may also influence quality; research carried out with other plants has indicated that variety plays a very important role in viscosity. The author describes two sets of experiments designed to determine whether this is true in cassava. The first six varieties studied were Castelinha, Mata-forme, Ipe, Vassourinha, Pao do Chile and Cuiabana. Starch viscosity was determined, using an Engler viscosimeter. Results showed great differences; but in spite of some production deficiencies, the results were interesting. The second experiment was carried out using varieties that are largely cultivated for industrial purposes: Vassourinha, Branca Central, Branca de Santa Catarina, and Marion. For greater accuracy, viscosity was measured with an Engler viscosimeter and with a Brabender amylograph. Starch samples were not classified according to size of granules, as the aim was to verify differences among varieties and between the methods of measurement. The following conclusions were reached: (1) There is no doubt as to the influence of plant variety upon starch viscosity. (2) Differences are great at all points during the development of viscosity. (3) Results can be used as practical guides, but further observations must be made. (4) Engler results are of little value because (a) only one point of the curve is measured, and this cannot be the point of highest viscosity; (b) it is impossible to have sufficiently uniform operations because of differences among operators. *(Summary by T.M.)* 102 C03

1510-2328 RAUX, J. **L'emploi du manioc en brasserie.** *(Use of cassava starch in the brewing industry).* Brasseur Francais 4:7-8. Fr., Sum. Fr.

Cassava. Cassava beer. Beverages. Food products. Processed products. Uses. France.

Cassava starch, as a substitute for rice and corn, is very advantageous from the standpoint of extraction but must be neutralized with H_2SO_4 for normal saccharification because it possesses a strong alkali; in other words, it fixes by adsorption part of the acids existing in the malt and the added acids. Addition of the acid is preferably carried out when the wort is returned to the brewing vat. *(Author's summary)*102

1511-0990 NEWEL DUNFORD gari plant. n.p. 1972. 8p. Engl., Illus.

Cassava. Food products. Industrialization. Gari. Fermentation. Factories. Processing. Development research. Nigeria.

Information on cassava fermentation at the Newell Dunford Gari Plant and the F.I.I.R. Pilot Plant (Nigeria) is presented. There are great differences of opinion on the following: time required for fermentation, the use of inoculant or starter obtained from press liquor, and the type of vat to be used. Proposals for the improvement of gari manufacturing and a diagram of a gari plant are given. *(Summary by H.J.S.)* 102

1512-0970 FAVIER, J.C., CHEVASUS-AGNES, S. and GALLON, G. **Les amylaces du Cameroun; II. Les transformations technologiques du manioc; leur influence sur la valeur nutritive.** *(The starch crops of Cameroon; II. Processing of cassava. The effect on nutritive value).* Yaounde, Centre de l'Office de la Recherche Scientifique et Technique d'Outre-mer 1969. 99p. Fr., 60 Refs., Illus.

Cassava. Consumption. HCN. Minerals. Processing. Digestibility. Gari. Food products. Ca. Production. Human nutrition. Supplements. Analysis. Fibre content. Vitamin content. Cassava pastes. Composition. Nutritive value. Iron. Fat content. Water content. Food energy. Proteins. Cassava meal. Economics. Industrialization. Africa. Cameroon. Angola. Congo. Ghana. Nigeria. Malagasy Republic.

Cassava is dug as it is needed, so its production is difficult to estimate. In the French-speaking east Cameroon it was about 525,000 tons calculated from area, planting density and yield from agricultural statistics, or 490,000 tons calculated from population and average daily intakes ranging from 991 g in the east to 3 g in the north. In 1966, FAO estimated it as 450,000 tons, with another 250,000 for the rest of the country (the English-speaking west Cameroon). Production and intake for other African countries are also noted. The corky layer of the cassava tuber is easily peeled off. The inner 1- or 2 mm-thick layer, although richer in nutrients than the rest, has to be removed because of its high content of cyanogenetic glucosides and fiber. Tables give the proximate composition and content of minerals and vitamins for the peeled tuber and the inner cortex, raw and cooked. The weight and percentage loss or retention of constituents for the other cassava products, such as the sticks of cooked paste and cooked paste made of sun-dried or smoke-dried flour are given sometimes after storage and at different stages in their preparation. Digestibility of starch is presented in graphs. Nutrient losses were great, especially in ascorbic acid, thiamin, nicotinic acid and Ca and more so when the tubers were peeled before being soaked. Fe sometimes increased by contamination. Commercial production of industrial starch from cassava is not worthwhile, but that of foodstuffs may be. A mill in Adamawa already produces 600 to 700 tons of flour a year from sun-dried cassava for the towns, mostly for communal feeding. Ways are suggested in which cassava might replace imported grain for brewers and bakers; results of preliminary trials are encouraging but psychological and technical difficulties are expected. Commercial production of starchy baby foods and of traditional foods, and the use of cassava for growing microorganisms for protein are discussed. Cassava, though not a balanced food, is an important staple, and it would be better to find ways of fortifying it than to attempt to discourage its use. *(Summary by Nutrition Abstracts and Reviews)* 102 H01

1513-2310 BAYBAY, D.S. **Storage of some root crops and other perishable farm products.** Philippine Agriculturist 10(9):423-440. 1932. Engl., Sum. Engl., 6 Refs.

Cassava. Sweet-potatoes. Yams. Maize. Vegetable crops. Diseases and pathogens. Pests. *Xanthosoma sagittifolium*. Colocasia. Storage. Tubers. Philippines.

Results are given of experiments carried out to determine successful storage methods for a variety of root crops and other perishable produce. As regards cassava, it was found that it could not be stored long in any kind of storage room. Over a 25-day storage period in cellars, the lowest percentage of loss was 63.96. *(Summary by T.M.)* 102

1514-0272 KUPPUSWAMY, S. **Studies on the dehydration of tapioca.** Food Science 11(4):99-100. 1962. Engl.

Cassava. Processed products. Cassava flour. Toxicity. Human nutrition. Storage. HCN. Drying. India.

Comments are given about dehydration of cassava. It was observed that carefully prepared cassava flour can be used as a substitute for flour made from corn, wheat, rice and pulses in many food preparations. It is suggested that the dehydration process needs to be demonstrated to the growers at the centers of production. *(Summary by H.J.S.)* 102

1515-2140 KRUIJFF, E. DE. **Iets over gaplek, cassave meel, tapioca en flake.** *(A note about gaplek, cassava flour, tapioca and flakes).* Teysmannia 20:433-435. 1909. Dutch.

Cassava. Human nutrition. Gaplek. Processing. Cassava products. Dried tubers. Tapiocas. Cassava flour. Tapioca flakes.

Certain uses of cassava are briefly described. Gaplek is a local food; in the process cassava roots are peeled, sliced lengthwise and sun dried. Cassava is exported to Europe for alcohol and flour production. Cassava flour is used for stiffening cloth and in the bakery industry. Tapioca flakes, pearls, etc. are products obtained by gelatinization of starch. *(Summary by A. van S.)* 102

1516-0951 MAKING TOP-GRADE **tapioca flour; newly engineered line raises output, quality of Brazilian product.** Food Engineering 24:132-135. 1952. Engl., Illus.

Cassava. Processing. Factories. Cassava flour. Brazil

A description is made of the high-quality cassava flour being manufactured in factories in southern Brazil. A flow diagram of the process is given as well. *(Summary by H.J.S.)* 102

1517-0429 DIAZ D., R.O. **Industrialización de la yuca.** *(Cassava industrialization).* Palmira, Colombia, Centro Internacional de Agricultura Tropical, 1972. 12p. Span., 38 Refs., Illus.

Cassava. Cassava chips. Cassava meal. Industrialization. Processing. Cassava starch. Uses. Industrial machinery. Colombia.

This is a summary of a lecture on cassava given to CIAT's trainees. The following areas are discussed: cassava as a raw material for human nutrition, animal feeding and industrial uses. The processing of cassava meal, starch and chip manufacturing and diagrams of the processes are included. Cassava and maize industrialization are compared. Diagrams are included of industrial machinery used in Colombia for manufacturing cassava starch. *(Summary by R.O.D.)* I02

1518-0886 **TAPIOCA Bovril Research Library Bulletin no. 4:1-3. 1969. Engl.**

Cassava. Tapiocas. Cultivation. Uses. Human nutrition. Processing.

Data given on cassava refer to its cultivation, uses, preparation of tapioca and advantages of its products as compared to other starch foodstuffs. *(Summary by H.J.S.)* I02 D00

1519-0888 NARAYANA RAO, M. *et al.* **Quantitative determination of fibre present in tapioca starch and sago globules.** Journal of Scientific and Industrial Research. Section B. (India) 15(4):202-204. 1956. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Sago. Food products. Cassava starch. Composition. Fibre content. Analysis. Laboratory experiments. Malaysia.

A colorimetric method for the detection and approximate quantitative estimation of fiber in cassava starch and sago is described. The method is based on the aniline acetate color test for pentosans present in the fiber. The starch was found to have a 1% fiber content. *(Author's summary)* I02

1520-0903 SCHMIEDEL, W. L. VON. **Bau und Einrichtung einer modernen Maniokstärkefabrik.** *(Building and establishing a modern cassava starch factory).* Stärke 11(9):271-276. 1959. Germ., Sum. Germ., Engl., Fr., Illus.

Cassava. Tubers. Industrial machinery. Cassava starch. Industrialization. Factories. Distribution. Productivity.

After briefly explaining the demands of developing countries, expedient methods for transporting roots and improving yield and starch quality are given. The fundamental layout of machinery for a cassava starch factory is illustrated, together with building plans. *(Author's summary)* I02

1521-0873 BERGAMIN, F. **Residuos da mandioca.** *(Cassava waste products).* Suplemento Agricola (Brazil) 13(616). 1967. Port.

Cassava. Industrialization. Wastes. Ecology. Brazil.

A description is given of the pollution of the streams and rivers in the state of São Paulo caused by cassava industries. Procedures employed for detoxification of water have failed mainly because this activity has been administered by private industry and not by the Government. *(Summary by H.J.S.)* I02

1522-0882 HOLLEMAN, S. W. J. **Les nouvelles méthodes de recherches concernant la qualité du tapioca** *(New methods for quality research on tapioca).* Etudes d'Outre Mer 38:97-104. 1955. Fr., 3 Refs., Illus.

Cassava. Processing. Viscosity. pH. Industrialization. Legal aspects. Laboratory experiments. Tapiocas. Fibre content. Ash content. Water content. Analysis. Composition. Brazil. Java.

The author discusses research work on the quality of tapioca carried out at the Chemical Research Laboratory, Bogor (Indonesia). Investigations covered the water content, color intensity, viscosity, mesh, degree of acidity and ash content. A comparison is made to current American methods. *(Summary by Tropical Abstracts)* I02 C03

1523-0924 **INSTALACAO PARA produzir farelo de hastes e ramas de mandioca para substituir a alfalfa, nas regiões tropicais.** *(Installations for the manufacturing of bran from cassava stems and branches as a substitute for alfalfa in tropical regions).* n.p. 1951? 12p. port.

Cassava. Brans. Stems. Leaves. Processing. Nutritive value. Feeds and feeding. Economics. Costs. Industrialization. Proteins. Vitamin A. Animal nutrition. Substitutes. Alfalfa. Costa Rica.

Bran produced from cassava leaves and branches bears 17.63% protein, 22.20% fiber and 208,000 IU of Vitamin A. Positive results were obtained when the cassava meal was used for dairy cow feeding. Five tons of fresh stems and branches render 1 ton of dried bran. Costs and profits concerning the production process are calculated. A plan is presented for small-scale cassava growers of Costa Rica to supply the raw material for the bran preparation. *(Summary by H.J.S.)* 102 H03

1524-0946 LEVI, S. S. and ORUCHE,C. B. **Some inexpensive improvements in village-scale gari making.** Lagos, FEDERAL Ministry of Commerce and Industry. Research Report no. 2. 1958. 10p. Engl., Sum. Engl., Illus.

Cassava. Gari. Fermentation. Industrial machinery. Processing. Food products. Human nutrition. Industrialization. Factories. Rasping. Pressing. Secreening. Nigeria.

Gari is an important staple food in many parts of west Africa. It is prepared from the root of cassava *(Manihot utilissima).* In the process, the starch is modified by fermentation and frying, resulting in a granular, gelatinized product with cold swelling properties and a distinctive sour flavor. Gari is made almost exclusively by a village process consisting of the following stages: (1) washing and peeling, (2) grating, (3) pressing and fermentation, (4) sifting and frying, (5) sifting of the finished product. Inexpensive improvements in the equipment used in grating, pressing and frying including detailed drawings and a simple seeding method, which will considerably cut down the time of fermentation, are described. *(Author's summary)* 102

1525-0883 BAINS, G. S. *et al.* **Investigations of grain substitutes. II. Storage quality of grains from blends of tapioca and groundnut.** Bulletin. Central Food Technological Research Institute. (India) 3(7):183-186. 1954. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Groundnut flour. Storage. pH. Temperature. Processing. Food products. Substitutes. Diets. Cassava products. Water content. Packaging. Composition. Cassava flour. Composite flours. India.

Synthetic food grain prepared from a blend of cassava and groundnut flours is hygroscopic in character, like natural cereals. The moisture content of the product tends to play an important role in influencing its storage behavior. If the moisture content is below 7%, the product becomes oxidatively rancid whereas moisture above 7 % acts as an antioxidant, providing a simple and inexpensive means of controlling rancidity. The grain containing 7-11 % moisture has been found to store well for 8-10 months under normal conditions. The product is fairly insect resistant and offers no special storage problems as compared to the natural grains, except that it should not be exposed to rain and excessive relative humidity. *(Author's summary)* 102

1526-0902 FULLGRABE, A. **Maniokawurzelverarbeitung.** *(Processing of cassava roots).* Stärke 8(2):27-37. 1956. Germ., Sum. Germ., Engl., 18 Refs. Illus.

Cassava. Tubers. Harvesting. Processing. Washing. Peeling. Grinding. Pressing. Silting. Drying. Screening. Water requirements (processing). Cultivars. Composition. HCN content. Starch content. Carbohydrate content. Ash content. Fibre content. Ca. P. Mineral content. Industrialization. Iron. Industrial machinery. Cassava flour. Cassava starch. Philippines.

The processing of the cassava root into flour and starch is described, using a plant in the Philippines as an example. Details of the raw material, the finished product, the manufacturing and the net production costs are given. *(Author's summary)* 102

1527-0948 AKINRELE, I. A. **The water relations of some processed Nigerian foods.** Nigeria. Ministry of Commerce and Industry. Federal Institute of Industrial Research. Research Report no. 33. 1965. 10p. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Gari. Food products. Temperature. Processing. Fermentation. Composition. Human nutrition. Water content. Packaging. Nigeria. Africa.

The water content of gari and other Nigerian processed food has been found to change considerably under different humidities, making it necessary to package them against ambient conditions. The process of "garification" seems to consist of 2 distinct stages which could, however, be satisfactorily combined as in traditional processing, when 1 g of fermented cassava pulp (47% moisture content) was fried at 140°C on a 3.5 cm^2 surface for a period of about 15 minutes. *(Author's summary)* 102

1528-0841 PAKISTAN COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH. **Biochemical and nutritional studies of some starches.** *In*_______. Report on the work of East Regional Laboratories 1959-1961. Dacca, 1962. pp. 30-31. Engl.

Cassava. Cassava starch. Analysis. Biochemistry. Nutritive value. Pakistan.

The following aspects are briefly studied: starch from cassava *(Manihot utilissima)* and shati *(Curcuma zedoaria)*; quality of sun-dried fish; protein-rich diets; ascorbic acid in vegetables; biochemical and nutritional studies of raw and parboiled rice and starches; powdered rice and wheat; starch content of potatoes; recovery of vitamin C and removal of tannin from amlaki *(Phyllanthus emblica)*; composition of banana *(Musa paradisiaca)* and tamarind *(Tamarindus indica)*. *(Summary by Nutrition Abstracts and Reviews)*102

1529-0899 TORRES, F. S. **The manufacture of cassava starch.** Philippine Agricultural Engineering Journal 1953-54:184-186. Engl., Illus.

Cassava. Processing. Factories. Production. Forestry. Productivity. Harvesting. Industrialization. Washing. Rasping. Drying. Screening. Cassava starch. Philippines.

Cassava starch was manufactured by the Ramona Milling Co. at Porac (Pampanga) in the 1930's. The factory had a capacity of 40 tons of fresh roots per 24 hours. The steps in the manufacture of starch were washing, rasping, sieving, sedimentation (the sedimenting canals were made of Oregon pine (which was) found to be stainless, water resistant and not subject to warping), rewashing, centrifuging, drying, pulverizing, bolting and bagging. The recovery of starch ranged from 2.50-3.50 piculs (1 picul = 63 kg) per ton of roots. The annual average yield was only about 8 ton|ha, and it was calculated that an average 16 ton|ha was necessary to break even. Attempts were made for the mechanization of harvesting. *(Summary by J.L.S.)* 102

1530-0876 HOLLEMAN, L. W. J., GOETHALS, C. A. and SOENARTO, R. **A simple remilling process for tapioca.** Journal for Scientific Research 1(5):130-134. 1952. Engl., Sum. Engl., 4 Refs.

Cassava. Food products. Processing. Drying. Viscosity. pH. Legal aspects. Cassava flour. Tapiocas. Grinding. Water content. Composition. Ash content. Production. Costs. Java.

By a simple remilling procedure, principally consisting of washing a crude and variable rural product with water, a cassava flour may be produced which, apart from quality features governed by purely mechanical operations (mesh and pulp) or by atmospheric conditions (moisture content) comes within grade A of the specification system for this kind of flour prevailing in the United States. The process, especially with regard to viscosity, is successful only if starting with the crude flour from rural factories before drying. Differences in quality of the individual lots subjected to remilling are partly eliminated by the process. If suitably completed and adapted to large-scale conditions, the method is to be recommended for the production of Java tapioca of improved quality. *(Author's summary)* 102

1531-0724 CHIRIFE, J. **Diffusional process in the drying of tapioca root.** Journal of Food Science 36(2):327-330. 1971. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Tubers. Drying. Laboratory experiments. Water content. Composition. Industrialization. Processing. Analysis. Argentina.

Experimental results obtained in the through-circulation drying of cassava root slices were analyzed to determine the effective diffusivity. Results are in good agreement with the theoretical solution which assumes that diffusivity is constant; however, for a better comparison, a model with variable diffusivity appears to be necessary. It can also be seen that as temperature increases, the constant diffusivity model approximates the experimental results closely. The assumption that water migrates within the root by a process of liquid diffusion is also confirmed by the Arrhenius-type temperature dependence of calculated values of the effective diffusivity. *(Author's summary)* 102

1532-0949 ADEYINKA, O. and AKRAN, C.D. **Improvements on the 1 ton|day gari plant.** Nigeria. Ministry of Commerce and Industry. Federal Institute of Industrial Research. Research Report no. 29. 1964. 24p. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. Food products. Gari. Fermentation. Production. Processing. Mechanization. Industrial machinery. Human nutrition. Factories. Industrialization. Economics. Nigeria. Africa.

This is a summary of new ideas, research and designs ... out on the mechanized production of gari. The report is primarily concerned with modifications ... fyer, with a view to improving the general product quality. No attempt has been made to eco... fuel or labor. General product quality was achieved by reducing the large number of lumps formed ... garifyer. The results and observations made should help equipment manufacturers to design and construct a completely successful plant. *(Author's summary)* 102

1533-0972 KROCHMAL, A. **Tapioca plant of the prehistoric Indians.** Arya Swapatra 2(27):9-10. 1966. Engl., Illus.

Cassava. Tapiocas. Processing. Cassava flour. Surinam.

A brief description of tapioca preparation by Amerindians in Surinam is given. *(Summary by H.J.S.)* 102

1534-1637 VIGNOLI, L. **Caractéres analytiques des "tapiocas".** (*Analytical character of tapioca*). *In* Congrés du Manioc et de Plantes Féculentes Tropicales, Marseille. 1949. Marseille, Institut Colonial, 1949. pp. 81-83. Fr.

Cassava. Tapiocas. Analysis. Cassava flour. Composition. Water content. Ash content. Mineral content.

Analyses were carried out on the composition of tapioca. The results were: moisture 13-14%, ash $< 0.3\%$, Fe <5 mg| 100 g and SiO 100 mg| 100 g. *(Summary by Chemical Abstracts)* 102

1535-1902 VEENDAM. NIVOA BV. **Pilotplant for the continuous production of cassava starch.** Veendam, Nederland. 1974. 12p. Engl., Fr., Dutch., Illus.

Cassava. Cassava starch. Factories. Industrialization. Industrial machinery. Economics. Costs. Processing.

A detailed description of a pilot plant for the cotinuous production of cassava starch with a capacity of 76 kg starch per hour (with a moisture content of 11%) is presented. A detailed sketch of the process is included. *(Summary by J.L.S.)* 102

1536-2662 BAYMA, A. C. **Fabricação da farinha de mandioca.** *(Manufacture of cassava flour).* Revista de Agricultura (Brazil) 21(7|8):303-304. 1946. Port.

Cassava. Cassava flour. Processing. Brazil.

Care must be taken in the processing of cassava flour since prices and consumer acceptance depend on the quality of the final product. It is advisable to use fresh roots. Toasting of the ground, wet mass requires a mild temperature in an open oven. Extraction of starch before toasting the wet mass gives a product of low nutritive value. *(Summary by A.N.)* 102

1537-3873 SAVITHRI, P. **A survey on sago in Salem District.** Madras Agricultural Journal 51(6)249-252. 1964. Engl., Sum. Engl.

Cassava. Tapioca. Composition. Water content. Protein content. Fat content. Mineral content. Carbohydrate content. Processing. Production. Costs. Economics. Marketing. India.

A survey was conducted on sago in the Salem district of Madras State. Aspects on the history of development of the sago industry, manufacturing techniques, production costs and marketing problems are mentioned. *(Author's summary)* 102 J00

1538-0965 GOPALAKRISHNA RAO, N. **Studies on the shelf-life of enriched tapioca macaroni products.** Food Science 12:40-42. 1963. Engl., Sum. Engl., 13 Refs.

Cassava. Tapioca macaroni. Composite flours. Storage. Composition. Analysis. Water content. Vitamin content. Temperature. Organoleptic examination. Food enrichment. India.

Storage studies carried out for 6 months have shown that the enriched tapioca macaroni products containing 10% nonfat milk solids and 15% processed chickpea flour, respectively, have satisfactory shelf life. The added vitamins were fairly stable in the products during the storage period. *(Author's summary)* 102 H01

1539-3300 MANDIOCA NO **Nordeste vai bem, mas pode ir melhor.** *(Cassava production in the Northeast is progressing, but it could be better).* Dirigente Rural 1(6):42. 1962. Port., Illus.

Cassava. Industrialization. Development. Factories. Cassava flour. Cassava meal. Brazil.

Production of cassava and its transformation into flour and meal are briefly analyzed. The author encourages the establishment of modern large-scale factories, even though a great number of small-scale factories processing cassava play an adequate socioeconomic role. *(Summary by H.J.S.)* 102 J00

1540-3224 LA FABRICATION **de l'alcool par les procédés H. Boulard.** *(Alcohol extraction by H. Boulard's methods).* Les Produits Coloniaux et le Materiel Colonial 91:177-184. 1931. Fr.

Cassava. Alcohol. Fermented products. Processing. Cassava starch. Production.

One hundred kg of dried cassava tubers renders 75 kg of starch. This starch renders 40-44 liters of alcohol. A description is made of different methods of alcohol extraction stressing Boulard's method. *(Summary by H.J.S.)* 102

1541-0985 BURTON, L. V. **How 15 years of research developed a continuous process of tapioca manufacture.** Food Industries 1929:491-494. August 1929. Engl., Illus.

Cassava. Tapiocas. Processing. Industrial machinery. Industrialization. Production. Human nutrition. USA.

Description is given of the 15 years of evolution in U. S. industrial methods for preparation of "Minute Tapioca." The American development of a quick-cooking tapioca was to eliminate the soaking period previously required for the preparation of this food at home. A plan for continuous manufacturing of the product is described. *(Summary by H.J.S.)* 102

1542-1622 CLERK, J. DE and MBAGIRENTE, F. S. **Etude du manioc comme grain cru en brasserie.** *(Cassava as a raw material for brewing).* Bulletin de l'Association des Anciens Etudiants en Brasserie de l'Université de Louvain. 67(3):109-114. 1971. Fr., Sum. Fr., 3 Refs.

Cassava. Processed products. Cassava beer. Composition. Mineral content. Analysis. pH. Cassava products.

The unpleasant flavor of cassava beer was investigated. Experimental brews were prepared from pure malt and malt with 40% cassava, rice flour or maize grits with mineral salts (chiefly K) added, to bring their minerals to the same level as in cassava. Analysis of wort showed no differences between brews except for stronger color with cassava; analysis of cassava beer showed slightly higher pH, lower foam stability and stronger color. High K contents caused reduced taste scores for the beer but did not provide a complete explanation of its inferior flavor. *(Summary by Food Science and Technology Abstracts)* 102

1543-1664 SUTHERLAND, E.C. **Process for treating meal and flour and milling products.** British Patent 121, 943. 1918. Engl.

Cassava. Processed products. Cassava meal. Biochemistry. Cassava flour. Deterioration. Enzymes. England.

Before treating flour, meal, or the like with a peroxide, a substance containing active Cl or a small quantity of free Cl is added to the flour or meal to render inactive the enzymes which are able to decompose H_2O_2. As a substance containing active Cl, $CaOC_{12}$ may be used. As examples of materials to which the process may be applied, potato flour, rice flour, starch, cassava root—meals rendered wholly or partially soluble or dextrinized—and dextrin itself are mentioned. *(Summary by Chemical Abstracts)* 102

1544-0987 SANDOVAL, G. M. and ACENA, B. **A cassava processing plant.** Philippine Agricultural Engineering Journal 4(4):181-183. 1953-54. Engl., Illus.

Cassava. Cassava flour. Processing. Industrial machinery. Factories. Cassava starch. Philippines.

The process for producing cassava flour and starch is described. This description intends to encourage the development and design of locally (Philippines) produced machinery for the mass production of cassava flour and starch. A flow sheet of the process is presented. *(Summary by H.J.S.)* 102

1545-2159 SHORTS, R. **Starch and vegetable oil extracting machine.** United States Patent 1,516,215. 1924. 6p. Engl., Illus.

Cassava. Industrial machinery. Industrialization. Mechanization. Processing. Patents. Cassava starch. USA.

This describes a device for extracting starch from cassava and other starch and oil crops. The machine is adapted for treating cassava tubers or similar materials by grinding., screening and treatment with water. *(Summary by J.L.S.)* 102

1546-0986 GHOSH, B. N. **The manufacture of starch from cassava roots in Uganda.** East African Agricultural and Forestry Journal 34(1):78-83. 1968. Engl., 9 Refs., Illus.

Cassava. Industrial machinery. Processing. Drying. Viscosity. Consumption. Glucose. Cassava starch. Packaging. Production. Composition. Economics. Industrialization. Africa. Uganda. Kenya.

This describes the factory for the production of industrial starch from cassava being set up at Lira (Uganda). The supply of raw material will be mainly from peasant farmers. An annual production rate of about 1,000 tons of starch is envisaged, while the production of glucose at a later date is under consideration. Dextrin has been omitted from the present production program, because of the low local consumption. By 1970, East African starch consumption is expected to increase to 2,500 tons and glucose consumption up to 1,600 tons. A description of the process is presented. *(Summary by Royal Tropical Institute)* 102

1547-3817 RIO DE JANEIRO. INSTITUTO NACIONAL DE TECNOLOGIA. **Perspectivas para o amido de mandioca.** *(Prospects for cassava starch).* Rio de Janeiro, 1974. 139p. Port., Sum. Port.; Engl., 92 Refs., Illus.

Cassava. Production. Economics. Marketing. Trade. Cassava starch. Modified starches. Prices. Consumption. Industrial starches. MSG. Glucose. Dextrose. Cassava beer. Paper industry. Textiles. Food products. Statistical data. Productivity. Tuber productivity. Cultivars. Industrialization. Factories. Legal aspects. Processing. Tapiocas. Viscosity. Temperature. Composition. Starch content. Ash content. Water content. pH. Brazil.

This work describes the world-wide panorama of the starch industry and its by-products, in particular the Brazilian agro-industry which produces starch from manioc (cassava). Production, consumption, international trade and future possibilities for said products are examined. Consideration is given to the development of new, highly productive varieties of cassava with high starch yields and shorter maturing cycles, as well as to manufacturing processes used in Brazil for extraction of starch from tubercles. Emphasis is placed on technological research on new starch raw materials and to the development of new starch products. The work focuses on the possibilities of new uses for cassava starch in the domestic and foreign market. Although some importing countries such as the United States are restricting their purchases of this product, other markets are rising or reappearing; Japan, for example, is already importing the same quantities of cassava starch as the United States. There are also good prospects for negotiations with South and Central America, as well as Africa, besides various alternatives for its transformation into more refined products, such as modified and semihydrolized starches for domestic consumption and exportation. *(Author's summary)* 102

1548-1862 ROA, G., BAKKER-ARKEMA, F. W. and JOHNSON, L. **Drying of cassava.** East Lansing, Michigan. Michigan State University. CIAT, 1974. 15p. Engl., Sum. Engl., 6 Refs., Illus.

Paper presented at Annual Meeting of the American Society of Agricultural Engineers, 1974.

Cassava. Cassava chips. Processing. Drying. Solar drying. Colombia.

Cassava chips are an important ingredient in animal feeds in many parts of the world. The chips are conventionally dried on wooden trays. A number of improved, natural-drying methods were investigated. A system consisting of vertical trays proved most successful. *(Author's summary)* 102

1549-3233 LEBEDEF, S. **As possibilidades de aproveitamento da madeira de mandioca para a frabrição da celulose.** *(The possibilities of using cassava wood for the manufacture of cellulose).* Boletim do Secretaria de Agricultura, Industria e Comércio (Redife, Brazil) 4(1):63-66. 1939. Port., Illus.

Cassava. Cellulose. Industrialization. Stems. Paper industry. Brazil.

A cassava variety was found being used to fence fields near Recife (Brazil). The plants are shrubs whose stems have a diameter of 7-9 cm and whose tubers may reach 8-13 cm in diameter and 1-3 m in length. Preliminary tests of cellulose quality were carried out, resulting in a by-product that the author recommends for use as a binder in the manufacture of newsprint. A brief description is also given of cellulose. *(Summary by H.J.S.)* 102

1550-2937 NOBRE, A., TAVARES, M. and ORLANDO, J. C. **Viabilidade técnica-economica do enriquecimento proteico da farinha de mandioca.** *The technical-economic feasibility of protein enrichment of cassava flour).* Rio de Janeiro. Centro de Tecnologia Agricola e Alimentar. Boletim Técnico no. 9:1-26. 1973. Port., Sum. port., Engl., 21 Refs.

Cassava. Cassava flour. Processed products. Industrialization. Proteins. Food enrichment. Methionine. Production. Consumption. Economics. Prices. Tubers. Concentrates. Human nutrition. Brazil.

Several pilot experiments were carried out with the purpose of fortifying cassava flour with protein. Four protein sources were employed: (a) soybean isolated protein, containing 90.6% pure protein; (b) calcium caseinate, containing 86.7% protein; (c) fish protein concentrate, containing 50.1% protein; and (d) soybean meal (20-40 meshes) containing 47% protein. The only material that did not present technological problems was soybean meal. It can be mixed directly, (without previous preparation) with pure cassava flour, without imparting any foreign flavor to the mixture and does not require any sophisticated mixing techniques or equipment. This product, however, is still manufactured only on a small industrial scale that does not permit its use on short-and medium terms in a nationwide program. Products a, b and c have a very fine texture to give, them the same texture as cassava flour, they were added to the flour at the manufacturing stage (wet mass with 30-35% water), thereby resulting in a superconcentrate product (Premix) with over 45% protein. Products b and c have better possibilities for enriching cassava flour in a long-term program as they are proteins of animal origin, having higher biological value than products a and d. At present, the use of product b is out of the question, due to the higher cost of the final product. Product c can not be used either because it is not available on the market. Immediate use of the enrichment process with isolated soybean protein presents the problem of its protein efficiency, which can be overcome by adding synthetic methionine. The use of the product Proteimax plus methionine does not present any restriction of supply since a program exists for its production on short and medium terms. It is advisable to conduct a preliminary market test for the enriched flour. During the test, the ordinary flour and enriched flour should be kept at the same price levels. Besides the flavor test, retailers will be given samples of the flour for a practical test of the product. In time it will be necessary to make a technical and economic assessment of the results from the manufacturing and marketing of the product. In a nationwide program, it will be necessary to find the best way to reach the lower-income consumer, perhaps a centralized enrichment plant or cooperatives that would be responsible for a wide distribution of the superconcentrated product (Premix) or the enriched flour on an ideal level of efficiency. *(Author's summary)* 102 H01

1551-0989 DOLE, G. E. **Techniques of preparing manioc flour as a key to culture history in tropical America.** *In* Wallace, A. F. C., ed. Men and cultures. Philadelphia, University of Pennsylvania Press, 1956. pp. 241-248. Engl., 28 Refs., Illus.

Cassava. Cassava flour. Processing. Processed products. Pressing. Detoxification. Detoxification **processes. Colombia. Guianas. Brazil. Peru. History. Plant geography. Maps.**

Because of the complexity and wide distribution of the tipiti (sieve press), a study of its development and distribution may throw light on the place of origin and spread of cassava cultivation. The author traces the evolution of the tipiti in reverse to provisionally establish the distribution of various techniques for preparing cassava flour and the linguistic stocks and culture types with which they are associated. A map of the distribution of devices for preparing cassava flour is included. The tipiti consists of a cylindrical container constructed by diagonal weaving. By stretching the cylinder lengthwise, the diameter is reduced, thus exerting pressure on the contents for dehydration. *(Summary by J.L.S.)* 102 A00

1552-1970 AULSEBROOK, J. B. and AULSEBROOK, T. W. **Tapioca product and process of manufacture thereof.** Australia Patent 17,248. 1928. 3p. Engl. Illus.

Cassava. Tapiocas. Tapioca pearls. Industrial machinery. Food products. Patents. Processing. Australia.

A liquescent, processed food product is manufactured by dusting tapioca with an innocuous powder insoluble in water, subjecting it to a temperature of 500-600°F and a pressure of about 600 lb | in² for 10-19 s and suddenly releasing the pressure. *(Summary by Chemical Abstracts)* I02

1553-2157 **THE CASSAVA starch industry.** The West India Committee Circular 1915:151. April 1915. Engl.

Cassava. Industrialization. Factories. Cassava starch. Trinidad and Tubago.

Brief notes are given on the cassava starch industry. There are 3 factories in Trinidad. It is expected that cassava plantations will increase in the West Indies. *(Summary by H.J.S.)*I02

1554-1933 DUARTE, A. C. **Conservação da mandioca.** *(Cassava storage).* Rural 40(466):46. 1960. Port.

Cassava. Storage. Tubers. Animal nutrition. Silage. Brazil.

Cassava (roots) can be preserved by salt, a practice which has been introduced into Brazil by German colonists. Thus treated, cassava is readily eaten by cattle and swine. The practice offers several advantages, which are enumerated. Three kg of salt will treat 100 kg of cassava. The cassava, which must be chopped up, can be used as fodder 20 days after the treatment. *(Summary by Tropical Abstracts)* I02

1555-2144 JAVA. DEPARTMENT OF AGRICULTURE. INDUSTRY AND COMMERCE. **Products of the Dutch East Indies; cassava products.** Buitenzorg, Java, 1926?. 5p. Engl., Illus.

Cassava. Cassava products. Cassava flour. Tapiocas. Tapioca pearls. Gaplek. Industrialization. Fresh products. Processed products. Production. Marketing. Trade. Java. Uses.

In Java cassava roots are chiefly used for the manufacture of tapioca flour, flakes and pearls, which are exported in large quantities. The production of cassava for 1925 was estimated at 93,361,000 piculs (one picul=63 kg) of fresh roots. Cassava products are used as raw materials for various industries. It has been proved that because of its lasting white color, tapioca flour is much more suitable for the sizing of cotton fabrics than potato flour and others. Tapioca flour, flakes and pearls are used in the preparation of various foodstuffs, paste, dextrin and as binding matter in the manufacture of paper. Dried roots (gaplek) are used in liquor and glucose factories. *(Summary by J.L.S.)*I02 J00

1556-2156 **TAPIOKAGEWINNUNG AUF Java.** *(Obtaining tapioca in Java).* Tropenpflanzer 9:466-467. 1905. Germ.

Cassava. Cultivation. Tapiocas. Processing. Java.

A very general description is given of cassava cultivation in Java. A short description is given of how tapioca is obtained. The roots are crushed, washed and the flour is dried. *(Summary by A. van S.)* I02 D00

1557-2158 **THE PROSPECTS of cassava starch.** Jamaica. Bulletin of the Department of Agriculture. Jamaica 2(3):49-51. 1904. Engl.

Cassava. Development. Processing. Productivity. Economics. Cassava starch. Costs. Jamaica.

Data are given dealing with tuber yields, cost of starch manufacture, commercial prospects and recommendations on improving cassava cultivation and processing. *(Summary by H.J.S.)* I02 J00

1558-2141 NEUVILLE, H. **Les dérivés du manioc.** *(Cassava by-products).* Journal d'Agriculture Tropicale no. 29:323-328. 1903. Fr.

Cassava. Cassava starch. Cassava products. Cassava bread. Cassava flour. Trade. Marketing. Processed products. Economics. Processing.

Notes are given on the preparation of some cassava products: couac, flour and meal starch. Cassava starch is beginning to play an important role in the international market, together with potato starch. *(Summary by H.J.S.)* I02 J00

1559-2107 KRUYFF, M. E. DE. **La fabrication de la farine de manioc à Java.** *(Manufacturing of cassava meal in Java).* Journal d'Agriculture Tropicale no. 101:321-323. 1909. Fr., Illus.

Cassava. Cassava flour. Prices. Processing. Industrialization. Production. Java.

Data given refer to the manufacture of cassava flour on both a small and large scale. Brief notes are given on production, yields and prices of the product. *(Summary by H.J.S.)* I02

1560-0118 EKANDEM, M. J. **Preparation of cassava in the human diet of Nigeria.** Nigeria, Federal Department of Agricultural Research, 1961. 9p. Engl., 5 Refs.

Cassava. Diets. Gari. Foofoo. Human nutrition. Cassava pastes. Food products. Processing. Uses. Nigeria.

This paper reviews the present-day Nigerian methods of preparing foodstuffs from cassava (*Manihot utilissima* Pohl), with emphasis placed on "gari" and "fufu" (or foofoo).*(Summary by P.A.C.)* I02 H01

1561-0966 **OPPORTUNITY FOR industry in the Federation of Rhodesia and Nyasaland. Manufacture of tapioca starch and grocery tapioca.** Agency for International Development. Report no. 7. 1962. 71p. Engl., Illus.

Cassava. Industrialization. Factories. Development. Dextrins. Glucose. Economics. Costs. Maps. Marketing. Cassava starch. Rhodesia. Nyasaland.

This report analyzes the possibilities of establishing cassava starch factories in the Federation of Rhodesia and Nyasaland. The analysis covers domestic and export markets, cassava production, electricity and some general factors. Transport rates are shown. A comparison is made to Thailand, which shows that the costs of transporting starch to the United States and European Markets are approximately the same for both Thailand and the Federation. *(Summary by L. A.)* I02 J00

1562-0119 PEIRIS, E. A. **Manioc starch and its possibilities.** Tropical Agriculturist (Ceylon) 91:27-29. 1938. Engl.

Cassava. Cassava starch. Arracacia. Industrialization. Marketing. Economics. Processing. Composition. Sri Lanka.

Some remarks are given on large-scale cassava cultivation and the possibilities of starch extraction in marketable quantities in Ceylon. A short description of starch extraction and a comparative chemical analysis of imported arrowroot and local cassava starch are included. *(Summary by J.L.S.)* 102 J00

1563-096 COPELAND, E. B. **Manioc or cassava.** Philippine Agricultural Review 1:139-156. 1908. Engl., Illus.

Cassava. Cultivation. Industrialization. Cassava starch. Uses. Processing. Toxicity. Philippines.

This article provides practical recommendations for the growing and the industrialization of cassava in the Philippines. Emphasis is made on the use and commercialization of cassava products such as starch, which has a wide range of application. Brief notes are included on the process for cassava starch extraction. *(Summary by J.L.S.)* 102

1564-2215 BALENĊIE, H. **Notes sur la culture du manioc a la Station Agricole Expérimentale de Ben-Cat du service économique de la Cochinchine.** *(Notes on cassava cultivation at the Ben-Cat Agricultural Experiment Station of the Cochinchina economic service).* Bulletin Economique de l'Indochine 23(141):272-275. 1920. Fr.

Cassava. Cultivation. Processing. Cassava flour. Cultivars. Tubers. Composition. Indochina.

Notes on varieties used for research, as well as a brief description of cultural practices and preparation of flour, are presented. Results of chemical analysis of cassava roots are also presented. *(Summary by H.J.S.)* 102

1565-2235 COURS, G. **Etude sur la fécule de manioc.** *(A study on cassava starch).* Agronomie Tropicale 1(3-4):138-147. 1946. Fr., Illus.

Cassava. Cassava starch. Timing. Processing. Particle size. Silting. Tubers. Clones. Analysis.

Precipitation of starch grains is a function of their thickness with thicker ones precipitating first. Starch from young cassava plants, which is formed of small grains, has a very inadequate precipitation rate. Thus, it is convenient to grow cassava giving thick starch grains. A study was carried out to study cassava starch. Data deal with general characteristics of starch grains, distribution of starch grains in the tubers, seasonal variation of starch grain thickness and variation of starch grains from different clones. *(Summary by H.J.S.)* 102

1566-2100 MARTIN, F. **Le manioc dans la France d'Outremer.** *(Cassava in the French Overseas Territories).* Revue Internationales des Produits Coloniaux 26:231-233. (Concl.). 1951. Fr.

Cassava. Cassava programs. Development. Cassava starch. Tapiocas. Processing. Industrialization. Economics.

A general overview is presented of the status of cassava in the French Overseas Territories and plans for developing improved and high-yielding varieties. Emphasis is on the industrialization of cassava products to be used not only as human food, but also as animal feed. Short remarks are given on the extraction of starch and the preparation of tapioca. *(Summary by J.L.S.)* 102

1567-2201 BATAVIA. DIVISION OF COMMERCE. **Cassava.** Batavia, Java, 1931. p.6. Engl.

Cassava. Gaplek. Dried tubers. Processed products. Tapiocas. Trade. Marketing. Economics. Java.

Small- and large-scale production systems for manufacturing and marketing tapiocas (flour, pearl and seeds) and gaplek (dried roots sliced or cut in pieces) are compared in Java. *(Summary by H.J.S.)* 102 J00

1568-4343 RODRIGUEZ V., M. **Espléndido porvenir tiene la industria de la yuca.** *(A splendid future for the cassava industry).* Revista del Instituto de Defensa del Café (Costa Rica) 13:407-409. 1943. Span.

Cassava. Processing. Cassava flour. Cassava starch. Tapiocas. Dextrins. Alcohol. Uses. Costa Rica.

Methods and processes for producing starch and cassava flour, as well as tapioca, dextrin and motor alcohol, are also described. *(Summary by L.C. Trans. by T.M.)* 102

1569-2165 BIGWOOD, E. J., ADRIAENS, E. L. and MEDARD, O. **Extraction de la matière azotee du manioc.** *(Extraction of nitrogenous materials from cassava).* *In* Bruxelles. Institut de Recherches Scientifiques au Congo. Rapport annuel 1952. p. 183. Fr.

Cassava. N. Cassava flour. Analysis. Zaire.

Trials on the extraction of small quantities of nitrogenous materials from cassava flour were carried out to determine the amino acid content of the flour. Two methods were used salting with NaCl and extraction with 70% alcohol. The extraction is very difficult and does not give constant results. *(Summary by H.J.S.)* 102

1570-2217 ACENA, B. and MACATANGAY, P. **Production of glucose from cassava or corn starch and its use by various industries.** Sugar News 42(2):88-89. 1966. Engl.

Cassava. Maize. Cassava starch. Industrial starches. Uses. Glucose. Glucose industry. Processing. Development.

The technical advantages of using cassava starch over corn starch in the manufacture of glucose are briefly discussed. The production of glucose from cassava or corn starch involves the process of acidification, conversion or hydrolysis, neutralization, decoloration, filtration, evaporation, cooling and packing. These processes are briefly described. *(Summary by H.J.S.)* 102

1571-2008 INGRAM, J. S. and HUMPHRIES, J. R. O. **Cassava storage; a review.** Tropical Science 14(2):131-148. 1972. Engl., Sum. Engl., 76 Refs., Illus.

Cassava. Storage. Tubers. Temperature. Cassava products. Cassava flour. Gari. Farinha. Cassava starch. Tapiocas. Cassava chips. Diseases and pathogens. Pests. Mycoses. Deterioration. Disease control. Injurious insects.

Knowledge of techniques for preserving and storing fresh cassava is still rudimentary, and few reliable data exist. The most effective measure appears to be refrigeration – either at deep freeze temperatures or just above freezing – but on a commercial scale, cold storage would normally be too expensive in tropical countries. Clamp storage methods, such as those originally described by Reine as early as 1941, appear to warrant further systematic attention, but a more complete knowledge of the postharvest phytopathology of the cassava root is needed. There are inconsistencies in published observations on optimum humidity conditions, with some authors recommending dry storage and others, moist conditions. Physiological considerations, such as the effect of point of cutting from the plant, also need further attention. The study of the storage of dried cassava products is at a more advanced stage, and on a commercial scale some promising methods such as sealed container storage have been developed. Entomological problems are the main ones in the storage of cassava products, although in situations where the product is imperfectly dried, molding can also cause difficulties. The principal need is for further research into improved storage procedures at or near the subsistence farming levels, using local materials and methods that are within the reach of, and acceptable to, local producers. *(Author's summary)* I02

1572-1898 BOOTH, R. H. **The storage of fresh cassava roots.** London, Tropical Products Institute, 1973. 15p. Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd. Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* Tubers. Fresh products. Storage. Deterioration. Timing. Temperature. Developmental research. Research. Colombia.

The rapid postharvest deterioration of cassava roots has hitherto prevented their storage in the fresh state. There is a strong correlation between mechanical damage during harvesting and the onset of deterioration. It has been found that, like several other root crops, cassava roots can be cured, during which process wounds are healed and the onset of normal deterioration prevented. Curing of cassava roots has been achieved in the field in structures similar to a European potato "clamp." Once cured,cassava roots can be stored in these clamps for 8 weeks. *(Summary by D.H. and L.J.)* I02

1573-1914 OKE, O. L. **Changes in soluble amino acids of some tropical starchy roots during chilling.** Ile-Ife, Nigeria, University of Ife, 1973. 14p. Engl., 1 Ref.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Yams. Potatoes. Banana-plantains. Starch crops. Storage. Temperature. Amino acids. Tubers. Fresh products. Analysis. Nigeria.

The soluble amino acids of yam, potato, cassava, plantain and banana were determined at ambient temperature and after chilling for 2 months to simulate storage conditions during transportation. Most of the amino acids were lost during chilling. In yams, amino acids were reduced from 20 to 6 and in cassava, from 8 to 3. Unripe plantain and banana contained many more amino acids than the ripe ones, and they suffered fewer losses during chilling. The ripe ones were streaked after chilling, probably due to formation of peptides. *(Summary by D.H. and L.J.)*I02 C03

1574-1531 ROXAS, M. L. and MANIO, R. V. **Industrial alcohol from cassava.** Philippine Agriculturist 10:75-84. 1921. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava starch. Cassava flour. Analysis. Alcohol. Production. Processing. Fermentation. Hydrolysis. Philippines.

A study was made of the hydrolysis of cassava under different conditions and its fermentation to alcohol by different yeast preparations, with and without the use of stimulants. The following is suggested for the hydrolysis of cassava flour for fermentation on a commercial scale. For every 100 kg of cassava flour, use 50 liters of acid solution containing 1 liter sulfuric acid (sp gr 1.84), hydrolyze under pressure at 120°C (15 lbs| in^2) for 2.5 hours, neutralize it with 2 liters of ammonium hydroxide (sp gr 0.9), dilute it to 600 liters, and then add 6 liters of the yeast prepared by the Molhant process. The fermented liquid should be distilled after the second day, but not later than the third day. A comparison of the cost of cassava flour and molasses as raw materials for alcohol manufacture is also given. Under the conditions given in this paper, cassava would be more expensive as a raw material for alcohol production than molasses. Costs could be reduced by good management and the use of more efficient machinery *(Author's summary)* I02

1575-1894 PURCELL, J. G. and WILLIAMS, D. H. **History of the development of the first mechanized, continuous gari manufacturing plant.** Surrey, England, Newell Dunford Engineering, 1973. 14p. Engl., 6 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Gari. Factories. Industrialization. Food products. Processing. Industrial machinery. Mechanization. Development. Nigeria.

The historical development of the first mechanized, continuous gari manufacturing plant is discussed. The operations described include peeling, grating, mixing, fermentation, dewatering, sifting, garification, drying and splitting into flour parts; i.e., trash, oversize gari, fines and the product gari. Oversize gari is passed through a light hammer mill that returns the milled gari.nto the screen. Also discussed are investigations of future developments for making the batch stages of peeling, fermentation and dewatering into a continuous process. *(Summary by D.H. and L.J.)* 102

1576-1923 ROA, G. and COCK, J. H. **Natural drying of cassava.** Palmira, Colombia, Centro Internacional de Agricultura Tropical, 1973. 11p. Engl., Sum. Engl., Span., Illus.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Drying. Cassava chips. Water content. Temperature. Colombia.

A trend exists for using natural dried cassava as an animal feed. However, the technology of cassava drying is not well developed. The rate at which cassava dries when placed in the open air depends on the drying system, the relative humidity, the air temperature and the wind velocity. Particles in the form of rectangular bars (0.8 x 0.8 x 5.0 cm) dry much more rapidly than standard sliced chips. The drying rate can further be increased by placing the bars in horizontal or better, vertical wire mesh trays. These drying systems utilize the available energy of the air more efficiently to evaporate the water. *(Author's summary)* 102

1577-1917 NUSBAUM, S. J. **Development-oriented integrated cassava products.** New York, International Development Consultant, 1973. 6p. Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Cassava products. Industrialization. Cassava programs. Development. Uses.

The paper describes world trade in cassava briefly and suggests the general orientation of future cassava development projects. Conclusions are that a successful cassava project in almost every developing country also requires (1) a cassava policy by each government with a much higher priority and a greater means than allotted so far in its agricultural development projects, and (2) competent but concentrated local entrepreneurship, supported—if necessary—by technological guidance ana advise—essentially temporary—not only from public institutions but also from highly specialized, fairly small, private consulting teams. *(Summary by D.H. and L.J.)* 102

1578-2410 CASSAVA INDUSTRY **in Brazil.** Pacific Islands Monthly 11:28-30. 1941. Engl.

Cassava. Industrialization. Economics. Cultivation. Cassava flour. Production. Trade. Brazil.

A brief overview of the cassava industry and cultivation in Brazil is presented. *(Summary by H.J.S.)* 102

1579-3174 SILVEIRA, A. H. DA. **Industrialização da mandioca na fazenda.** *(Cassava industrialization on farms).* Revista de Quimica Industrial 18:24. 1949. Port., Illus.

Cassava. Processing. Alcohol. Cassava products. Processed products. Cassava meal. Cassava flour. Cassava chips. Tapiocas. Brazil.

Brief notes are presented on the characteristics of some cassava products. Data deal with flour, meal, dried slices, flour prepared from dried slices, tapioca, "beiju" and "aguardente." *(Summary by H.J.S.)* 102

1580-2412 SMART, H. P. **The cassava *(Manihot utilissima)* industry in British Honduras.** Proceedings of the Agricultural Society of Trinidad and Tobago 38:126-128. 1938. Engl.

Cassava. Cassava starch. Industrialization. Factories. British Honduras.

Historical aspects are given of the establishment and development of a company, the Empire Starch Products Ltd., in British Honduras. *(Summary by H.J.S.)* 102

1581-0367 DENDY, D. A. V., CLARKE, P. A., JAMES, A. W. **The use of blends of wheat and non-wheat flours in breadmaking.** Tropical Science 12(2):131-142. 1970. Engl., 6 Refs., Illus.

Cassava. Flours. Cassava flour. Millet flour. Wheat flour. Composite flours. Food products. Bakery products. Breads.

The effects, methods and feasibility of making bread with substitute and composite flours are discussed. Yam, banana, millet, sorghum, rice, maize and durum wheat flours, as well as cassava, were evaluated as diluents in bread-making. *(Summary by Biological Abstracts)* 102 H01

1582-4347 GILL, K. S. and KINCL, F. A. **Separation of starch by elutriation.** Journal of Scientific and Industrial Research 13B:96-99. 1954. Engl., Sum. Engl., 7 Refs. Illus.

Cassava. Cassava starch. Screening. Particle size. Laboratory experiments. Analysis.

An experimental unit, based on the elutriation principle, has been developed for separating starch particles from coarser particles and pulp during the manufacture of starch from cassava. The influence of slurry concentration and velocity of flow on the total starch recovered as overflow has been studied, and the unit has been found to run efficiently at slurry concentrations between 2 and 3% and at flow velocities between 1.8 and 2.0 mm|s. *(Author's summary)* 102

1583-2428 TKATCHENKO, A. **Note sur un essai de sedimentation accelerée effectuée à la féculerie d'Ampangabe.** *(Notes on an accelerated sedimentation test at the Ampangabe starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 33p. Fr., Sum. Fr., Illus.

Cassava. Industrial starches. Industrialization. Factories. Cassava starch. Silting. Processing. Factories. **Malagasy Republic.**

Methods of starch sedimentation commonly used at the starch factory take from 96-120 hours. The new method tested takes 44 hours. Yields of starch production increased 5%. All operations are described. *(Summary by H.J.S.)* 102

1584-1726 BORDAS, M. **Del contenido de ácido cianhídrico de la harina industrial de mandioca, de la harina de trigo y de los productos panificados.** *((Hydrocyanic acid content of cassava flour, wheat flour and bakery products).* Paraguay, Universidad Nacional de Asunción, 1965. 9p. Span., Sum. Span., 8 Refs.

Cassava. Cassava flour. Composition. HCN content. Food products. Bakery products. Wheat flour. Flours. Argentina.

The feasibility of mixing cassava flour with ordinary wheat flour was investigated. On the one hand, there is the problem of cassava's HCN content, produced by the hydrolysis of certain cyanogenetic glucosides. On the other hand, the possible economic benefits of employing cassava flour are considerable: (1) cassava production would be stimulated, thus benefiting the agricultural sector; and (2) wheat imports could be reduced, thereby saving foreign exchange. This study recommends the adoption of cassava flour supplements and publishes findings on the HCN content in various samples of cassava flour. *(Author's summary. Trans. by N.U.)* 102

1585-3102 ARBOLEDA, D. M. **What's cooking; from India-curly crunchy cassava chips.** Agriculture at Los Baños 12:9. 1971. Engl.

Cassava. Storage. Cassava chips. Dried tubers. Processing. Philippines.

A recipe for the preparation and storage of crunchy cassava chips is given. The best tuber age for this purpose is between 8 and 9 months, as older tubers are woody and have a very large pith. *(Summary by H.J.S.)* 102

1586-2284 FIERENS, P. **Detection de la farine de manioc dans la farine de maïs, par la réaction du biuret.** *(Detection of cassava starch in maize starch by the biuret reaction).* Bulletin des Séances de l'Academie Royale des Sciences Coloniales 4(6):1203-1225. 1958. Fr., Illus.

Cassava. Analysis. Laboratory experiments. Cassava starch. Maize.

Essays showed that the standard method of the biuret reaction does not permit the detection of cassava starch in maize starch. Detection could be made if a relative character based on granulation properties were introduced in the experimental method. Research was carried out to develop an improved detection method. Data given refer to granulation of cassava and maize starch, the biuret reaction applied to granulation of pure maize or cassava starches and to a mixture of them. *(Summary by H.J.S.)* 102

1587-2426 TKATCHENKO, B. **Note technologique concernant la féculerie de la Mahajamba.** *(Technological notes on the Mahajamba starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 93 p. Fr., Illus.

Cassava. Industrial starches. Processing. Factories. Bakery products. HCN. pH. Composition. Cassava starch. Malagasy Republic.

A description is given of the Mahajamba starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining the rate of extraction and starch quality, and general observations on processing. Sixteen tables are presented, giving data on physical and chemical composition of the products involved. A diagram showing the process is also given. *(Summary by H.J.S.)* 102

1588-3657 CASTILLO, L. S. **The cassava industry of the Philippines.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.63-71. Engl., Sum. Engl., Fr., 19 Refs.

Cassava. Production. Productivity. Sweet-potatoes. Economics. Marketing. Trade. Consumption. Income. Human nutrition. Animal nutrition. Statistical data. Research. Philippines.

In the Philippines, cassava is used for food, starch and animal feed; it is mainly cultivated by subsistence farmers in small plots. In area planted it is second to the sweet potato but it has the highest yield of all the root crops; nevertheless, this yield of 6.9 metric tons is low as compared to the world average of 9.1 ton. This can be attributed to inferior genetic material and poor production methods. Also, areas subject to typhoons grow sweet potatoes rather than cassava because the sweet potato has vines that creep along the ground rather than upright stems like cassava. From 1973-72, areas planted to cassava have decreased. Cassava starch is imported primarily from Thailand, because production does not meet local requirements. The demand for cassava as a food and for industrial purposes has been increasing. About two thirds of the cassava produced in the Philippines is used for human consumption, but cassava is second to sweet potato as a source of calories because of the larger amount of sweet potato consumed. Studies on cassava culture, flour and fermentation have been carried out since 1955 by universities and agricultural colleges; however, the cassava industry ranks a poor second among the root crops in attractring the attention of research workers. Some financing of cassava research and production has taken place; but more specific, integrated, multidisciplinary research on the production, processing and storage aspects for human and animal consumption is recommended. *(Author's summary)* 102 J00

1589-2289 FRANCOIS, E. **Le manioc sa production et son utilisation.** *(Utilization and production of cassava).* Revue de Botanique Appliquée et d'Agriculture Tropicale 18:682-707. (Concl.). 1938. Fr., Illus.

Cassava. Industrial starches. Food products. Dextrins. Glucose. Cassava starch. Uses. Trade. Fertilizers. Industrialization. Economics. France. Malagasy Republic.

Cassava production and processing in Madagascar are discussed. Topics include cassava diseases and pests, industries processing cassava, starch extraction, dextrin, starch and glucose preparation, world trade and French markets for cassava and its derivatives. *(Summary by H.J.S.)* I02 J00

1590-2425 TKATCHENKO, B. **Note technologique concernant la féculerie de la Mangoro.** *(Technological notes on the Mangoro starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 47p. Fr., Illus.

Cassava. Industrial starches. Processing. Factories. Bakery products. HCN. pH. Composition. Cassava starch. Malagasy Republic.

A description is given of the Mangoro starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining the rate of extraction and starch quality, and general observations on processing. Eight tables are presented giving the physical and chemical composition of the products involved. A diagram showing the process is also given. *(Summary by H.J.S.)* I02

1591-2427 TKATCHENKO, B. **Note technologique concernant la féculerie d'Ambatosoratra.** *(Technological notes on the Ambatosoratra starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 60p. Fr., Illus.

Cassava. Industrial starches. Industrialization. Factories. Bakery products. HCN. Composition. Cassava starch. Processing. Malagasy Republic.

A description is given of the Ambatosoratra starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining the rate of extraction and starch quality, and general observations on processing. Twelve tables are presented giving data on the physical and chemical analysis of the products. A diagram showing the process is also presented. *(Summary by H.J.S.)* I02

1592-3666 BOOTH, R. H. and COURSEY, D. G. **Storage of cassava roots and related post-harvest problems.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada, International Development Research Centre, 1974. pp.43-49. Engl., Sum. Engl., Fr., 23 Refs., Illus.

Cassava. Tubers. Fresh products. Storage. Deterioration. Colombia.

This paper reviews present knowledge of postharvest deterioration and storage of fresh cassava roots and summarizes recent experimental work undertaken by the senior author at the Centro Internacional de Agricultura Tropical (CIAT), Cali (Colombia). Two types of postharvest deterioration are recognized: primary deterioration, which involves internal discoloration and which is usually the initial cause of loss of acceptability; and secondary deterioration due to pathogenic rots, fermentation, softening of the roots, or all three. The rate at which primary deterioration occurs differs among varieties, but it always commences at the sites of mechanical injury. A process of curing and wound healing of the roots is described and is reported to prevent the onset of primary deterioration. These processes use simple field storage structures (similar in design to European potato clamps), in which cassava roots have been stored for periods of more than 2 months. Following successful curing and storage, certain quality changes—notably a longer shelf life, a conversion of starch to sugars, and a reduction in HCN levels—are discussed. The possible use of the curing process to aid other types of storage practices is also discussed. The prospects of storing fresh cassava roots for several weeks or even months appears very promising. *(Author's summary)* 102

1593-2429 TKATCHENKO, B. **Note technologique concernant la féculerie d'Ambanja.** *(Technical note on the Ambanja starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 67p. Fr., Illus.

Cassava. Industrial starches. Processing. Factories. Bakery products. HCN. pH. Composition. Industrialization. Cassava starch. Malagasy Republic.

A description is given of the Ambanja starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining the rate of extraction and starch quality, and general observations on processing. Thirteen tables are presented, giving data on the physical and chemical composition of the products involved. Yields and starch quality could be easily improved at this factory. *(Summary by H.J.S.)* 102

1594-3645 MARRIOT, J., BEEN, B. O. and PERKINS, C. **Storage of fresh cassava roots in moist coir dust.** Kingston, Jamaica, Ministry of Industry, 1974? 7p. Engl., Sum. Engl., 4 Refs.

Cassava. Tubers. Fresh products. Storage. Deterioration. Temperature. Jamaica.

Vascular streaking in cassava roots stored at ambient humidity began within 3 days of harvesting and developed rapidly, but roots packed in moist coir dust remained sound for 28 days at ambient temperature. Holding at ambient humidity for more than 2 days before packing into moist coir increased vascular streaking after storage. Roots packed together in bulk to reduce weight loss to about half that at ambient humidity were held for 8 days before packing in moist coir without any increase in vascular streaking after storage. When roots packed in moist coir were stored at 13°C, vascular streaking was greater than at ambient temperature but decreased in roots held for 7 days at ambient temperature before cooling to 13°C. *(Author's summary)* 102

1595-3660 MANURUNG, F. **Technology of cassava chips and pellets processing in Indonesia, Malaysia, and Thailand.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974 pp.89-112. Engl., Sum. Engl., Fr., 23 Refs., Illus.

Cassava. Cassava chips. Pellets. Processing. Drying. Factories. Cottage machinery. Solar drying. Industrial machinery. Pressing. Storage. Indonesia. Malaysia. Thailand.

At present, the processing methods for the production of cassava chips and pellets in Indonesia, Malaysia and Thailand involve root cleaning, chipping, sun drying and pelletizing. Whereas in Indonesia the roots are peeled and cut by hand before drying, the practice in Malaysia and Thailand is to feed the unwashed, whole roots into chipping machines. For roots harvested from clay soil, the use of root washers, as employed in the manufacture of cassava starch, is suggested. The chipping machines used in Malaysia and Thailand are described, in addition to methods of improving their performance. Sun drying is carried out by many methods in Indonesia. In Malaysia and Thailand, however, sun drying is done exclusively on cement drying floors. The overall heat efficiency during sun drying of cassava chips was estimated to be between 11 and 14%, and the main cost of sun drying was labor. Causes of low-heat efficiency were analyzed, and methods of improving sun drying with respect to chip quality and cost reduction are suggested. The possibility of using artificial heat drying, a combination of sun and artificial heat drying, and a combination of mechanical dewatering and artificial heat drying are discussed. Static-bed, moving-bed, rotary, fluidized-bed and pneumatic drying systems are described. Pelletizing presses, as used by the feed millers in Europe and the USA, are used in Thailand and Indonesia for the production of pellets from cassava chips and dried roots. Native presses manufactured in Thailand made up about 75% of the total pelletizing capacity in Thailand and about 20% in Indonesia. The pellet quality is affected by the nature and the percentage of different components in the material to be pressed, the condition of the material before pressing (i.e., moisture content, particle size and temperature) and the dimensions and shape of the dies in the pelletizing presses. In addition to the above factors, the performance of the pelletizing plants is very dependent on the quality of the dies and rolls. The low quality of products (i.e., soft pellets and high meal percentage) from the native plants was the result of too high moisture content, low-quality dies and rolls, incomplete removal of tramp metals, and in some instances, dismantling of pellet cooler and screen. Methods of improving the performance of both the native and the imported pelletizing plants are suggested. Fields of research were selected with a view to the collection of basic information, development of new techniques and improvements of present practices in the production of chips and pellets. *(Author's summary)* 102

1596-2286 FILHO, J.C. and AZEVEDO, E. **Nota prévia sôbre as possíveis relações entre alguns constituintes e a côr da farinha de mandioca.** *(Preliminary note on the possible relationships between some cassava components and the color of cassava meal).* Brasil. Instituto de Pesquisas Agronomicas de Pernambuco. Boletim Técnico no. 9. 1964. pp.11-23. Port., Sum. Port., Engl., 7 Refs., Illus.

Cassava. Roots. Cultivars. Cassava meal. Analysis. Protein content. Composition. HCN content. Farinha. Processing. Organoleptic examination. Brazil.

An attempt was made to correlate the proportion of some constituents in fresh root stocks of 115 cultivars of cassava to the quality of cassava meal made by the ordinary process. For the classification of the meals, a photoelectric apparatus, based on light reflection, was used. The color of meal and its quality depend on the ratio in pigments and the manufacturing process employed. None of the other components studied was found responsible for either of those two properties. *(Author's summary)* 102

1597-3661 NGUYEN CONG THANH. **Technology of cassava chips and pellets processing in Thailand.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada, International Development Research Centre, 1974 pp.113-112. Engl., Sum. Engl., Fr., 29 Refs., Illus.

Cassava. Production. Maps. Fresh products. Storage. Cassava chips. Pellets. Processing. Drying. Industrial machinery. Industrialization. Economics. Marketing. Thailand.

Thailand ranks ninth in the world as a producer of cassava roots and is the world's largest exporter of cassava products; however, cassava is not an important part of the people's staple diet. Many objections have been raised about the utilization of cassava chips and pellets from Thailand. Sometimes the drying period for chips is very short, and the moisture content is rarely reduced bellow 19%. This high moisture content constitutes a favorable medium for the growth of bacteria and mold. Sand and waste products are added to the chips to minimize the drying time and to make the process economically viable. In general, the main criticisms of Thai cassava pellets from European customers are that minimum starch content is not achieved; a great deal of sand and crude cellulose are present; bacteria and mold content are high; and pellets are of friable consistency. Optimum conditions for the conventional sun drying of sliced or chipped cassava need to be evaluated. The influence of the of size of cassava chips on the duration of drying is also an important variable. The use of black body or solar reflecting paint offers the possibility of drying in a shorter time. The preheating of dried cassava chips with steam and also the cooling of cassava pellets after pressing are two main factors to be considered. *(Author's summary)* 102 J00

1598-0221 ACENA, B. and PUNO, G. D. **A study on the use of cassava in beer industry.** Philippine Journal of Agriculture 20(1-2):1-13. 1955. Engl., Sum. Engl., 23 Refs.

Cassava. Food products. Cassava beer. Cassava flour. Composition. Processing. Gaplek. Dried tubers. Analysis. Industrialization. Philippines.

The use of cassava starch, flour and gaplek as possible brewing adjuncts was studied for the purpose of determining whether they can be used as substitutes for corn and its products from the United States and

Philippine rice in the production of bottled beer. The physical and chemical analysis of cassava starch, flour and gaplek show that they compare with the analyses of the common brewing adjuncts such as corn grits, corn flakes and rice. The extract yield of cassava products was found to be comparable with the best, commonly used adjuncts. The contained lower moisture, fat and oil, making them preferable for brewing purposes. The curve for the saccharification time in minutes against the percentage in weight shows that complete saccharification was obtained in 48-50 minutes. The analysis of the boiled wort is comparable to that of the wort produced from rice brewed by the Halili Brewery, Inc., Caloocan, Rizal (Philippines). The analyses of the cassava beers brewed in the Philippines, the United States and Canada were compared. Beer from cassava was pale yelow in color, with a mild, smooth and delicate taste. It had a subdued hop character with only small modulations of sweetness. There was no indication of chill haze. It had a stable white foam *(Author's summary)* 102.

1599-3418 GODOY, J.M. DE and GODOY, P. DE A. **Emprego do bagaco das fecularias de mandioca no fabrico do álcool.** *(Utilization of waste products from cassava starch factories in the alcohol industry).* Sao Paulo, Brasil, Secretaria de Agricultura, Industria e Comercio, 1946. 25p. Port.

Cassava. Manihot. Waste utilization. Cassava starch. Alcohol. Fermentation. Industrial microbiology. Starch content. Composition. Suphuric acid. Processing. Costs. Production. Processed products. Cassava products. Labour. Economics. Factories. Analysis. Laboratory experiments. Silting agents. Industrialization. Brazil.

Waste products from cassava starch factories are used as raw material in distillation industries; these wastes contain up to 70% saccharic substances in relation to dry matter content. Due to their composition, the waste products are recovered and used in the alcohol industry. For the best results, the saccharification process must last for half an hour in 3 atmospheres. Acidity must correspond to 6% of the weight of sulfuric acid in relation to dried waste material and must be in a proportion of 1 part waste material to 5 parts acid solution. *(Summary by J.L.S.)* 102.

1600-2276 LES INDUSTRIES du manioc. *(Cassava industries).* Bulletin Economique de l'Indochine. Renseignements 1927:457-460. 1927. Fr.

Cassava. Production. Processing. Cassava meal. Tapiocas. Trade. Marketing. Economics. Java.

Brief notes are presented on cassava from Java. Data refer to production, processing of cassava meal and tapioca, and cassava exportation. *(Summary by H.J.S.)* 102 J00

1601-0869 THAILAND. MINISTER OF ECONOMIC AFFAIRS. **Standards for tapioca chips.** Bangkok, 1963. pp. 53-54. Engl.

Cassava. Cassava chips. Dried tubers. Legal aspects. Processing. Thailand.

Items standardized include definitions of cassava chips, fiber and foreign material, grades of the chips, color characteristics for grading and packing bags for chip exportation. *(Summary by H.J.S.)* 102

1602-0641 GHOSH, B. N. **Recent developments in the manufacture of starch from cassava roots in Uganda.** *In* International Symposium on Tropical Root Crops, Ist., St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2, pp. 37-47. Engl., 9 Refs., Illus.

Cassava. Factories. Production. Cassava starch. Industrialization. Industrial starches. Composition. Uses. Uganda.

Some basic considerations are given for the extraction of starch from cassava. A description of a starch factory is presented together with a flow sheet for starch manufacturing. *(Summary by H.J.S.)* 102

1603-1685 TSUCHIYA, M. **Butanol-acetone fermentation. VIII. From dried cassava.** Journal of the Agricultural and Chemical Society of Japan 22:64-65. 1948. Jap.

Cassava. Fermentation. Fermented products. Industrial microbiology. Alcohol.

Nonpeeled, dried cassava (starch value 72.8) could be well fermented to produce Me_2CO, BuOH and EtOH in the combined yield of 30.63-32.70% when soybean cake was added. The combined yield was 18.68-25.43% when rice bran was the N source. Peeled cassava gave similar results. *(Summary by Chemical Abstracts)* 102

1604 0774 LAGOS U., J. A. **La yuca y el almidón.** *(Cassava and starch).* Revista de Agricultura (Costa Rica) 20(1):26. 1948. Span.

Cassava. Cassava starch. Processing. Industrialization. Costa Rica. Central America.

Manihot utilissima is grown in Costa Rica in the central, upland plateau, in the Esparta region of the Pacific Coast, and at Turrialba and other places on the Atlantic Coast. The method of extracting starch is described. *(Summary by Field Crops Abstracts)* 102.

1605-0945 CASSAVA PRODUCTS **and gari.** Nigeria. Report of the Federal Department of Commerce and Industry, 1956|57. 1958. pp.29-30. Engl.

Cassava. Human nutrition. Fermented products. Gari. Processing. Industrialization. Cassava products. Food products. Nigeria.

Research and practical operations carried out on cassava products are briefly described. Data refer to the fermentation process involved in the production of gari and improving production methods of gari, both at the farm and industrial level. *(Summary by H.J.S.)* 102

1606-2033 SINGH, K. K. and MATHUR, P. B. **Cold storage of tapioca roots.** Bulletin of the Mysore Central Food Technological Research Institute 2(7):181-182. 1953. Engl.

Cassava. Storage. Tubers. Temperature. Deterioration. Moulds. Fresh products. India.

Cassava storage at 8 different temperatures was tested. Temperatures ranged from 32-35°F to 72-85°F. A temperature of 32-35°F and a relative humidity of 80-90% are optimum for cold storage of cassava tubers, the approximate storage life being 6.5 months. At the end of 2 weeks, tubers stored at all other temperatures except 32-35°F and 35-38°F had to be discarded due to internal browning. Other types of deterioration are also described. *(Summary by H.J.S.)* 102

1607-2034 THE PRESERVATION **of manioc.** Ceylon. Department of Agriculture. Leaflet no. 202. 1943. 5p. Engl., Illus.

Cassava. Storage. Tubers. Processing. Drying. Cassava chips. Peeling. Washing. HCN. Detoxification. Sri Lanka.

Once harvested, cassava roots cannot be stored too long, being subject to fast deterioration. It has been found that if fresh roots are peeled, cut up into small pieces (chips), and dried, roots will keep indefinitely under suitable conditions. When required for consumption, they can be converted into flour that can be consumed in many ways. The principal procedures for the proper conservation of the roots are: peeling, washing, slicing, drying and storage of dried chips. Drying of chips can be carried out in different ways: sun drying; use of tea driers, copra driers and coconut desiccators; cardamon curing sheds, tobacco flue-curing barns, and old-fashioned driers for rubber, etc. All these methods can be easily converted for drying cassava chips. When chips are stored for long periods, they should be turned out and redried once a month; this will keep them crisp and will reduce the danger of weevil attack. *(Summary by J.L.S.)* 102

1608-0811 FERNANDES, S. **Mandioca: secagem de raspas.** *(Cassava: drying coarse meal).* Chacaras e Quintais 113(2):105. 1966. Port.

Cassava. Drying. Cassava meal. Solar drying. Processing. Brazil.

An answer is given to a letter asking for methods of drying cassava meal. The author recommends the sun-drying method, provided that it is a case of small-scale production. *(Summary by H.J.S.)* 102

1609-2267 **FROM JAVA to Brazil -A ten-year "Tapioca Odyssey".** Food Industries 1950:50-51. April 1950. Engl., 1 Ref., Illus.

Cassava. Cassava starch. Factories. Industrialization. Gelatinization. Production. Processing. Brazil.

Notes are given on the cassava starch industry in Brazil. Gelatinization of starch in São Paulo is different from that in Santa Catarina; and yields are lower in São Paulo than in the other state. Differences are probably due to the settling basin technique in São Paulo mills. Flow diagrams of the tapioca process in both states are given. *(Summary by H.J.S.)* 102

1610-0867 **MACHINE FOR processing cassava into gari developed in Nigeria.** World Crops 23(4):224. 1971. Engl.

Cassava. Industrial machinery. Gari. Industrialization. Food products. Nigeria.

News is given about the development of a completely sophisticated, mechanical system producing gari which will provide a sound basis for the growth of both large- and small-scale industries in Nigeria. *(Summary by H.J.S.)* 102

1611-0954 **PRODUCTION INDUSTRIELLE de farine de manioc en paysannat.** *(Production of cassava flour by small farmers).* *In* Brussels. Institute Nationale pour L'Etude Agronomique du Congo. Rapport Annuel 1955. pp.251-252. Fr.

Cassava. Cassava flour. Processing. Zaire.

After some trials carried out in cooperation with the Chemistry Division, a method of preparing cassava flour was established for small farmers. This method is briefly described. *(Summary by H.J.S.)* 102

1612-2189 **YUCA Y maiz.** *(Cassava and maize).* *In* Los indios arauacos se hacian sepultar con sus mujeres vivas. El Pais, Cali; Febrero 4, 1973:14. Span., Illus.

Cassava. Beverages. Maize. Colombia.

This is a newspaper article on the Arawak Indians (Colombia), who used to drink beverages made of maize or cassava. *(Summary by H.J.S.)* 102

1613-0665 KROCHMAL, A. and KILBRIDE, B. **An inexpensive laboratory method for cassava starch extraction.** Journal of Agriculture of the University of Puerto Rico 50(3):252-253. 1966. Engl., Illus.

Cassava. Cassava starch. Processing. Laboratory experiments.

In the course of cassava research, the authors developed an inexpensive and simple method for quantitative starch extraction. Equipment includes an electric kitchen slicer, a high-speed kitchen blender with the largest blades available, a stainless steel sieve, a forced-draft drying oven, a balance and several cake pans. The method appears to be accurate enough to detect any differences of economic importance to a commercial processor of cassava. *(Summary by J.L.S.)* 102

1614-0932 GHANA ACADEMY OF SCIENCES. **Food storage section; cassava.** *In* ______ Annual Report 1964. p. 50. Engl.

Cassava. Storage. Dried tubers. Water content. Temperature. Composition. Ghana.

It has been possible to obtain acceptable "kokonte" by sun drying peeled cassava for 2 days and then oven drying at 80°C until a moisture content of 12% is obtained. Thus prepared, "kokonte" will store very well. *(Full text)* 102

1615-0950 BHATIA, D. S. **Processing and food value of tapioca and its products.** Indian Coffee 16:6-9. 1962. Engl.

Cassava. Rice. Human nutrition. Processed products. Dietary value. Cassava products. Cassava flour. Processing. India.

Research conducted so far has been done on the utilization of cassava as a synthetic grain (rice substitute), tapioca soji (semolina-like product) and cassava flour for "chapates," "pooris" and vermicelli. The preparation of these products is described, and considerations on acceptability and food value are given. *(Summary by H.J.S.)* 102 H01

1616-2423 TKATCHENKO, B. **Note technologique concernant la féculerie d'Ampangabe.** *(Technological notes on Ampangabe starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 25p. Fr., Illus.

Cassava. Industrial starches. Processing. Factories, Bakery products. HCN. pH. Composition. Cassava starch. Malagasy Republic.

A description is given of the Ampangabe starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining starch quality and the rate of extraction, and general observations on processing. Five tables giving data on the physical and chemical composition of the products involved and a diagram showing the process are also given. *(Summary by H.J.S.)* 102

1617-0681 AVERRE, C. W. **Vascular streaking of stored cassava roots.** *In* International Symposium on Tropical Root Crops, lst, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2, pp. 31-35. Engl., 8 Refs.

Cassava. Storage. Temperature. Enzymes. Tubers. Deterioration.

Effects of temperature and other storage factors on the control of vascular streaking in cassava tubers are reported. *(Summary by Plant Breeding Abstracts)* 102

1618-3316 BAUMER, G. W. A. **Report to the government of Nigeria on the processing of gari and tapioca in rural industries.** Food and Agricultural Organization of the United Nations. Report no. 1486. 1962. 18p. Engl.

Cassava. Gari. Fermented products. Development. Industrialization. Factories. Economics. Productivity. Processing. Food products. Nigeria.

Improvements were made in a pilot-scale gari plant established at the Federal Institute of Industrial Research. It has a capacity of about 1 ton of gari| 24 h. Suggestions which led to total improvement of the plant are reported in detail for every step of the process. Data for the establishment of a 10-ton gari plant are given, as well as for the possibility of establishing a cassava starch plant. Gari is compared with tapioca. *(Summary by H.J.S.)* 102 J00

1619-1706 BASSLER, R. and PUTZKA, H.A. **Zur bestimmung des stärkegehaltes in Maniokprodukten.** *(Determination of starch content in cassava products).* Kraftfutter 53(5):238-240; 53(6):290,292-293. 1970. Germ., Sum. Germ., Engl., Fr., 6 Refs.

Cassava. Cassava products. Cassava chips. Pellets. Cassava flour. Starch content. Soluble carbohydrates. Analysis.

An analysis is made of the carbohydrate content of cassava feeds for cattle. The method of starch determination (modified Ewers method) recommended by the Feed Control Section of the German Association of Agricultural Control and Research Stations is well suited for this purpose; possibly the total sugar content may also be included in the evaluation. *(Author's summary)* I02

1620-3313 AKINRELE, I. A. *et al.* **Gari pilot plant (1 ton a day) results of 3 month trial run.** Nigeria. Federal Institute of Industrial Research. Research Report no. 13. 1962. 30p. Engl., Sum. Engl.

Cassava. Human nutrition. Industrialization. Factories. Processing. Gari. Costs. Economics. Prices. HCN. Cassava starch. Proteins. Nigeria.

A pilot plant capable of producing 1 ton of gari|day from cassava roots was run for 3 months to test the technical feasibility of the equipment and the economics of the process. Full cost details and the results of quality-control testing are given. Although good-quality gari was produced, considerable difficulty was found in purchasing the quantity of cassava roots required at a reasonable price. It is suggested that the minimum economic size of the factory is 10 tons|day. *(Author's summary)* I02 J00

1621-3488 HEIN, E. A. **Erfahrungen und Uberlegungen über die Verarbeitung und Verwendung der *Manihot utilissima*.** *(Experiences and considerations on the processing and utilization of Manihot utilissima).* Deutsche Tropenlandwirt 66:75-83. 1965. Germ.

Cassava. *Manihot esculenta.* Tubers. Processing. Cassava flour. Mechanization. Drying. Grinding. Screening. Industrialization. Wheat flour. Composite flours. Breads. Bolivia. South America.

The objectives, development and advantages of a new method of processing cassava tubers into quality flour are described. The process consists of desintegration in a special machine, followed by drying, milling and sifting, which separates the fibers and the dark skin particles from the flour. The technique was successfully carried out in South America in the 1950's. New factories are now being planned in Bolivia for the production of a quality cassava flour to be mixed with wheat flour for making bread. The aspects and advantages of the industrialization of cassava processing are discussed. *(Summary by Tropical Abstracts)* I02

1622-0967 VITTI, P. **Industrialization of cassava - production of starch, chips and flour.** Boletim do Centro Tropical de Pesquisas e Tecnologia dos Alimentos no. 6:26-33. 1966. Port.

Cassava. Processing. Industrialization. Industrial machinery. Production. Cassava flour. Productivity. Cassava starch. Cassava chips. Dried tubers. Washing. Rasping. Screening. Silting. Centrifuging. Drying. Grinding. Brazil

As extraction of cassava starch is an easier process than for cereals, its industrialization is of great interest. Diverse products having a variety of uses, are obtained: alcohol, acetone, acids, gums, glues, etc. By weight cassava is second in Brazil (17 to 22 million tons|year). The most suitable variety for industrial purposes is Branca de Santa Catarina, which normally yields 16-20 ton|ha. Detailed description of the procedures for starch extraction (weighing, cleaning, grating, screening, purification, sedimentation and centrifugation, drying, milling, bagging) is given, as well as the description of machinery used. One ton of roots gives 200-250 kg of dry starch, which corresponds to 93-97% of the starch in the roots. The scheme for chips manufacture is included; normally 300 to 350 kg of chips are obtained from 1 ton of roots. In the extraction of flour from 1 ton of chips, 870 to 910 kg of flour is normally obtained. *(Summary by J.L.S.)* I02

1623-2658 PACHECO, J. A. DE C. **A côr e a aparencia de polvilho para exportação.** *(Color and appearance of cassava starch for export).* Revista de Agricultura (Brazil) 24:167-180. Port., Sum. Engl., 11 Refs.

Cassava. Cassava starch. Legal aspects. Economics. Trade. HCN. Processing. Brazil.

Brazilian cassava starch does not satisfy the American market because of poor color and appearance. Experiments have shown that cassava tannin and HCN have little or no influence on starch color. Color is influenced, however, by the quality of the processing water, by the time between harvesting and processing the roots, and by the care used in washing and peeling them. For starch to be satisfactory in appearance and color, (1) the processing water should have as little iron as possible; (2) washing and peeling should be done carefully; and (3) the time between harvesting and processing should be as short as possible. *(Author's summary)* 102 J00

1624-3381 NEUMAYER, P. **Die Gewinnung von Maniokastärke in Kartoffelstarkefabriken.** *(Extraction of cassava starch in potato starch factories).* Stärke 5:113-115. 1963. Germ., Sum. Fr., Engl., 3 Refs.

Cassava. Potatoes. Factories. Processing. N. Sugars. Cortex. Food products. Starch crops. Tubers. Cassava starch. Dried tubers.

Cassava roots are sliced, sun dried and used for starch extraction. The drying process makes starch extraction more difficult when combined with fresh roots due to the properties of the epidermis, the N-containing substances in the roots which cause coagulation, and the increase of sugar content in dried roots. The larger starch granules of cassava make the machinery for potato starch extraction useless. The starch extraction procedure for dried roots is described and compared when different from potato starch extraction. The wash water should not be alkaline. Drying of both starches is also compared. *(Summary by A. van S.)* 102

1625-1676 HOOD, L. F. and SEIFRIED, A. S. **Effect of frozen storage on the microstructure and syneresis of modified tapioca starch-milk gels.** Journal of Food Science 39(1):121-124. 1974. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Food products. Modified starches. Food thickeners. Analysis. Storage. Cassava starch.

Gels prepared with modified tapioca starch (hydroxypropyl distarch phosphate) in skim milk were stored for up to 60 days at -3 to -32°C. The effect of cyclic freezing and thawing and automatic defrost freezers on gel structure was valuated by electron microscopy. Syneresis was determined. Coat-core type granules disappeared after several freeze-thaw cycles. Starch granules were ruptured by freezing and thawing, and the nongranular starch was dispersed throughout the continuous phase. Casein micelles were distorted, and the subunits were almost completely disaggregated after 60 days. Syneresis increased with time, but the amount of increase varied with the conditions of frozen storage. *(Author's summary)* 102

1626-0947 BANKS, L. and COOK, A. S. **Estimates for a factory producing 10 tons a day of gari.** Lagos. Federal Ministry of Commerce and Industry. Federal Institute of Industrial Research. Technical Memorandum no. 14. 1962. 12p. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Food products. Processing. Industrial machinery. Gari. Production. Mechanization. Tubers. Costs. Fermentation. Human nutrition. Factories. Proteins. Economics. Distribution. Africa. Nigeria.

With the growing urbanization and industrialization of Nigeria and the gradual increase in purchasing power, there will be a need of mechanized production of gari. Mechanization will allow control of the standard production of high-quality material under hygienic conditions and will fortify this low nutritional food with a protein additive. Detailed estimates are given for a factory of 10 tons of gari per day, based on the results of the pilot plant described in the Research Report of the Federal Institute of Industrial Research No.

13,1962. A diagram of the equipment is given. The viability of such a factory directly depends on the price o the cassava roots including transportation to the factory. Total capital requirements, including workin capital, are estimated; a cost study is also made. *(Summary by Tropical Abstracts)* 102

1627-1806 NOBRE, A. and MENEZES, D. M. DE. **A zona mandioqueira e as Industrias de farinha d mandioca do norte Fluminense.** *(The cassava-growing regions and cassava flour mills in the norther part of the state of Rio de Janeiro).* Boletim Técnico do Centro de Tecnologia Agricola e Alimenta no. 5:32-39. 1973. Port., Sum. Port., Engl., 11 Refs., Illus.

Cassava. *Manihot esculenta.* **Production. Productivity. Costs. Cassava flour. Factories. Labou Economics. Brazil.**

Four micro cassava-growing regions were located in the northern part of the state of Rio de Janeiro. Th cassava flour mills in the regions were registered, and the counties with the largest production were classified The county of São João da Barra was the largest cassava-growing center, having more than 50% of the state' flour mills (250 were recorded in 1970-71). The climatic and soil conditions for cassava growing were studie and recorded, as well as the varieties used by local farmers, production costs for several years, market price and the selling prices for flour. *(Author's summary)* 102

1628-0991 JARMAI, S. **A new fast method for the production of kokonte.** Ghana Journal of o Agricultural Science 1:59-63. 1968. Engl., Sum. Engl., Fr., 3 Refs., Illus.

Cassava. Food products. Processing. HCN. Industrialization. Packaging. Fermentation. pH. Drying Lactic acid. Moulds. Dried tubers. Human nutrition. Cassava meal. Processed products. Water content Ghana.

Traditional methods of producing kokonte in Ghana from cassava (*Manihot utilissima* Pohl) are described. It has been shown that a drying period of 5 days is sufficient to achieve the acidity of 0.25-0.60% (expressed in lactic acid) required, even when the traditional procedure is used. Experiments undertaken to work out a suitable technology for the industrial production of this fermented and cooked dish showed that a period of about 24 hours is sufficient to achieve a satisfactory degree of fermentation and a desirable taste. A total acidity (expressed in lactic acid) of 0.30-0.50% should be maintained, and a fermentation time of 20-24 is required. Results of organoleptic tests on laboratory-prepared kokonte are given, and an outline for the establishment of an industrial pilot plant is presented. *(Author's summary)* 102

1629-3348 FULLGRABE, A. **Maniokawurzelverarbeitung.** *(Processing of cassava tubers).* Stärke 8:27-37. 1956. Germ., Sum. Germ., Engl., 18 Refs., Illus.

Cassava. Tubers. Processing. Economics. Costs. Industrialization. Philippines.

The processing of the cassava root to flour and starch is described, using a plant in the Philippines as an example. Details are given of the raw material, the finished product, the manufacturing and the net manufacturing cost. *(Author's summary)* 102.

1630-0734 WILLIAMS, C. N., BEENY, J. and WEBB, B. H. **A solar heat drier for crops and other products.** Tropical Agriculture (Trinidad) 46(1):47-54. 1969. Engl., Sum. Engl., Illus.

Cassava. Food products. Solar drying. Packaging. Cassava meal. Economics. Drying. Processing. Costs. Temperature. Rice. Malaysia.

A solar heat crop drier which utilizes laminated corrugated roofing sheet as a heat trap is described. The sheeting also forms a roof over the material to be dried. Air is drawn between the laminations, the upper surface of which is fully exposed to the sun, and the heated air is passed to a drying chamber. The proportion of solar heat trapped varied with the exposure or elevation of the roof. When it was near ground level and in a sheltered location, heat trapping efficiencies of between 45-90% were obtained, depending on the rate at which the drying air stream was drawn between the laminations. When the roof was set about 10 ft above ground heat, trapping efficiencies of between about 15-30% were observed. A coincidental advantage of this crop-drying roof over ordinary sun drying is the protection of the crop from rain. *(Author's summary)* I02 J00.

1631-0968 CASSAVA (MANIOK). Gordian 69(1623):26-27. 1969. Dutch.

Cassava. Processed products. Gari. Foofoo. Processing. Boiling. Bakery products. Human nutrition. Cassava products. Dried tubers. Processed products. Water requirements (processing). Food products. Nigeria.

The article describes the following local methods of preparing cassava:(1) Boiled cassava: Fresh roots are peeled, boiled and mashed (called fufu). Fufu is prepared in two successive steps: it is mashed and prior to consumption, mashed for a second time. Water is constantly added to keep it soft. (2) Fermented cassava preparation for dough: ground cassava is fermented for 3 days, and a preparation of pieces of cassava, soaked for 5 days in water, is added. This can be boiled (banky) or baked into a cake (yaka yake) after water is pressed out (especially to wash cyanides out of Nigerian cassava). (3) Gari: fresh, ground roots are dried and fermented under pressure and fried, some times after adding palm oil. It can be prepared with sugar, beans, pepper, fish or egg. (4) Kokonte: Pieces of cassava roots are sun dried for some weeks and fermented. After this, they are ground and boiled. *(Summary by A. Van S.)* I02 H01

1632-0555 AKINRELE, I. A., ERO, M. I. O. and OLATUNJI, F. O. **Industrial specifications for mechanized processing of cassava into gari.** Nigeria. Federal Institue of Industrial Research. Technical Memorandum no. 26. 1971. 14p. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. History. Food products. Industrialization. Gari. Fermentation. Marketing. Production. Processing. Industrial machinery. Costs. Gelatinization. Drying. concentrates. Proteins. Human nutrition. Economics. Packaging. Nigeria.

This report reviews the historical development of a mechanized process for the production of gari from cassava, indicating its potential impact on the market's economy. Based on more than 12 years of sustained research at the Institute, specifications are proposed for process conditions and production equipment; a diagramatic flow sheet of a gari plant is given. A minimum economic plant size of 3 tons of gari per 24 hours and larger version at 10 tons of gari per 24 hours are initially recommended. These specifications are the subject of a patent application in the United Kingdom and Nigeria. *(Author's summary)* I02.

1633-3345 ACENA, B. **The effect of high drying temperature on the physical and chemical characteristics of cassava starch.** Starke 8(6):135-139. 1956. Engl., Sum. Engl., Germ., 9 Refs., Illus.

Cassava. Drying. Temperature. pH. Particle size. Cassava starch. Water content. Composition. Storage. Silting. Analysis.

As the drying temperature increased from 104°F to 550°F, the bulk density decreased from 35 to 28 lbs| ft^3. Apparently the moisture content of the starch did not affect the bulk density. The rupturing of granules was affected by low pH and high moisture content of the starch feed and the percentage of ruptured granules was greater in the starch dried at 330°F with a pH of 4.4-4.7 and a moisture content of 40% in the feed. There was no apparent enlargement of the granules due to increased drying temperature, the sizes coming within the average of 15μ-25μ. The grade of the starch was lowered when the drying temperature was increased according to the settling test. The storage life of the starch is highly affected by the pH value of the starch feed remaining more or less the same; the percentage of water soluble extract increased correspondingly as the drying temperature increased. The chemical analysis of the starch showed that there was no significant change. *(Author's summary)* I02 I01

1634-0081 ORDOÑEZ A., J. A. **Elaboración del almidón de yuca.** *(Manufacture of cassava starch).* Nuestra Tierra Paz y Progreso (Nicaragua) 8(74):47-48. 1964. Span.

Cassava. Cassava starch. Processing. Washing. Peeling. Grinding. Rasping. Screening. Silting. Drying.

This paper presents a general overview of the process of starch extraction. *(Summary by J.L.S.)* 102.

1635-0630 PERCY, M. J. and REDMAN, S. **Development of a cassava mill for small processors.** Journal of the Agricultural Society of Trinidad and Tobago 65:179-184. 1965. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Processing. Mechanization. Industrial machinery. Grinding. Industrialization.

A small mill was developed to grind cassava automatically to the desired fineness for starch extraction, livestock feed or farina production. Drawings of the equipment are given, together with data obtained from test runs. *(Summary by T.M.)* 102.

1636-2123 PAULA, R. D. de G. **Algumas indicações sobre industrialização de mandioca e subprodutos.** *(Some indications on the industrialization of cassava and its by-products).* Revista de Quimica Industrial 33(286):20. 1964. Port.

Cassava. Industrialization. Processing. Farinha. Cassava starch. Proteins. Animal nutrition.

Brief notes are given on the preparation of starch, farinha, dextrin, glucose, alcohol and ketones. Information is also presented on the protein content of branches and leaves and their use in animal feeding. *(Summary by H.J.S.)* 102.

1637-0879 RAJASEKHARAN, N. *et al.* **Keeping quality of tapioca and nutro-macaroni.** Food Science 9(7):240-243. 1960. Engl., Sum. Engl., 6 Refs.

Cassava. Tapioca macaroni. Composite flours. Packaging. Storage. Timing. Processing.

One-year storage trials were carried out on steamed and roasted tapioca macaroni rice, and nutro-macaroni (shells) packed in different containers. All 3 macaroni products had good keeping quality, storing well for more than 12 months under normal conditions. The product is also fairly insect resistant. *(Author's summary)* 102.

1638-3640 CZYHRINCIW, N. and JAFFE, E. **Modificaciones químicas durante la conservación de raíces y tubérculos.** *(Chemical changes during the storage of roots and tubers).* Archivos Venezolanos de Nutrición 2(1):49-67. 1951. Span., Sum. Span., Engl., Germ., 5 Refs.

Cassava. *Manihot esculenta.* **Sweet cassava. Tubers. Storage. Temperature. Composition. Starch content. Sugars. Ascorbic acid. Dry matter. Analysis. Biochemistry. Enzymes. Vitamin content. pH. Venezuela.**

A study was made on the storage of the following products at different temperatures: "arracacha" *(Arracacia xanthorriza)*, sweet potatoes *(Ipomoea batatas)*, yampee *(Dioscorea trifida)*, yam *(Dioscorea alata)*, *(Xanthosoma sagittifolia)* and cassava *(Manihot aipi)*. The temperatures used were 3°C, 12°C and room temperatures (25°C). The following factors were determined at weekly intervals: total loss, dry weight, starch, sugars, pH, total acids, vitamin C, peroxidases, catalases and dehydrogenases. Cassava was stored best at a temperature of 3°C. At this temperature, there was 14% loss after two weeks and 23% after 4 weeks. An increase in dry weight, starch and pH was generally observed during storage of these crops; acidity varied very little. The vitamin C content dropped to about one half the initial value in most cases. Dehydrase activity, as determined by the reaction with triphenyl-tetrazol, showed characteristic values for each product but remained relatively stable during the observation period. *(Author's summary)* 102 C03

1639-1692 VAN BIEMA, G. and SHIPMAN, L. C. **Tapioca capacity and quality.** Food Engineering 24 (3):56-58, 182, 184. 1952. Engl., Illus.

Cassava. Industrialization. Industrial machinery. Factories. Silting agents. Cassava flour. Processing.

A description is given of the commercial proc tion of cassava flour. *(Summary by Chemical Abstracts)* 102.

T-1028

1640-3373 TSENG, R. H. **Puli tapioca starch factory.** Taiwan Sugar 10(1-4):32-35. 1963. Engl., Illus.

Cassava. Legal aspects. Factories. Processing. Uses. Cultivation. Taiwan.

A sugar factory at Puli, in the central part of Taiwan, was closed and converted into a cassava starch factory. A description is given of cassava cultivation, in addition to production of cassava starch and procedures to control starch quality. A table is presented of specifications of cassava starch for export. *(Summary by H.J.S.)* 102.

1641-0768 CZYHRINCIW, N. **Consideraciones sobre industrialización de raíces y tubérculos tropicales.** *(Considerations on the industrialization of tropical roots and tubers).* Revista de la Facultad de Agronomía (Venezuela) 5(2):108-117. 1969. Span., Sum. Span., Engl., 14 Refs.

Cassava. Arracacia. Industrialization. Yams. Cocoyams. Composition. Nutritive value. Venezuela.

In response to the need to increase world food production, a study was made of 5 tropical roots and tubers (including cassava) grown in Venezuela. Their relatively high nutritive value is pointed out. Problems involved in industrializing these products are discussed, together with their physicochemical properties. *(Summary by T.M.)* 102

1642-1663 MORIN, R. L. M. **Method of preparing tapioca and apparatus for executing said method.** British Patent 316, 291. 1928. 4p. Engl.

Cassava. Tapiocas. Processing. Industrial machinery. Water requirements (processing). Patents.

Tapioca is prepared by moistening dry cassava root fecula (starch) and cooking it with steam (exhaust steam with a temperature of 80-100°C is suitable) in a closed boiler, in which the starch is spread out in thin layers (1 cm thick) on plates. The procedure is described in detail. *(Summary by Chemical Abstracts)* 102

1643-0750 AYRES, J. C. **Manioc; the potential exists for increased use of this tropical plant and its products.** Food Technology 26(4):128-132,134,136,138. 1972. Engl., 38 Refs., Illus.

Cassava. Production. Processing. Uses. HCN. Gari. Cassava starch. Trade. Marketing. Productivity. Food products. Cassava meal. Economics. Industrialization. Composite flours. Brazil. Thailand.

The production, processing, properties, and uses of cassava and tapioca are reviewed in detail. Recomendations for improving the technology and economics of cassava are also presented. *(Summary by Food Science and Technology Abstracts)* 102 J00

1644-0826 TAPIOCA IN **Thailand.** Foreign Agriculture 15(12):270-271. 1951. Engl., Illus.

Cassava. Development. Tapiocas. Processing. Thailand.

Tapioca is a popular thickening for fruit pies, soups and puddings. It is made from the roots of the cassava plant, a native of tropical America, which, like the rubber tree, has been transplanted to southeastern Asia, where commercial production is centered. Although output of tapioca in Thailand is small in terms of world trade, its Government is attempting to encourage increased production and to establish methods that will insure a high-quality product. Tapioca processing methods vary from country to country; the methods commonly used in Thailand are illustrated. On delivery to the mill, the roots are sorted, washed and fed into a grinding machine, through which a stream of water is kept flowing. The ground roots, mixed with water, are passed through a revolving sieve, where the coarse fibers are separated from the finer, starchy material. The starch passes through the meshes of the sieve into a trough that carries it to a screen-covered vat, where the last of the fiber is removed. After a series of washings, the starch is spread out to dry, either on open-air drying floors or on flue-heated brick platforms. When the starch is dry, it is lumpy and must be ground. The resulting flour is only one form in which tapioca is offered for sale. The other—granular tapioca—is produced by moistening the flour and agitating it thoroughly in a hammocklike device to convert the flour into pellets. To obtain tapioca of uniform size, the pellets are passed through screens. They are then dried in shallow iron pans over charcoal fires. *(Full text)* 102.

1645-0321 INGRAM, J. S. **Cassava processing: commercially available machinery.** Tropical Products Institute. Report no. G75. 1972. 8p. Engl.

Cassava. Industrial machinery. Cassava starch. Pellets. Gari. Cassava chips. Cassava flour.

A list of manufacturers of machinery for processing cassava is presented. No opinion is given regarding the performance or efficiency of the different machines. *(Summary by H.J.S.)* 102

1646-0621 **PROPIEDADES DE la harina de yuca.** *(Characteristics of cassava flour).* México Agrícola 15(179):28. 1969. Span.

Cassava. Cassava flour. Processed products. Uses. Mexico.

In Mexico cassava flour is used mainly for industrial purposes, but it can be an important source of animal feed. Studies showed that the chemical composition of the cassava root can differ considerably, resulting in differences of nutritive value. Among 30 varieties studied, the dry matter content of the roots varied between 24 and 52% (average 35%), and the protein content varied between 1 and 6% (average 3.5%). *(Summary by Tropical Abstracts)* 102

1647-0887 SEIDEMANN, J. **Sago und Tapioka.** *(Sago and tapioca).* Gordian 69:323-326, 382-385. 1969. Germ., Sum. Germ., Engl., 82 Refs., Illus.

Cassava. Food products. Processed products. Tapiocas. Sago. Processing. Human nutrition. Cassava flour.

Descriptions are given of sago, pearl sago, sago starch, sago flour, cassava starch, cassava flour, tapioca and pearl tapioca. It appears that a different name is frequently used for the same product. Exact definitions are proposed for the aforementioned products, taking into account the legal aspect. Terms artificial sago, sago substitute, etc. are rejected such as since sago or pearl sago and tapioca or pearl tapioca manufactured from potato starch or other starches represent products derived from natural starch and as such are not synthetic or substitute products. *(Author's summary)* 102 H01

1648-0627 NOBRE, A. **Conservação de raizes de mandioca frescas.** *(Storage of fresh cassava roots). In* Reunião da Comissão Nacional da Mandioca, 5, Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuária do Centro-Oeste, 1971. pp. 43-46. Port., 1 Ref.

Cassava. *Manihot esculenta*. Cultivars. Storage. Deterioration. Tubers. Timing. Laboratory experiments. Field experiments. Brazil.

An experiment was carried out to determine the effectiveness of paraffin wax, benzoic acid (1% and 5%), and lactic acid (1% and 5%) in the storage of fresh roots. Waxing cassava roots was most profitable in large-scale production. *(Summary by J.L.S.)* 102

1649-0791 HACHERO, L. **A cottage cassava slicer.** Philippine Journal of Agriculture 22(1-4):81-88. 1957. Engl., Sum. Engl.

Cassava. Cottage machinery. Cassava chips. Gaplek. Processing. Philippines.

Slicing is one of the costly items in processing gaplek (a preserve form of cassava). An improved cottage-type slicer developed in the Philippines is described, together with the method of preparing gaplek, including production costs. Other roots such as sweet potatoes, etc. may also be sliced by means of this new instrument. In view of the recurrent shortage of rice supply, the promotion of gaplek production is considered to be highly important. *(Summary by Tropical Abstracts)* 102

1650-0936 HALLIDAY, D., QURESHI, A. H., and BROADBENT, J. A. **Investigations on the storage of gari.** Report of the Nigerian Stored Products Research Institute. Technical Report no. 16:131-141. Engl., 7 Refs.

Cassava. Gari. Human nutrition. Storage. Industrial microbiology. Food products. Water content. Temperature. Moulds. Deterioration. Processed products. Composition. Nigeria.

Two types of gari are sold in southern Nigeria, white and yellow. Gari destined for long-term storage should have a moisture content in equilibrium with a relative humidity of less than 65%. Investigations were carried out concerning the relationship between moisture content and equilibrium relative humidity to determine the maximum permissible moisture content for safe storage. Surveys of the moisture content of gari on sale at Lagos and Ibadan markets were also made under both rainy and dry season conditions to determine the extent to which the requirement for maximum permissible moisture content (calculated from the relative humidity| moisture content equilibrium data) was met. In addition, observations of moisture uptake, incidence of mold growth and decline in palatability in bags of gari stored at Ibadan under ambient conditions were made in order to determine the likely maximum period for which typical "market" gari can be safely stored. A microbiological examination of the gari was made at the end of the storage period. Samples of gari just obtained from the market were also subjected to microbiological examination for comparison purposes. Both white and yellow gari presently available in Nigeria are not immediately suitable for long-term storage as their moisture contents are usually higher than the levels of 12.1 and 13.0% determined as the maximum permissible if the possibility of mold growth is to be completely avoided. It will very likely be possible to store white gari on a long-term basis if it is first dried to a moisture content below 12.1%. Subsequent moisture uptake from the humid atmosphere may be avoided by storage in polythene or polythene-lined bags. Sacks of market white and yellow gari may be kept for some 2 and 6 weeks respectively, before significant reduction in palatability occurs. *(Author's summary)* 102

1651-3346 WEGMANN, K. **Untersuchungen über die Lagerfähigkeit von Manioc-Mehl.** *(Investigations of the storability of cassava flour).* Brot und Gebäck 24(1):16-18. 1970. Germ., 6 Refs.

Cassava. Cassava flour. Cassava chips. Storage. Deterioration. Analysis. Temperature.

Cassava roots, chips or flour are often infected with microorganisms Acid treatments are made at different relative humidities and temperatures to prevent microbial growth. Acids can act in two ways: (1) A low pH (below 4) can prevent their growth to have sufficient nondissociated acids. With 1% formic acid, this was not achieved. (2) They can act as antimicrobial agents. However they are generally insensitive to organic acids and do not play a role in the storability. Therefore, the only workable method of storing cassava flour is to reduce RH to below 65% and the moisture content of the flour to below 10%. This corresponds to storability of wheat flour. *(Summary by A. van S.)* 102

1652-0463 LEWIS, Y. S. and JOHAR, D. S. **Control of fermentation in settling tanks of sago factories.** Food Science 7(10):285. 1958. Engl. 1 Ref.

Cassava. *Manihot esculenta*. Fermentation. Processing. Factories. Industrial microbiology. Cassava starch. Tapiocas. Tapioca pearls. India.

The manufacture of tapioca pearls from *Manihot utilissima* involves, among other things, separation of the fibrous matter of the tubers from the starch and the sedimentation of this product. During this process, there is a heavy microbiological load on the sago globules, which is very objectionable. The addition of small quantities of sulfur was most effective in suppressing excessive microbial growth for 48-72 hours. *(Summary by Tropical Abstracts)* 102

1653-0938 NIGERIA. **FERMENTING a staple food more effectively.** New Scientist 25(428):218. 1965. Engl.

Cassava. Fermented products. Fermentation. Gari. Processing. Human nutrition. Food products. Nigeria.

The staple food of more than 20 million people in Central and West Africa is gari, a granular carbohydrate that swells in water to give a semistiff porridge. It is produced by fermenting the root of cassava (*Manihot utilissima* Pohl), which acquires a characteristic flavor in the process that makes it palatable on its own or mixed with other foods. However, there are serious disadvantages: It is nutritionally poor and in most of the villages is fermented under unhygienic conditions. An attempt has been made to increase protein and vitamin content (adding concentrates of groundnut and soybeans) and to carry out production under factory controlled, hygienic conditions. Extensive research into the physical, biochemical and microbiological changes brought about by traditional processing leading to proposals for a better and speedier alternative, has been carried out by I. A. Akinrele, at the Federal Institute of Industrial Research, Oshodi (now at the University of Ibadan), Nigeria. He found that fermentation of the pulped roots takes place in two stages. Bacteria within the cassava first attack the starch, producing lactic and formic acids; a host of gases are also produced, making the medium anaerobic and thus slowing up the attack. A mold forms, bringing about further acidification and production of the characteristic aroma of gari. These steps, together with the increasing of its vitamin and protein content, have been incorporated by Akinrele in a mechanized process. The cassava roots are washed, tumble peeled, grated to pulp and inoculated with 3-day-old cassava liquor to speed fermentation. After centrifuging the mash, granules of gari are produced, dried and packed in jute sacks lined with polythene. Fermentation now takes only 24h, where traditionally it takes at least 3 days, and the gari can be stored longer because its moisture content is properly controlled. *(Full text)* 102

1654-0448 MAJUMBER, S. K. *et al.* **Control of spoliage in fresh tapioca tubers.** Food Science 5(5):108-109. 1956. Engl. 8 Refs.

Cassava. Storage. Tubers. Fresh products. Deterioration. Disease control. Laboratory experiments.

A study was made on the causes of spoilage and measures that would prolong the quality of fresh roots under factory conditions. Rotting was associated with the development of acidity (activity of a bacterium under anaerobic conditions) and discoloration (result of the growth of the fungus **Rhizopus** sp. under aerobic conditions). Infections were concentrated in injured areas of roots. Sterilized roots stored under aseptic conditions did not develop acidity or discoloration. Sterilization with various chemicals (ethyl bromide and/or ethylene dibromide, and formaldehyde) lengthened storage life of roots up to 25 days. *(Summary by T.M.)* 102

1655-0626 PAPE, G. **Novo processo de fabrico de farinha de raspa de mandioca de qualidade especial.** *(A new process for manufacturing excellent quality cassava flour). In* Reuniao da Comissao Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. *Anais. Sete Lagoas,* Minas Gerais, Instituto de Pesquisa Agropecuária do Centro-Oeste, 1971. pp. 9-11. Port.

Cassava. Cassava flour. Industrialization. Processing. Brazil.

Studies were undertaken by ITA (Instituto de Tecnologia Alimentar) to develop a faster and cheaper process for producing cassava flour. In the traditional and Hein's methods, cassava roots are submitted to long processes. In the ITA process, the washed and grated cassava roots, are pressed in a helicoidal press (a turbine or hydraulic press may also be used) to eliminate the water content; then the material is passed to a flash dryer. The dry product is put into a cyclone. The flour obtained by this process is of excellent quality. *(Summary by J.L.S.)* 102

1656-0095 TOSELLO, A. **Secagem de amido pelo ar quente.** *(Dehydration of starch by hot air.).* Bragantia 10(2):357-363. 1950. Port., Sum. Engl., Illus.

Cassava. Cassava starch. Processing. Drying. Temperature. Water content. Composition. Analysis. Dextrins. Centrifuging. Brazil.

In the industrial production of starch from cassava roots (*Manihot utilissima* Pohl) in the state of São Paulo, the drying operation is carried out by the slow and costly method of vacuum dehydration. The need for a quicker, less expensive method led the writers to investigate the dehydration of raw starch by hot air. Studies were then made to determine the effect of water content of raw starch and temperature of hot air used in drying the starch on the amount of dextrins present in the dehydrated product.Samples of raw starch with a water content ranging from 8-30% were prepared by slow drying at 30°C. The samples were arranged in comparable groups, including the whole range in water content; and each group was further dried by hot air at temperatures ranging from 30-100°C. After the dehydration was completed, each sample was tested for dextrins. The results of these tests indicated that hot air dehydration of raw, centrifuged starch is feasible and that the degree of dextrin formation may be held below 0.3% if the following procedure is used: (1) the water content of the raw starch should be lowered to 30% or preferably less by centrifugation; (2) the hot air dehydrator should be of the "reversed current" type; (3) the temperature of the air and rate of drying should be regulated according to the illustrated indications in the text. *(Author's summary)* 102

1657-0871 LAVIGNE, R. **Etude sur le séchage du manioc.** *(Study on cassava drying).* Bulletin de Madagascar 240:442-466. 1966. Fr., 4 Refs., Illus.

Cassava. Drying. Industrial machinery. Temperature. Cassava chips. Dried tubers. Processing. Malagasy Republic.

The problem of drying chips of cassava roots, for local livestock feed or export was investigated at Lake Alaotra Station, Madagascar. Simple equipment, suitable for small- or medium-sized farms, is described. The equipment is made of locally available materials and consists essentially of grids, each measuring 1.5 m^2 and raised about 40 cm above the ground. A waterproof sheet is required for covering the chips at night or in rainy weather. The chips are loaded on the grids at a rate of 10-15 kg| m^2 and are turned over every day. About 70 h of sunshine are required for dying. *(Summary by Field Crop Abstracts)* 102

1658-0934 NIGERIA. FEDERAL INSTITUTE OF INDUSTRIAL RESEARCH. **Mechanized processing of gari.** *In* ________.Quarterly Progress Report 1970. pp. 28-33. Engl., Illus.

Cassava. Gari. Food products. Industrialization. pH. Mechanization. Fermentation. Processing. Temperature. Corynebacterium. *Geotrichum candidum.* **Industrial microbiology. Nigeria.**

Observations were made on the behavior of each type of mash as it transversed the process line. The village method of frying cassava mash readily facilitated the measurement of the temperature and moisture content history of the mash. In the mechanized garification procedure, sampling was difficult and mostly aborted. Work was done on collecting further data with the objective of integrating the process of accelerated fermentation with the mechanized production of gari. The pH of the fermenting mash of 4.00±0.15, which is normally attained in about 3 days in unseeded fermentation, is now reached in about 15 hours. *(Summary by H.J.S.)* 102 103

1659-2088 PRAMANIK, A. **Prospects for tapioca cultivation and pelletization in Malaysia.** Planter 47(543):240-246. 1971. Engl., Sum. Engl., Illus.

Cassava. Cassava programs. Development. Prices. Economics. Distribution. Productivity. Industrialization. Cassava chips. Dried tubers. Trade. Marketing. Pellets. Production. Malaysia.

A study was made on the feasibility of cultivating cassava in Malaysia and setting up a pelletizing plant for processing it. This project would help diversify the country's economy and earn valuable foreign exchange (higher for pellets than for rubber or palm oil). As a compound feed, it would also be in line with the country's livestock development plan. Estimates were made on the basis of 200,000 acres being planted to cassava, yielding 15 tons|acre. Profit margins are very high (50-60%). The possibility of local Government incentives and foreign capital for loans is also mentioned. *(Summary by T.M.)* 102 J00

1660-2093 LELOUSSEY, J. **L'industrialisation des produits agricoles tropicaux en Gote d'Ivoire.** *(The industrialization of tropical farm products in the Ivory Coast).* Industries Alimentaires et Agricoles 87(6):721-723. 1970. Fr.

Cassava. Yams. Cassava products. Cassava pastes. Atieke. Starch crops. Processing. Economics. Ivory Coast.

Even though the Ivory Coast has favored the industrialization of agriculture, the country still imports 4,000,000 quintals of wheat. Nutritional institutions charged with agricultural improvement and development programs have made remarkable progress in storage and treatment of cereals. Silos and dryers have been installed in the country. As for starch crops, little attention has been paid to them. The International Institute for the Industrialization of Tropical Agricultural Products has undertaken the task of transforming tuber crops into food products, which can be stored for long periods of time. Yam and cassava are the main crops being studied. "Atieke", which is a heavy cassava paste, is formed by pounding the fresh or boiled root. The process also applies to yams and plantains. The mass is fermented in 2-3 days, then it is crushed again, drained, kneaded and lightly cooked. Due to the fast deterioration of this product, an effort is being made to obtain a dried, industrial atieke like that of semolina, which can be kept indefinitely, marketed easily and can be used instantly after steam reheating. Prospects are given for the establishment of a pilot plant. *(Summary by J.L.S.)* 102

1661-2010 COLOMBIA. INSTITUTO DE INVESTIGACIONES TECNOLOGICAS. **La yuca parafinada.** *(Paraffinized cassava).* IIT Tecnología 14(78):47-51. 1972. Span., 5 Refs., Illus.

Cassava. Storage. Economics. Trade. Marketing. Tubers. Colombia.

Cassava roots start rotting a few days after harvesting. Two days after harvesting roots become dark; then become soft, fungi appear and roots taste bitter. Darkening is due to peroxidase and softening to amylases. To preserve cassava, it was considered necessary to avoid epidermis breakage to decrease enzyme activity, to prevent fungi and yeast growing, and| or to protect the roots against oxygen action. The process preserves cassava for 30 days and it includes (1) selection of roots in good condition, (2) washing, (3) drying, (4) paraffinized by immersion, (5) tempering, (6) inspection and (7) packaging. Economic aspects related to the process, such as capital investment for paraffin plants and the possibilities of extending markets locally and abroad, are discussed. *(Summary by H.J.S.)* 102 J00

1662 0935 AKINRELE, I. A., COOK, A. S. and HOLGATE, R. A. **The manufacture of gari from cassava in Nigeria.** *In* International Congress of Science and Technology. London, 1962. London. 1966. v.4, pp.633-644. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Food products. Gari. Fermentation. Processing. Composition. Industrialization. Factories. Production. Nigeria.

Cassava is the main staple food in southern Nigeria and consumption is about 20 million tons per year. Analysis of cassava is given and a process for the production, by fermentation, of gari described. This is a type of meal which is usually eaten in the form of a stiff "porridge" by adding hot water. The Federal

Institute of Industrial Research (FIIR) was set up by the Nigerian Government to introduce new industries to the country, and the mechanization of gari production was one of the first major products to be undertaken. The pilot plant described in detail produced 1 ton of gari per day from about 3 tons of cassava. *(Author's summary)* 102

1663-0785 ADRIANO, F. T. **Possibilities of developing the cassava industry in the Philippines.** Philippine Journal of Agriculture 4:271-285. 1933. Engl., 12 Refs., Illus.

Cassava. Industrialization. Processing. Bakery products. Production. Factories. Economics. Costs. Cassava flour. Breads. Composition. Productivity. Wheat flour. Trade. Cultivars. Cassava starch. Philippines.

To show the importance and the need of developing the cassava industry in the Philippines, it is only necessary to point out the heavy annual importations of wheat flour and starch; wheat flour is mentioned because of the possiblity of displacing a certain proportion of it with cassava flour in the preparation of bread and other baking products. Culture and chemical composition of cassava is given, as well as a description of uses of some foodstuffs and by-products prepared from it. For the manufacture of starch, the bitter and high-yielding varieties, which are rich in starch are preferred. Differences in composition of some important varieties grown in Philippines are given. An ample observation of processing cassava starch is also given for a cassava starch factory with a capacity of 10 tons of tubers a day. *(Summary by J.L.S.)* 102

1664-0933 NIGERIA. FEDERAL INSTITUTE OF INDUSTRIAL RESEARCH. **Mechanized production of gari.** *In* ______. Quarterly Progress Report 1970. pp. 22-35. Engl., Illus.

Cassava. Gari. Food products. Fermentation. Processing. Starch content. Centrifuging. pH. Water content. Rasping. Screening. Mechanization. Industrialization. Gelatinization. Composition. Nigeria.

As a result of the inconsistency of acid taste in gari, efforts were directed at finding the effect of centrifuging on the moisture content, acidity and free starch concentration of the fermentation mash. Besides, extensive grating of cassava roots using 3 types of grating equipment has been carried out recently. The work was divided into two sections: effect of the type of grater on fermentation characteristics and effect of type of fermentor (bag or tank) on fermentation characteristics. A brief description of the procedures for mash sampling, volatile and total acidity and free starch concentration determinations are given. *(Summary by H.J.S.)* 102

1665-2120 COLLENS, A. E. **Cassava. Recent developments in Trinidad.** Bulletin of the Department of Agriculture, Trinidad and Tobago 14(2):56-57. 1915. Engl.

Cassava. Composition. Bitter cassava. Factories. Development. Trinidad and Tobago.

Brief notes are given on cassava. Starch, glucose, alcohol and other products are normally obtained from maize; but maize has other very important uses. This has led to the possibility of growing cassava on a commercial scale to replace maize for these industrial uses. The stem composition of bitter cassava is given. *(Summary by H.J.S.)* 102

1666-0759 PACHECO, J. A. DE C. **Alteracoes do teor de amido durante o armazenamento das raizes de mandioca.** *(Changes in starch content during the storage of cassava roots).* Bragantia 13:15-16. 1954. Port., Sum. Engl., 2 Refs.

Cassava. Tubers. Storage. Starch content. Composition. Timing. Brazil.

The starch content of fresh cassava roots and that of roots stored under field conditions for 24, 48 and 72 hours was determined by Ewers' method. In the majority of cases, the quantity of starch was not altered; this fact was probably due to the relatively low air temperatures that prevailed during the experiments. Since storage of cassava roots is carried out under similar temperature conditions, it is concluded that losses in starch content are not frequent during storage. Since, however, losses in root weight occur (2-7%) and the quality of the starch is lowered, storage for periods longer than 24 hours is not advisable. *(Author's summary)* 102 C03

1667-1683 MECHANISED PRODUCTION of **gari.** Food Manufacture 47(5):62-63. 1972. Engl., Illus.

Cassava. Gari. Food products. Processing. Mechanization. Factories. Industrialization.

A pilot plant for the manufacture of gari was designed and developed by Newell Dunford Engineering Ltd. and is in operation at a research institute at Oshodi, near Lagos, Nigeria. Operation of the plant is briefly described with the aid of a flow diagram. Processing stages are washing and peeling the cassava root, milling and bagging the root, fermenting the root in vats, hydraulic pressing of water from fermented material, separating fiber from usable material, preparing fermented material for "garifying" garifying (heating to gelatinize the starch), drying gari, screening dried material, milling oversize material, and weighing into 1-cwt bags. *(Summary by Food Science and Technology Abstracts)* 102

1668-2339 BRITISH GUIANA; **New cassava processing factory.** Nederlands Handelscommisariaat Caribisch Gebied. Brief no. 503. 1961. p.8. Engl.

Cassava. Processing. Factories. Industrial starches. Human nutrition.

A brief note is given on a new cassava-processing industry in British Guiana. Emphasis will be placed upon the production of farina for food and starch for export. *(Summary by Tropical Abstracts)* 102

1669-2341 SOMASUNDARAM, S. S. **Cooperative organization of the Salem sago industry.** Cooperative News Digest (India) 6(8):152-155. 1955. Engl.

Cassava. Industrialization. Tapiocas. Production.

In Salem (Madras, India) sago production formerly amounted to 30,000 tons|yr and provided employment for 100,000 people; on the whole it was not a flourishing industry. The Government of Madras has now organized the sago growers and manufacturers into a cooperative marketing society. Credit arrangements and direct sales to the consumer have been set up. *(Summary by Tropical Abstracts)* 102

1670-2392 COMO SE **fabrica a tapioca.** *(How tapioca is manufactured).* Seleções Agricolas 15(176):90. 1960. Port.

Cassava. Tapiocas. Processing.

A brief description is given of the manufacturing of tapioca. *(Summary by H.J.S.)* 102

1671-2320 TEIXEIRA, C., ANDREASEN, A.A. and KOLACHOV, P. **Ethyl alcohol from cassava.** Industrial and Engineering Chemistry 42(9):1781-1783. 1950. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Ethanol. Industrial starches. Productivity. Processing. Industrial microbiology.

Cassava starch can be converted into alcohol most efficiently when submerged culture fungal enzyme preparations are used to hydrolyze the starch into fermentable sugars. Investigators who have employed acid hydrolysis report yields of 43-74% of the theoretical. The use of barley malt for conversion has resulted in yields of 70-74% of the theoretical; the use of an equivalent amount of corn malt resulted in lower yields. When mold bran preparations were used for conversion, yields of 80-85% of the theoretical were obtained. Cassava mashes converted by submerged fungal cultures, resulted in a plant efficiency of 90%. *(Author's summary)* 102.

1672-2343 EISENLOEFFEL, A. and FISHER, J. **Report to the Government of Tanzania on brown sugar production and general considerations on the processing of other agricultural products.** Food and Agricultural Organization of the United Nations. Report no. TA 2381. 1967. 22p. Engl., Sum. Engl.

Cassava. Processing. Development. Human nutrition. Tanzania.

Zanzibar now produces 560 tons of sugar cane a year on Pemba Island. The Góvernment is advised to expand the area under cane, the product to be processed to noncentrifugal sugar. As regards cassava, it was recommended that more sophisticated methods of preparing cassava for home consumption should be publicized and that the Government should promote a drying and milling industry to dispose of surplus production, thereby encouraging planting when other local food crops are in abundant supply. At present the export market does not seem profitable unless a centralized marketing system is developed. Appendices contain statistical data on agricultural exports and imports of Zanzibar. *(Summary by T.M.)* 102 H00

1673-2391 **INDUSTRIALIZAÇÃO DA mandioca.** *(Cassava industrialization).* Selecoes Agricolas 18(201):66-68. 1963. Port.

Cassava. Industrialization. Rasping. Farinha. Processing. Washing. Productivity. Cassava flour.

The manufacturing of cassava flour is described. *(Summary by H.J.S.)* 102

1674-2147 COLLENS, A. E. **Alcohol from cassava.** Bulletin of the Department of Agriculture, Trinidad and Tobago 14(2):56. 1915. Engl.

Cassava. Alcohol. Processing.

Three experiments are described on the extraction of alcohol from cassava. Yields obtained were 27.3, 75.6 and 81.5 gal| ton of dried cassava slices. *(Summary by H.J.S.)* 102

1675-2184 BOUILLON, J. **Une nouvelle machine pour les féculeries de manioc.** *(A new machine for cassava starch factories).* Revue Internationale des Produits Coloniaux 26(257):44. 1951. Fr.

Cassava. Industrial starches. Industrial machinery. Silting. Washing. HCN content. Development. Water requirements (processing). Composition. Processing. Cassava starch. Malagasy Republic.

This new machine for manufacturing starch has a concentrator which shortens the time of decantation and permits the rapid exchange of water used to wash the material. In this way, factories using low-quality water can improve the quality of the final starch. *(Summary by H.J.S.)* 102

1676-2319 HUTCHINSON, R. C. **A report on the possibility of producing power alcohol in New Guinea.** New Guinea Agricultural Gazette 7:141-164. 1941. Engl., Sum. Engl., Illus.

Cassava. Ethanol. Productivity. Tubers. Industrialization. Processing. Sago palm. Alcohol. Production. Starch content. Composition.

The possibility of producing alcohol from cassava tubers, the sago palm and the nipa palm are discussed. Figures for the possible yields per ton and per acre are given, these figures are compared to similar figures for crops grown in temperate climates. *(Author's summary)* 102

1677-2301 L'INDUSTRIE DU **manioc au Togo.** *(The cassava industry in Togo).* Institut d'Emission de l'Afrique Occidentale Française et du Togo. Note d'Information no. 35. 1958. 10p. Fr., 4 Refs., Illus.

Cassava. Cultivation. Cultivars. Composition. Trade. Marketing. Prices. Economics. Cassava meal. Cassava flour. Tapiocas. Gari. Processed products. Industrialization. Factories. Togo.

Cassava is exported in 3 different forms; meal, flour and tapioca. Cassava flour is prepared according to the most modern techniques in a factory located at Ganave. Data are given on exports of these different products for the years 1955-57. Remarks on the status of cassava cultivation and the industrialization of these products are presented. *(Summary by J.L.S.)* 102 J00

1678-3267 VITTI, P. **Industrialização da mandioca; produção de amido, raspa e farinha de raspa.** *(Cassava industrialization; production of starch, grated meal and flour).* Tecnologia de Alimentos e Bebidas 9:26-33. 1966. Port.

Cassava. Industrialization. Processing. Cassava starch. Cassava flour. Cassava meal. Processed products. Production.

Descriptions are given of the manufacturing processes of 3 types of cassava products. A flow chart is included. One ton of cassava tubers (harvested after 16-20 mo) renders 200-250 kg of dry starch and 300-500 kg of grated meal. One ton of meal renders 870-910 kg of flour. *(Summary by H.J.S.)* 102

1679-2321 TUBANGUI, M. A., MASILUNGAN, V. A. and HIPOLITO, D. **The fermentation of cassava and molasses for the production of acetone and normal butyl alcohol.** Philippine Journal of Science 70(2):123-131. 1939. Engl., Sum. Engl., 10 Refs.

Cassava. Molasses. Maize meal. Soybeans. Alcohol. Composition. Fermentation. Industrial microbiology. Proteins. Gaplek. Philippines.

A strain of *Clostridium acetobutylicum* (Weizmann), which was isolated from rice field soil, was used as the fermenting agent. Mashes prepared from either cassava or molasses alone cannot maintain the normal growth of the acetone-butyl alcohol organism because of inadequate nutrients. For this reason it is necessary to supplement them with materials, such as corn meal or soybean powder, which are rich in nutrients. Soybeans are a better a source of nutrients than corn. The additon of at least 0.4 g of soybean powder to every 100 cc of mash with a carbohydrate content equivalent to 4% starch will furnish the necessary nutrients for the fermentation of either cassava or molasses. The procedure is simple and is believed to be more advantageous than the Arroyo process for the production of solvents from molasses. The ability of *Clostridium acetobutylicum* to utilize cassava and molasses can be increased by gradually acclimatizing it to grow in the presence of these substances through repeated subculturing, sporulation and heat-shocking. With the use of derived cultures, fermentation is complete after a period not exceeding 69 h in the case of cassava-soybean mixtures and 93 h in the case of molasses-soybean mixtures. The yield of total solvents is from 34-38% of the dextrose equivalent of the carbohydrate content of the mash and has an average composition of approximately 31% acetone, 58% normal butanol, and 11% ethyl alcohol. The average yield from 1 kg of cassava (gaplex) is 0.8 lb and from 1 gal of molasses 2.5 lb of total solvents. Mashes with carbohydrate contents equivalent to between 4.06-5.56 g of dextrose| 100 cc of mash give the highest yields of solvents per sugar unit. At the optimum sugar concentration of 5.56%, the maximum yield is 2.040 g of total solvesnts| 100 cc of mash. Mashes with higher carbohydrate contents do not yield larger amounts of solvents, probably due to the inability of the vegetative phase of the butyl organism to withstand the presence of solvents at higher concentrations. *(Author's summary)* 102

1680-2451 LAVIGNE, R. **Etude sur le séchage du manioc.** *(Study on the drying of cassava).* Tananarive, Institut de Recherches Agronomiques de Madagascar, Station Agronomique du Lac Alaotra, 1962. 26p. Fr., Illus.

Cassava. Drying. Industrialization. Temperature. Distribution. Cassava chips. Dried tubers. Solar drying. Processing. Malagasy Republic.

A description is given of the operations involved in the sun drying of cassava chips and slices. Climatic conditions during the experiments are given. Diagrams of installations are presented. *(Summary by H.J.S.)* 102

1681-2179 BONNEFOY, J. V. **Projet de fabrication industrielle à Madagascar de l'alcool à base de manioc.** *(Project on the industrial manufacture of alcohol from cassava in Madagascar).* Bulletin Economique de Madagascar no. 52:65-73. 1931. Fr.

Cassava. Alcohol. Industrialization. Economics. Productivity. Fermented products. Uses. Fermentation. Cassava starch. Processing. Malagasy Republic.

Producing alcohol from fresh cassava in Madagascar is cheaper than producing it from dried cassava, maize, rice or potatoes. Economic conditions for the production of alcohol are discussed. Technical notes on the transformation of starch into sugar and of sugar into alcohol are given. *(Summary by H.J.S.)* 102

1682-3022 PARK, Y. K. and LIMA, D. C. **Continuous conversion of starch to glucose by an amyloglucosidase-resin complex.** Journal of Food Science 38(2):358-359. 1973. Engl., 6 Refs.

Cassava. Industrial starches. Glucose industry. Uses. Laboratory experiments. Industrial microbiology. Glucose.

Amyloglucosidase obtained by submerged fermentation with *Aspergillus niger* NRRL 3122, was insolubilized by binding with an anion exchange resin (Amberlite IR-45). Conversion of liquefied starch into glucose by the enzyme-resin complex column is described. A liquefied cassava starch solution and a low dextrose equivalent corn syrup were used as substrates. *(Summary by Biological Abstracts)* 102

1683-1877 BANZON, J., FULMER, E. I. and UNDERKOFLER, L. A. **Fermentation utilization of cassava. The butyl-acetonic fermentation.** Proceedings of the Iowa Academy of Science 48:233-236. 1941. Engl., 2 Refs.

Cassava. Fermentation. Fermented products. Analysis. Alcohol. Production. Processing. Uses. Cassava starch. Industrial microbiology. Cassava pastes. Philippines.

The use of cassava in butyl-acetonic fermentation was studied at the University of the Philippines. Ground cassava chips (from unpeeled roots) were fermented anaerobically by *Clostridium acetobutylicum* to obtain the solvents butanol, acetone and ethanol. Corn mash was the control for measuring yields of total solvents. Cassava alone gave poor yields; however, when cassava replaced 80% of the corn in the substrate, yields were similar to those of corn alone. This was probably due to deficiency of nutrients for the bacteria. The percentage of glucose equivalent in total solvent yields of corn and satisfactory corn-cassava mixtures was about 30%. To test the effects of providing nutrients for the bacteria in a cassava substrate, shrimp powder, corn gluten meal, soybean flour, compressed yeast, peptone and urea were added in amounts up to 5% of the cassava. All nutrients, except the yeast and the urea, provided enough nutrition to bring solvent yields of the cassava near or equal to yields from the corn mash control. *(Summary by C.B.)* 102

1684-2349 AKINRELE, I.A. **Farming for famine.** Proceedings of the Agricultural Society of Nigeria 4:40-42. 1965. Engl., Sum. Engl., 6 Refs.

Cassava. Gari. Production. Factories. Development. Productivity. Economics. Food products. Industrialization. Proteins.

The problem of food shortage in the newly independent countries of Africa is discussed as regards: the economy where the food sector is the most backward, the magnitude of storage losses due to the lack of processing harvests, and the low level of productivity arising from the poor nutritional status of the people. Statistical data are cited from research carried out in Nigeria. Immediate relief is suggested through a sizable investment in food research based on the experience obtained from the technological studies carried out at the Federal Institute of Industrial Research, Oshodi (Nigeria) on the mechanization of the traditional method of making gari from cassava. *(Author's summary)* 102

1685-2332 KRISHNAMURTI, B. G. **Tapioca as a source of alcohol.** Current Science 29(9):346-348. 1960. Engl., 3 Refs.

Cassava. Fermented products. Alcohol. Laboratory experiments. Analysis. Research. Uses. Industrial microbiology. India.

Cassava tubers contain 25% starch and about 5% fermentable sugars. Saccharification and fermentation experiments were undertaken to examine how cassava, an indigenous raw material, could be used to supplement molasses in the production of alcohol. Optimum conditions for saccharification were obtained when cassava was heated with 2.5% of its weight of sulfuric acid, at 15-20 psi for 5-7 h. Sugar extraction from cassava under optimum conditions of saccharification was 36-38% glucose. In general production, an average yield of 35 gal of absolute alcohol per ton of cassava is estimated. *(Summary by J.L.S.)* 102

1686-5193 WEBB, B.H. *et al.* **Palm oil mill waste recov .ing as a by-product industry. I. Mechanical aspects.** Planter (Malaysia) 51:86-101. 1975. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Cassava meal. Uses. Waste utilization. Industrialization. Animal nutrition. Malaysia.

In Malaysia, palm oil mill waste represents a potential disposal problem of 4 million tons of liquid effluent, and 80% of the available heat energy is not being utilized. Liquid wastes can be converted into animal feedstuffs to replace maize. The CENSOR (Centrifugal Solids Recovery) system using MECRO (Mechanical Rotary Drying) cassava meal and palm kernel meal as an absorbent for the waste sludge produces an acceptable storable animal feed with a good market potential and a potential return of more than 100% on capital/year. Fermentation by an anaerobic process maximizes utilization of materials, improves quality and reduces input costs. *(Author's summary)* 102

1687-0842 SUNDHAGUL, M. **Feasibility study on tapioca waste recovery.** Kuala Lumpur, Malaysia, 1972. 13p. Engl. 4 Refs.

Paper presented at the Work Study on Waste Recovery by Micro-organisms, Kuala Lumpur, 1972.

Cassava. Wastes. Waste utilization. Industrialization. Cassava starch. Processing. Factories. Yeast production. Industrial microbiology. Malaysia.

In Thailand, water pollution caused by the discharge from cassava starch factories is acute. An ideal solution to this problem would be a by-product recovery to offset costs involved in waste treatment. The potential of cassava as a substrate for microbial protein production is studied. An explanation is given of the processing of cassava starch, as well as the characteristics of its waste products. The solid waste produced by the sand drum is dry and low in organic matter content and is therefore resistant to biodegradation. This waste product is economically insignificant and is used for land fill. The physiocochemical characteristics of liquid wastes from separation, wash and root wash waters are given. Alum coagulation tests were effective on waste water but not on separator waste waters; therefore, biological treatment was recommended. Torula yeast was grown on the separator waste waters. Data on yeast yields are given. *(Summary by T.M.)* 102

1688-3220 TAYLOR, J. N. **Glue and adhesives; a synopsis of information.** Industrial Reference Service 81:1-6. 1941. Engl.

Cassava. Industrial starches. Adhesives. Marketing. USA.

True glue is prepared from animal matter by appropriate treatment with hot water, but by extension the term has been applied to other adhesives. Glues are made from bones, hides, casein, plant materials (cassava, dextrin, starch and gum), soybeans, fish and synthetic resins. Tables are presented dealing with the USA production of certain types of glues and of gelatins made by all manufacturers engaged in the production of glue or gelatine as primary or secondary products. Data are also given on imports, exports, grades, prices, tariffs, producers, dealers and trade associations. *(Summary by H.J.S.)* 102

1689-3869 VERMA, U.P. **Flour from tapioca roots.** Indian Food Packer 5(9):13-15. 1951. Engl.

Cassava. Cassava flour. Processing. Costs. Uses. India.

Two varieties of plants are described: bitter and sweet cassava. The juice of the roots of almost all these plants contains HCN, a poisonous substance. The sweet varieties are generally less toxic and are grown extensively in tropical countries. Cassava is grown in abundance in southern India, where it is an important staple in the people's diet. The bitter variety is used especially to prepare flour and other tasty products. The facility of preparing tapioca and starch is emphasized. *(Summary by L.C. Trans. by T.M.)* 102

1690-3462 TKATCHENKO, B. **Utilisation de la fécule de manioc dans la panification.** *(Utilization of cassava flour in the bakery industry).* Bulletin de l'Institut de Recherches Agronomiques de Madagascar no. 3:201. 1959. Fr.

Cassava. Cassava flour. Bakery products. Processed products. Uses. Breads. Malagasy Republic.

The production of cassava roots for industrial purposes has been stabilized in Madagascar during the last years. Marketing this product locally as well as abroad may be a real problem. For this reason, the Institute de Recherches Agronomique de Madagascar has undertaken some studies that may lead to a use of surplus cassava flour in the local bakery industry. *(Summary by J.L.S.)* 102

1691-3194 RAJAGOPALAN, K. and WEBB, B.H. **Palm oil mill waste recovery as a by-products industry. II. Biological utilization.** Planter (Malaysia) 51:126-132. 1975. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Cassava meal. Uses. Waste utilization. Industrialization. Animal nutrition. Malaysia.

Concerning utilizable end-product recovery, direct anaerobic fermentation with specific bacterial populations appears to be the most advisable solution to the palm oil mill effluent pollution problem. Upgrading of the sludge proteins by concentrations in bacterial cells and consequent settling of these solids make available sediment of decreased moisture content which can be economically incorporated with cassava or kernel cake to provide an adequate animal feed. The supernatant liquid phase with remaining concentrations of organic materials can be used immediately as fertilizer or for algal and fish culture ponds to give a final effluent containing minerals that could easily be sprayed on fields. Another interesting feature of this process is the liberation during fermentation of appreciable amounts of combustible gas (methane), which can be utilized directly for domestic purposes or alternatively for the mechanical process described in Part I of this paper. *(Author's summary)* 102

1692-4873 HELLMAN, N.N. **Determination of moisture in starch by drying.** Cereal Chemistry 28(1):79. 1951. Engl., 2 Refs.

Cassava. Cassava starch. Water content. Drying. Temperature. Analysis. USA.

Procedures for determining moisture in starches by drying have generally involved drying starch at various elevated temperatures in the presence or absence of air. Even with vacuum oven drying, a variation in water content of 0.09% resulted from changing the temperature from 80°-100°C; it was therefore questioned to what extent heat-produced decomposition affected the results. A quartz, spring-balance apparatus permitted the author to observe continuously the effect of heat and vacuum on samples of starch. For corn, potato and cassava starches, it was found that samples dried at 25°C to 10^{-6} mm Hg pressure lost no more weight upon heating to 110°C at this same pressure; thus there appears to be a very considerable range in temperature where truly constant weight can be achieved. This does not prove that wet samples of starch dried at various temperatures will achieve the same constant dry weight; however, for those experiments in which the same sample was dried at a series of temperatures, the variations in water content reported for drying in this temperature range undoubtedly result from the different relative vapor pressures of water effective in the methods rather than from starch decomposition. *(Full text)* 102

1693-0957 LIMA, U. DE A. **Cassava flour.** Suplemento Agricola)Brasil) 13(617):12. 1967. Port. Also available in English translated by the Tropical Products Institute, London.

Cassava. Cassava flour. Processing. Brazil.

Small-and large-scale processing of cassava flour is described. A drawing is given of a "tipiti" used by the Amerindians to prepare the cassava. *(Summary by H.J.S.)* 102

1694-3329 TAKESHITA, M. **Manufacture of alcohol from cassava starch waste by the amylo method.** Journal of the Agricultural Chemical Society of Japan 16:725-730. 1940. Jap., 3 Refs.

Cassava. Alcohol. Waste utilization. Industrial microbiology. Cassava starch.

The amylo method is not suitable for cassava when the solution is prepared by the usual method employed for other kinds of materials. A better method of preparing the solution for processing with the amylo method was determined. *(Summary by K.K.)* 102

1695-5351 VENKATACHALLUM, C.N. and SRIKANTAN, B.S. **On cold starch base adhesives.** Journal of the Indian Chemical Society 16(2):114-118. 1953. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava starch. Adhesives. Gelatinization. Calcium chloride. India.

Cassava starch is treated to make it suitable for making adhesives. Caustic soda and calcium chloride treatments were studied in this paper; the latter gave better results. Data on different formulas are given in tables. *(Summary by T.M.)* 102

1696-0931 MYSORE. CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE. **Note on the preparation of glucose from tapioca starch.** *In*_____. Final report, 1952. pp.97-99. Engl.

Cassava. Glucose. Processing. Factories. Industrial machinery. Confectioneries. Costs. Economics. Industrial starches. Glucose industry. Food products. Uses.

Notes are given concerning the preparation of liquid glucose (confectionery), solid and lump glucose. The equipment needed for the small scale production of liquid glucose is listed. *(Summary by H.J.S.)* 102 J00.

1697-0868 MANIOCS SECHES. *(Dried cassava).* Etude d'Outre Mer 39:371-372. 1956. Fr., Illus.

Cassava. Packaging. Cassava products. Legal aspects.

Some legal specifications (issued by the French Ministry of Overseas Territories) as regards cassava products and packing bags are presented. *(Summary by H.J.S.)* 102

1698-3295 KAUFMAN, C. W. **This 10-test plan clinched tapioca quality.** Food Industries 1950:49-52. April 1950. Engl., Illus.

Cassava. Processing. Industrialization. Viscosity. Particle size. pH. Cassava flour. Tapiocas. Cassava starch. Legal aspects. Organoleptic examination. Water content. Ash content. Analysis. Composition.

Due to variations in the quality of cassava flour, the General Food Corporation of New York developed a special ten-test specification for the guidance of Brazilian producers. Specifications included the following items: mesh size, uniformity of lot, odor, moisture content, ash content, color, foreign contamination, pH determination, viscosity and sulfur dioxide content. Additional information is given on the use of an amylograph technique, which can be used to distinguish between cassava starches from various sources. *(Summary by H.J.S.)* 102

1699-4988 COLLINS, G. N. **Dumboy, the national dish of Liberia.** National Geographic Magazine 22(1):84-88. 1911. Engl., 1 Ref., Illus.

Cassava. Dumboi. Processing. Human nutrition. Africa.

In the preparation of "dumboy," cassava roots are peeled, boiled, and fibers removed. The cooked roots are placed in a mortar and beaten with a heavy pestle. To prevent sticking, the pestle is dipped in water; otherwise, the dumboy becomes sodden. The beating requires about 3|4 of an hour, when the mass becomes homogeneous, the pestle produces a loud crack each time it is drawn from the mortar. At this stage, the product is ready for consumption. If allowed to stand for a long time, it becomes very hard. Dumboy is also used to stiffen leather sheaths of the native swords and knives. It is eaten with a vegetable soup, which serves as a moistening agent. *(Summary by J.L.S.)* 102 H01

1700-3443 HEIN, R. **Lagerfahigkeit von brotmehl aus manioc.** *(Storability of cassava flour).* Brot und Geback 24(1):20. 1970. Germ., 1 Ref.

Cassava. Cassava flour. Storage. Deterioration. Uses. Human nutrition. Water requirements (plants). Composition. Water content.

Acid treatment of cassava roots does not make roots storable for long periods of time. When used to make high-quality flour, the roots should be peeled to eliminate bitter parts. To store this flour for long periods of time, the moisture content should be less than 10%, and sealed bags should be used. *(Summary by A. van S.)* 102.

1701-3427 LE MANIOC **source d' alcool industriel.** *(Cassava, source of industrial alcohol).* Revue de Botanique Appliquée et d'Agriculture Tropicale 3(27):782-783. 1923. Fr.

Cassava. Starch crops. Alcohol. Tubers. Productivity. Industrialization. Uses. Fermented products.

Comments are given on a paper by M. L. Tihon on cassava cultivation in the Belgian Congo. Details are given on the manufacturing of industrial alcohol in the French colonies. Cassava, sweet potatoes, sugar cane, rice, corn and other crops grown could become important sources of alcohol. It is estimated that 100 kg of starch render about 60 liters of alcohol. There is no correlation between the amount of alcohol yielded from cassava roots and the amount of roots yielded by the varieties. *(Summary by H.J.S.)* 102

1702-3273 THAILAND. MINISTER OF ECONOMIC AFFAIRS. **Standards of tapioca meal.** Bangkok, 1963. p.55. Engl.

Cassava. Cassava meal. Legal aspects. Packaging. Processed products.

Standardized items include definitions of cassava meal, fiber and foreign material; grades of cassava meal; color characteristics for grading, packing bags for exportation. *(Summary by H.J.S.)* 102

1703-4877 SWAMINATHAN, M., KRISHNA, B. H. and RAMA RAO, G. **A plant for tapioca "soji" factory.** Bulletin. Central Food Technological Research Institute (India) 2:79-81. 1952. Engl., 1 Ref.

Cassava. Cassava products. Factories. Industrial machinery. Costs. Prices. India.

Cassava is one of the chief food crops in the state of Travancore-Cochin and other areas of India. Yields vary from 2 to 8 tons|acre. Because of its high calorie yield per unit of land as compared to cereals, the extensive cultivation and use of cassava as a food will help to make up the present food shortage in India. It is used either in the fresh state or in the form of processed products such as soji, flour and tapioca. A brief outline of a plan for a cassava "soji" factory with an outturn of about 50 tons| mo is given. *(Summary by L.C. Trans. by T.M.)* 102 J00

1704 3297 MADAGASCAR. LE **conditionnement du manioc.** *(Madagascar. Drying cassava).* Marchés Coloniaux du Monde 5(187):1120. 1949. Fr.

Cassava. Drying. Legal aspects. Processing. Trade. Economics. Malagasy Republic.

Discussions are presented of a Government decree stating the necessity of drying unprocessed cassava products which are to be exported. The decree was directed to all the French overseas territories but did not take into account the differences in conditions prevalent in the territories. *(Summary by H.J.S.)* 102

1705-0914 MACHADO, F. DE C. **A laboração de fábrica de amidos.** *(The work of the starch factory)* Gazeta Agrícola de Angola 12(12):907-908. 1967. Port.

Cassava. Starch crops. Factories. Economics. Yams. Sorghums. Sweet potatoes. Angola.

A brief discussion is presented of the socioeconomic importance of a starch factory that will be established at the Angola Central Plateau. The factory will use cassava, yams, sorghum and sweet potatoes as sources of starch. *(Summary by H.J.S.)* 102

1706-3439 CONSERVACAO DA **mandioca e do milho.** *(Cassava and maize storage).* Chacaras e Quintais 113(5):474-475. 1966. Port.

Cassava. Maize. Storage. Drying. Solar drying. Cassava chips. Tubers. Packaging.

An answer is given to a question on the storage of grated cassava, husked and unhusked maize. The grated cassava should be as fine as possible. Small-scale producers can sun dry them, stirring them 4 times daily. Drying takes about 4 days or one week during the dry and wet season, respectively. After being dried and packed in clean bags, the grated cassava can be stored in a dry room. *(Summary by H.J.S.)* 102

1707-0913 NIGERIA, FEDERAL INSTITUTE ON INDUSTRIAL RESEARCH. **Cassava starch for textile sizing.** *In* ______. Annual Report 1966-67. pp.26-27. Engl.

Cassava. Industrial starches. Textiles. Viscosity. Analysis.

The intrinsic viscosity value of cassava starch was much higher than those of materials used by a textile industry in Nigeria. However, this value has been reduced to an acceptable level by a process which can be conveniently and cheaply incorporated into the manufacturing process. *(Summary by H.J.S.)* 102.

1708-0915 INGLETON, J.F. **Starch and its use in sugar confectionery manufacture.** Confectionery Production 37(1):29-30. 1971. Engl.

Cassava. Rice. Potatoes. Wheat. Soybeans. Confectioneries. Food products. Uses. Sorghums.

This paper deals with some types of starch which are of interest to the sugar confectioner. The composition and industrial characteristics of starch from sorghum, cassava, rice, potatoes, wheat and soybeans are briefly reviewed. *(Summary by H.J.S.)* 102

1709-0495 FLAWS, L. J. and PALMER, E. R. **The production of particle board from cassava stalks.** Tropical Products Institute. Report no. G34. 1968. 3p. Engl.

Cassava. Forestry. Industrialization. Stems. Uses.

Results are given on experiments concerning the manufacture of particle board from cassava stalks. The strength of particle board can be varied by altering the resin content or the density. The effects of the use of additives (wax and Santobrite) are discussed. *(Summary by Tropical Abstracts)* 102 •

1710-0911 AKINRELE, I. A. **Cassava starch for textile sizing.** *In* Ikeja, Nigeria. Federal Institute of Industrial Research. Annual Report 1967. p.17. Engl.

Cassava. Industrial starches. Dextrins. Drying. Textiles. Uses. Processing.

Further work has been carried out on the pretreatment of cassava starch with a view to lowering its high intrinsic viscosity. Dextrinization of the starch at temperatures of 62°C, 84°C and 102°C showed increased lowering of the viscosity. The conventional wet extraction of starch process is normally capital intensive and so consideration is now being given to the design of a dry process. *(Full text)* I02

1711-0549 FABRICACION ARTISANALE **de fécule de manioc.** *(Cassava flour processing as a rural industry).* Cahiers d'Agriculture Practique des Pays Chauds 26(2):113-118. (Concl.). 1971. Fr., Illus.

Cassava. Processing. Industrialization. Industrial machinery. Cassava flour. Washing. Rasping. Screening. Pulping. Silting. Flour tables. Drying.

This is a continuation of an article on small-scale production of cassava flour and presents practical, technical information on simple, hand and mechanical methods of cleaning and grating cassava roots, sieving of the pulp, sedimentation drying and further treatment of the flour. *(Summary by Tropical Abstracts)* I02

1712-3435 MODIFIED TAPIOCA **derivative for hard gum candies, glazes and sauces offers controlled low viscosity, high solubility and good clarity.** Food Engineering 36(5):54-55. 1964. Engl.

Cassava. Industrialization. Human nutrition. Food products. Modified starches.

Product (Crystal Gum) has a low hot viscosity similar to that of gum arabic, thus can economically replace the gum in hard-gum candies with high solids. It has a bland flavor, is compatible with high-sugar systems and can be used in concentrations up to 50%. The starch can also be combined with butter to produce a butter-extended sauce for frozen, cooked vegetables, especially peas. In a sauce containing 3 parts starch and 2 parts butter, the butter remains on the cooked vegetables in small fat globules. Thus, it provides greater gloss and more butter taste with lower butter consumption. *(Full text)* I02

1713-0034 BACON, R. F. **Starch production in the Philippine Islands.** Philippine Journal of Science 3A:93-96. 1908. Engl.

Cassava. Starch productivity. Processing. Production. Philippines.

A primary problem in the Philippines is how to obtain nutritious, but inexpensive feedstuffs for animals. Cassava roots are a promising source of animal feed. In addition, cassava can be processed into alcohol and should compete economically with molasses residues for that use. If mungo or peanuts are planted with the cassava, they would furnish N, as well as helping keep down weeds until the cassava becomes established. One acre of cassava in the Philippines yields a minimum of 10 tons of roots containing 5,000 lbs of extractable starch. *(Summary by L.C. Trans. by T.M.)* I02

1714-2211 LES INDUSTRIES **du manioc a Madagascar.** *(The cassava industries in Madagascar)* Revue Agricole de la Gudeloupe. 1931:216-220. 1931. Fr.

Cassava. Factories. Industrialization. Cassava meal. Cassava flour. Tapiocas. Trade. Consumption. Malagasy Republic.

Industrial installations to process cassava, the operational aspects of factories, and the processing and marketing of tapioca are briefly discussed. A few figures on the exportation and production of some tapioca products are given as well. *(Summary by H.J.S.)* I02 J00

1715-3248 **THE USE of manioc in brewing.** Journal of the Institute of Brewing 46:63. 1940. Engl.

Cassava. Maize. Rice. Industrialization. Processing. Cassava beer.

A paper by J. Raux is discussed. As a source of extract in the mash tun, cassava was used as a malt adjunct in France during the last war owing to its cheapness and the fact that it could be added to the mash tun without having to be rendered soluble by boiling. It can replace rice and maize satisfactorily as brewing adjuncts, provided that care is taken to neutralize its latent alkalinity at the mashing stage. It gives a high extract and is low in protein, but it absorbs acids, thereby raising the pH of the liquid in which it is presented. A method to solve this problem using sulfuric acid is briefly described. Whenever possible, it is advisable to use a proportion of maize or rice with the cassava. *(Summary by H.J.S.)* 102

1716-3428 THOMPSON, H. J. **Comestible stabilizer composition.** U. S. Patent 3,669,688. 1972. 2p. Engl., Sum. Engl., 1 Ref.

Cassava. Dextrins. Confectioneries. Food products. Palatability. Human nutrition. Food stabilizers. Patents.

A stabilizer composition, particularly useful for stabilizing comestible coatings such as sugar glazes, is formed from a major amount of malto-dextrin and minor amounts of tapioca dextrin and gel-forming substances. The incorporation of such a composition into a glaze comprising sugar and water results in a comestible coating which is nontacky and is resistant to extremes in ambient atmospheric conditions. *(Author's summary)* 102 H01

1717-3221 GUTHEIL, N. C. **A industria do alcool de mandioca e suas possibilidades no Rio Grande do Sul.** *(The manufacture of alcohol from cassava and its possibilities in Rio Grande do Sul).* Revista de Quimica Industrial 21:19-23. 1952. Port., 4 Refs., Illus.

Cassava. Alcohol. Industrialization. Factories. Economics. Costs. Molasses. Uses. Sugar cane. Brazil.

Characteristics are given of the factories producing alcohol from cassava in 5 Brazilian states. The manufacture of alcohol from cassava and from sugar cane is described and compared on the basis of costs, alcohol from sugar cane is cheaper. The author recommends the expansion of the manufacture of alcohol from cassava because the crop can give raw materials for other subsidiary industries and because it grows in poor soils that are not suitable for sugar cane. *(Summary H.J.S.)* 102

1718-3231 **NOTES ON the preparation of "gaplek" from cassava (tapioca) roots.** New Guinea Agricultural Gazette 7(1):38. 1941. Engl.

Cassava. Gaplek. Processing. Tubers. Human nutrition. Dried tubers. Cassava products. Java.

The use of gaplek as a partial substitute for rice in the Netherlands East Indies has been a great success. The preparation and culinary uses of gaplek are briefly described. *(Summary by H.J.S.)* 102 H01

1719-3211 **LA CONSERVATION du manioc par le procede de Reine.** *(Cassava storage using the Reine's method).* Revue Agricole de l'Ile Maurice) 23(3):105-105. 1944. Fr.

Cassava. Storage. Tubers. History.

Two experiments were conducted on cassava root storage. The first was a replicate of de Reine's procedure. In 1941, de Reine stored the roots by arranging them in alternate layers with soil in a pit 7.8 m long, 4.5 m wide and 1.8 m deep. A thick layer of soil was placed on top shaped like a ridge, sloping away on each side to carry away rain water. The second experiment used straw. Both methods maintained the roots fresh for a period of 9-10 months. Brief notes are given on the introduction of cassava into Africa. *(Summary by H.J.S.)* 102

1720-3222 **ALCOHOL FROM cassava.** Chemical Age 61:912. 1949. Engl.

Also in: International Chemical Engineering 31:233. 1950.

Cassava. Industrial starches. Alcohol. Economics. Industrialization. Industrial microbiology.

Brief comments are given on a paper by C. Texeira, A. A. Andreasen and Paul Kolachov dealing with uses of cassava starch and alcohol, economic and technical aspects of alcohol preparation, yields of alcohol obtained, and cassava cultivation in Brazil and in other countries. *(Summary by H.J.S.)* 102

1721-3218 **CASSAVA OF manioc.** Proceedings of the Agricultural Society of Trinidad and Tobago 33:114-118. 1933. Engl.

Cassava. Cassava products. Processed products. Tapiocas. Cassava starch. Trade. Marketing. Cassareep. Processing. Economics. USA. Trinidad and Tobago.

A description is given of the ways in which cassava starch and cassareep are prepared. International trade of cassava between Trinidad-Tobago and Canada and the U.S.A. are discussed. Figures are also given on the amount and value of cassava products imported into the United States from 1919 to 1928. *(Summary by H.J.S.)* 102 J00

1722-0982 SILVA, A. DE F. **A mandioca** *(Cassava).* Gazeta do Agricultor 16(179):109-117. 1964. Port., 8 Refs.

Cassava. Cassava products. Uses. Cultivation. Processing.

Products derived from cassava are listed. Notes are given on the manufacture of cassava flour, starch, tapioca, glucose, alcohol (ethyl and butyl), acetone, cellulose, glycerine and animal feeds. Data are also given on casssava toxicity. *(Summary by H.J.S.)* 102

1723-3446 EGELS, W. **Die Unterscheidung von Pellets aus Tapiokachips und Tapiokamehl mit Hilfe eines einfachen Ausschlammverfahrens.** *(Differentiation of pellets made from cassava chips or cassava flour by using a simple elutriating process).* Landwirtschaftliche Forschung 20:185-192. 1967. Germ., Sum. Germ., Engl., Fr., Illus.

Cassava. Cassava flour. Cassava chips. Processing. Silting. Pellets. Legal aspects.

Pellets made from cassava chips or flour can be differentiated by using a simple elutriating process, based on the amount of particles (measuring from 2.5 to 0.5 mm) that remain on the sieves. The total amount of particles larger than 1.5 mm, obtained from pellets made from chips, is about 15-20%; this is about 10 times as much as the amount from pellets made from flour (1.2%). *(Author's summary)* 102

1724-3331 BANZON, J. R. **Fermentative utilization of cassava.** Iowa State College Journal of Science 16:15-18. 1941. Engl., 1 Ref.

Cassava. Alcohol. Fermentation. Processing. Industrialization. Industrial microbiology. Fermented products. Philippines.

This paper is a summary of doctoral thesis on the fermentative utilization of cassava. Being starchy, cassava requires saccharification before it can be acted upon by yeast. Current methods of saccharification make use of acids or malt, both of which are too costly and inapplicable to local Philippine conditions. The mold bran employed for saccharification was prepared from a strain of *Aspergillus orzyae* and wheat bran. Alcoholic fermentation was carried out with a strain of *Saccharomyces cerevisiae.* In butyl-acetonic fermentation, the experimental mashes were inoculated with a spore culture of a strain of *Clostridium acetobutylicum.* *(Summary by H.J.S.)* 102

1725-1699 WEGMANN K. **Untersuchungen über die ursachen des schnellen verderbens von Maniokwurzeln und die wirksamkeit von konservierungsstoffen in Maniokmehl.** *(The cause of rapid deterioration of cassava roots and the efficiency of preservatives in cassava flour).* Brot und Geback 24(9):175-178. 1970. Germ., 4 Refs.

Cassava. Cassava flour. Moulds. Deterioration. Diseases and pathogens. Mycoses. Storage. Pests. Tubers.

Cassava roots rot very rapidly. Four typical molds were isolated. Some of the roots were sprayed with preservatives (benzoic acid, formic acid, lactic acid) and then dried and milled. The resulting flours kept only a few weeks longer than untreated controls. The only way to avoid microbial spoilage was storage at a RH< 65%, which corresponds to a moisture content of 10% in cassava flour. *(Summary by Food Science and Technology Abstracts)* 102

1726-3232 CONSIDERATIONS SUR **l'installation d'une feculerie de manioc á la colonie.** *(Comments on the establishment of a cassava starch factory in the colonies).* Les Produits Coloniaux et le Matériel Colonial no. 106:39-44. 1933. Fr.

Cassava. Cassava starch. Factories. Tapiocas. Industrialization. Processing. Drying. Storage. Productivity.

Provided that enough cassava tubers are produced, the establishment of a cassava starch factory in the colonies is advantageous. Factors to be considered in setting up the factory are described. Data concern starch extraction, water extraction, final drying of the starch and tapioca manufacturing. *(Summary by H.J.S.)* 102

1727-0499 JOHNSON, I. M. and LESCANO, A. **Diseño de un tipo de hidrociclón para la pequeña industria de almidón de yuca.** *(Design of a hydrocyclone of the small cassava starch industry).* Lima, Universidad Nacional Agraria "La Molina," 1970. 15p. Span., Sum. Span., 3 Refs., Illus.

Cassava. Factories. *Manihot esculenta.* **Processing. Roots. Particle size. Cassava starch. Silting. Industrialization. Industrial machinery. Water requirements (processing). Peru.**

This paper describes a method for the extraction of starch from cassava (*Manihot esculenta* Crantz) roots. A method of separating starch from water is discussed, as well as a method for the construction of a single hydrocyclone of epoxy resins. Trials using a prototype of a cyclone have been summarized. A design for a commercial unit of 12 cyclones, including a diagram of the processing operations for a factory with a capacity of 600 kg (120 kg starch) of roots|ha, is given. *(Author's summary)* 102

1728-0803 KERR, A. J. comp. **The storage of native food crops in Uganda.** The East African Agricultural Journal 7(2):75-76. 1941. Engl.

Cassava. Cassava chips. Dried tubers. Storage. Uganda.

The local methods for storing sun-dried cassava slices are described. Sweet varieties only keep for 3-6 months, after which they are liable to become weevil infested; but the bitter varieties will remain in good condition for a year or more. *(Summary by H.J.S.)* 102

1729-0350 THE PROCESSING **and uses of cassava flour.** Farm, Journal 15(1):7-8. 1951. Engl.

Cassava. Cassava flour. Sweet cassava. Bitter cassava. Washing. Rasping. Pressing. Drying. Solar drying. Screening. Guyana.

This paper describes briefly the two types of cassava grown in British Guiana (Guyana) and their differences (e.g., HCN content), the advantages of bitter cassava and its use in the manufacture of cassava flour. Emphasis is given to the opportunity for bulding a thriving cassava industry for the production of flour and the use of cassava by-products. *(Summary by L.C. Trans. by T.M.)* 102

1730-2278 HUCHETTE, M. **La transformation de l'amidon pour usages industriels et alimentaires.** *(Transformation of starch for industrial and nutritional purposes).* Annales des Falsifications et de l'Expertise Chimique 1969:296-308. Fr., Illus.

Cassava. Cassava starch. Analysis. Industrial starches. Industrialization. Human nutrition. Processing.

Information given refers to general characteristics of the starch molecule, starch behavior to heat, cold, acid and salty environment. Notes are also given about special starches that could improve and expand their present utilization for industrial and nutritional purposes. *(Summary by H.J.S.)* I02

1731-3234 WILLIAMS, A. E. **Glucose from the manioc plant; utilization of the whole root.** Chemical Trade Journal 93:133-134. 1933. Engl., 1 Ref.

Cassava. Tubers. Glucose. Alcohol. Processing. Sugars. Cassava starch. Production.

In extracting starch from cassava tubers, usually 5% to 6% of the starch is left in the tubers, and the fibrous by-product is contaminated with sulfuric acid from the starch-extraction process. Therefore it is of little value either for cattle feed or for fertilizer. A description is made of a method to prepare a good-quality, liquid or solid glucose from the whole root. This method is cheaper than the common methods, but the glucose gathered cannot be easily crystallized and is not readily fermented by yeast for the preparation of alcohol. *(Summary by H.J.S.)* I02

1732-0866 SUBRAMANYAM, H. and MATHUR, P. B. **Effect of fungicidal wax coating on the storage behaviour of tapioca roots.** Bulletin of the Mysore Central Food Technological Research Institute 5(5):110-111. 1956. Engl., 6 Refs.

Cassava. Tubers. Storage. Rhizopus. Aspergillus. Disease control. Mycoses. Diseases and pathogens. Pests.

The effect of several treatments on the storage behavior of cassava was studied, but a 2.2% aqueous emulsion of a fungicidal wax gave the best results. Its composition by weight is as follows: microcrystalline petroleum wax, 40 parts; low melting point, thermoplastic terpene resin, 31 parts; oleic acid, 7 parts; triethanolamine, 17 parts; orthophenyl phenol, 5 parts. The roots were dipped for one minute, drained and dried. Storage life (on a 10% wastage basis) was 16 days for treated roots and 2 days for the control group. Microorganisms responsible for decay during storage were found to be species of **Penicilium, Rhizopus, Aspergillus** and yeast. *(Summary by H.J.S.)* I02 E03

1733-0130 VAN BIEMA, G. **Tapioca and other food starches.** New York, Geismar and Co., n.d. Engl., 16 Refs.

Paper presented at the National Meeting of the American Chemical Society Symposium on Carbohydrates for the Food Industry, 1965.

Cassava. Tapiocas. Cassava starch. HCN content. Harvesting. Planting. Food products. Composition. Uses.

General background data are given to accompany a slide presentation on origins of cassava, characteristics of the plant, uses and properties of cassava flour and starch, and modern processing methods. *(Summary by T.M.)* I02 D00

1734-4501 PAPE, G. and CAMPOS, J. E. **Estudo sobre o comportamento do estearoil-lactil-lactato de calcio e do estearoil-lactil-lactato de sodio na fabricação de massas alimenticias.** *(Behavior of calcium stearyl lactylate and sodium stearyl lactylate in the manufacture of macaroni).* Brazil. Ministerio da Agricultura. Divisao da Tenologia Agricola e Alimentar. Boletim Tecnico no. 6. 1971. 8p. Port., Sum. Port., Engl., 2 Refs.

Cassava. Tapioca macaroni. Cassava flour. Calcium stearyl lactylate. Sodium stearyl lactylate. Analysis. Wheat flour. Brazil.

The behavior of calcium stearyl-2 lactylate (CSL) and sodium stearyl-2-lactylate (NSL) as additives in the manufacture of macaroni was evaluated and compared. Two types of macaroni were made: long spaghetti and broad noodles, using mixed wheat flour (5% cassava flour and cornstarch) and pure semolina, with and without the addition of cornstarch, with and without eggs, and with and without the addition of CSL or NSL. The addition of the NSL improved the quality of the cooked macaroni, as regards increase in volume, less stickiness and softness and improved the taste and brilliance. The additive NSL gave better results than CSL; however, the latter was slightly better than using no additive. It is suggested that NSL should be added as an aqueous solution. *(Author's summary)* 102

1735-0920 SUBRAHMANYAN, V., NARAYANA-RAO, M. and SWAMINATHAN, M. **Sago.** Science and Culture 25 (6):343-348. 1959. Engl.

Cassava. Sago. Processing. Industrialization. Development. Food products. Legal aspects. Tapiocas. Cassava flour. India.

According to the draft standards for sago established by the Indian Standards Institution, sago refers to the small globules or pearls made from either the starch of the sago palm or the tubers of cassava. The process of manufacturing sago from cassava is described. The problems of the industry have been investigated by the Indian Tariff Commission and the Sago Expert Committee, in the light of the recommendations made by the Central Food Technological Research Institute. The following recommendations were made: (1) maintain better hygienic conditions in the manufacturing process, (2) set up a laboratory for testing the quality of sago, and (3) enforce the food adulteration act to ensure the quality of sago. *(Summary by H.J.S.)* 102

1736-5027 SIQUEIRA, F. T. DE. **Relatorio sôbre uma viagem de observação as fábricas de amido do sul do pais.** *(Observation trip to starch factories in southern Brazil).* Boletim da Secretaria de Agricultura, Industria e Comercio (Recife, Brazil) 1945:122-127. Abril 1945. Port., Illus.

Cassava. Factories. Cassava starch. Brazil.

Experiments in São Paulo, Brazil, showed that 5 kg of top-quality cassava were required to produce 1 kg of starch. Using grated, ground cassava, 9 kg were needed, the process was 50% more difficult, and the product was of an inferior quality. An increase in cassava production is proposed in Pernambuco, in addition to the installation of small factories with transportation and processing in central regions and centralized administration at the Ihurá factory. Greater production could support the manufacture of grated, ground cassava for mixing with wheat and table flour. *(Summary by L.C. Trans. by T.M.)* 102

1737-5001 PARK, Y. K. and PAPINI, R. S. **Production of glucose syrup from cassava starch by enzyme-enzyme method.** Coletanea do Instituto de Tecnologia de Alimentos no. 3:65-74. 1969|1970. Port., Sum. Engl., 17 Res.

Cassava. Food products. Aspergillus. Enzymes. Confectionaries. Production. Cassava starch. Temperature. Biochemistry. Analysis. Brazil.

Amyloglucosidase was produced from *Aspergillus niger* NRRL 3122 and *A. awamori* NRRL 3112, which produce high amyloglycosidase and low transglucosidase. These enzymes were used to produce glucose syrup from cassava starch. Studies were made on the effect of varying concentrations of thermostable α-amylase and amyloglucosidase, temperatures for saccharification of the liquefied starch, and holding time for saccharification. For the production of high dextrose-equivalent glucose syrup from cassava starch, the following conclusions were made: (1) Liquefying process. 30% (w|w) cassava starch slurries and bacterial α-amylase of 1500 SKB units or more|500 g of starch mixed together, heating gradually at the rate of 1.5°C|min, adjusting pH to 6.0, with stirring at 85°C and liquefying for 30 min, then cooling to 60°C, adjusting the pH to 4.0. (2) Saccharifying process after the liquefying process, add amyloglucosidase 70 units (AU) or more| 500 g of starch, holding for the 78 h at the temperature of 60°C. *(Author's summary)* 102 101

1738-0545 **FABRICATION ARTISANALE de fécule de manioc.** *(Cassava flour processing as a rural industry).* Cahiers d'Agriculture Practique des Pays Chauds 26(1):51-54. (Cont.). 1971. Fr.

Cassava. Processing. Industrialization. Cassava flour. Marketing. Economics. Legal aspects. Water requirements (processing).

Small-scale cassava processing units in some Far Eastern countries tend to be replaced by large-scale units. Enterprises of the latter type, provided they are well managed, obtain yields of 30-40 tons of tubers| ha or 8,000 to 11,000 kg flour| ha, whereas small-scale units generally do not surpass yields of 5 to 7 tons of tubers| ha or 900 to 1,500 kg flour| ha only. Present trade and quality regulations, uses of cassava flour, and the main processing features are outlined. Use of pure, slightly acid (pH 5-6) water and quick processing of fresh, well-matured tubers are some of the main points to be taken into account for optimum results. *(Summary by Tropical Abstracts)* 102

1739-3241 HALEWIJN, E. K. E. **Invloed van de voorbehandeling van het cassavemeel op de viscositeit van de stijfsel.** *(The influence of pretreatments of cassava flour on the viscosity at gelatinization).* Holland. Department van Landbouw, Nijverheid en Handel. Mededeelingen van de Afdeeling Nijverheid no. 7:1-56. 1930. Dutch., 35 Refs., Illus.

Cassava. Cassava starch. Analysis. Viscosity. Gelatinization. Aluminium sulphate. Sulphur acid. Calcium chloride. Industrialization. Industrial starches.

This article describes several pregelatinization treatments in the manufacture of starch from cassava. The treatments include sulfuric acid, sulfur dioxide, chlorine, calcium preparations, sodium preparations and aluminum sulfate. The effects of cassava varieties and treatment temperatures on the starch product are also discussed. The gelatinization process for cassava starch and methods for measuring its viscosity are described. Industrial uses for the starch preparations at various viscosities are summarized. *(Summary by A. van S.)* 102

1740-5090 ALBURQUERQUE, M. DE. *et al.* **Utilização do tucupi na coagulação do latex da seringueira.** *(The use of "tucupi" in the coagulation of the latex of Hevea brasiliensis).* Belém. Instituto de Pesquisa Agropecuaria do Norte. Comunicado Técnico no 48. 1975. 14p. Port., Sum. Port., Engl., Fr., 2 Refs.

Cassava. Cassareep. Uses. Brazil.

The action of "tucupi" (prepared from cassava juice) as a coagulant agent of rubber plants was studied under statistical models. It was proved that tucupi submitted-raw or cooked, white or yellow, from domestic or wild plant varieties could be a perfect substitute for acetic acid on the rubber plantation without affecting the quality of the coagulated latex. *(Author's summary)* 102

1741-0725 KATIYAR, K. P. and FERRER W., F. **Evaluación del efecto del polvo de yuca en la dieta larval de la mosca del Mediterráneo** *Ceratitis capitata* **Wied.** *(Effect of cassava flour on the larval diet of the Mediterranean fruit fly Ceratitis capitata Wied).* Turrialba 15(4):350-353. 1965. Span. Sum. Engl. 2 Refs.

Cassava. Cassava flour. Insect control. Uses. Laboratory experiments. Entomology. Costa Rica.

Cassava flour was substituted in various proportions for the standard carrot powder in the larval diet of the Mediterranean fruit fly for 4 generations. The diet substrates contained carrot powder: cassava flour ratios of 4:0, 3:1, 1:1 and 1:3. The addition of cassava in the larval diet did not adversely affect individual pupal weight, adult emergence, fertility and fecundity of the females and the longevity of the adults. However, the pupal recovery from the larval medium was reduced with the addition of cassava flour. The average pupal yield| g of dry ingredients in the diet was 31, 29, 24 and 20 pupae for 0, 25, 50 and 75% cassava flour diet substrate. *(Author's summary)* 102

1742-0837 HOLLEMAN, L.W.J. and ATEN, A. **Elaboración de la yuca y sus productos en las industrias rurales.** *(Processing of cassava and its products in rural industries).* Organización de las Naciones Unidas para la Agricultura y la Alimentación. Cuaderno de Fomento Agropecuario no. 54. 1956. 123p. Span., 75 Refs., Illus.

Cassava. Processing. Drying. Analysis. Cassava flour. Factories. Textiles. Paper industry. Cassava products. Tapiocas. Cassava starch. Industrialization.

Outlines for individual farmers and farmer cooperatives in rural areas on the essentials of processing cassava flour are given. This information includes technological processes and a description of machinery and other accessory equipment. Detailed information is given regarding cultivation and manufacture of certain food products based on cassava flour used as a raw material. This product can be processed both in the farmer's home and by rural industries. Some important methods of analyzing cassava and tapioca, as well as the various applications of cassava flour, are also discussed. This is a good, small-scale handbook. *(Summary by J.L.S.)* 102

1743-3490 CRUZ, S. R. *et al.* **The mechanical, cassava-peeling machine.** Araneta Journal of Agriculture 6(3):184-205. 1959. Engl., Illus.

Cassava. Tubers. Peeling. Processing. Mechanization. Industrial machinery. Philippines.

A detailed description and drawings are given of a machine for peeling cassava mechanically. The test trials run with different abrasives ("palay" roots, rice hulls and sand) are dealt with in detail. A smaller, manually operated machine can be used by restaurants, etc. The author also feels that the machine can be used for peeling Irish and sweet potatoes. *(Summary by T.M.)* 102

1744-2424 TKATCHENKO, B. **Note technologique concernant la feculerie de Marovoay** *(Technological notes on the Marovoay starch factory).* Tananarive, Institut de Recherches Agronomiques de Madagascar, 1959. 154 p. Fr., Illus.

Cassava. Industrialization. Factories. Industrial starches. Processing. pH. Storage. Composition. Cassava starch. Malagasy Republic.

A description is given of the Marovoay starch factory. Data deal with raw materials, manufacturing control, commercial quality of the starches, technological factors determining the rates of extraction and starch quality, and general observations on processing. Starch production in 1957 was of low quality, with a high degree of heterogeneity and unsatisfactory yields. A project to modernize the entire process of starch production, as well as modifications of storage methods is presented. Tables on the chemical and physical characteristics of starch and graphs of items involved are also given. *(Summary by H.J.S.)* 102

1745-3249 HALEWIJN, E. K. E. **Gaplek als grondstoff voor de bereiding van cassavemeel.** *(Gaplek as a raw material for preparing cassava meal).* Landsdrukkerij, Batavia. Department van Landbouw. Mededeelingen van de Afdeeling Nijverheid no. 10. 1932. 28p. Dutch. Illus.

Cassava. Gaplek. Human nutrition. Cassava meal. Dried tubers. Starch content. Protein content. Composition. Marketing. Processing. Economics. Java.

Gaplek (dried cassava roots) is prepared by sun drying cassava roots after chopping and washing them to improve drying. It contains about 72% starch and 1.4% protein. The product is used for local consumption or ground and exported for cattle feed. As cattle feed, it is optimal to mix 30-40% ground dried cassava with corn or barley. Cassava flour is prepared from gaplek by grinding the dried cassava, washing the starch granules out and letting them settle. The sedimentation process is further discussed. The product is sun dried after the centrifugation process, which is described. The starch can be bleached chemically. Cassava flour contains about 86% starch and 14% water. Tables of dried cassava of exports are given for 1926-31. *(Summary by A. van S.)* 102

1746-1748 GECAN, J. S. and BRICKEY JUNIOR, P. M. **Collaborative study of an improved method for the isolation of filth from starches.** Journal of the Association of Official Agricultural Chemists 55(1):62-63. 1972. Engl., Sum. Engl.

Cassava. Cassava starch. Analysis.

The official AOAC method for filth in starches, 40.056, has been modified to obtain better recovery of extraneous materials. In lieu of wet sieving on a No. 140 sieve, the modified method utilizes No. 230 wet sieving followed by an acid hydrolysis if excessive starch material remains on the sieve. A limited collaborative study comparing the improved method to the official method resulted in higher recoveries of rodent hairs and equivalent recoveries of other spike elements by the improved method. The improved method is recommended for official adoption to replace 40.056. *(Author's summary)* 102

1747-3085 MONTALDO, A. **Vascular streaking of cassava root tubers.** Tropical Science 15(1):39-46. 1973. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. *Manihot esculenta.* **Tubers. Cultivars. Storage. Deterioration. Resistance. Timing. Diseases and pathogens. Pests.**

The results are given on an investigation into the reaction to vascular streaking of the root tubers of 65 varieties of cassava (*Manihot esculenta* Crantz) kept at an ambient temperature of 24°C at Maracay (Venezuela) and one variety of cassava kept at storage temperatures of 0°, 5° and 10°C. Vascular streaking is an abnormality that occurs in the root tubers, especially in the vascular bundles. It is possibly enzymatic in nature and results in an ash-blue discoloration which later turns brown, causing a loss in the culinary and industrial quality of the roots. Two varieties were very resistant to vascular streaking after 7 days of storage at ambient temperature, and one did not show any discoloration after 11 days. Roots kept well at 0° and 5° for 21 days. *(Author's summary)* 102

1748-1651 MONTALDO, A. and BARRIOS, J. R. **Tecnología de los productos de la yuca.** *(The technology of different cassava products).* Seminario Nacional sobre Yuca, Tacarigua, Venezuela, 1973. Revista de la Facultad de Agronomía de la Universidad Central de Venezuela. Alcance no. 22:95-106. Span., 14 Refs.

Cassava. Tubers. Leaves. Cultivars. Dry matter. Amino acids. Protein content. Carbohydrate content. Fat content. Fibre content. Ash content. Mineral content. Cassava products. Uses. HCN content. Vitamin A. Vitamin B. Ascorbic acid. Food energy. Venezuela.

The following topics are described: the use of cassava for human consumption and industrial use, its use in the extraction of starch, the making of food products, fermented products, flour for bread and improved techniques in casave production. Figures are given for the average chemical composition of the thick roots, precooked flour and the leaves (dry matter) of national varieties on the basis of percentages of dry matter, carbohydrates, protein, fiber, fat and ash. *(Summary by L.C. Trans. by T.M.)* 102

1749-5327 PRENTICE, N., CUENDET, L.S. and GEDDES, W.F. **Studies on bread staling. V. Effect of flour fractions and various starches on the firming of bread crumbs.** Cereal Chemistry 31:188-206. 1954. Engl., Sum. Engl., 28 Refs.

Cassava. Breads. Cassava bread. Analysis. Organoleptic examination. Cassava starch. Modified starches. Viscosity.

The influence of flour fractions from hard red spring and soft red winter wheat flours, of rye flour water-solubles and of several natural and modified starches on the firming of bread crumb was studied. Gluten, starch, starch tailings and water solubles separated from the flours were combined to yield synthetic flours designed to reveal the effect of individual constituents on the crumb firmness of bread after various storage times from 4-69 h at 25°C. In the experiments involving different natural and modified starches which showed wide variations in transition temperature (the temperature at which 20% slurries showed an increase in viscosity when heated in the Brabender Amylograph), the starches replaced 1|3 of the wheat starch. Increasing the protein content of the synthetic flours but maintaining a constant ratio of gluten to water solubles increased absorption and loaf volume but decreased the average crumb firmness and crumb firming rate. These findings were confirmed with bread baked from soft wheat flour which had been enriched with gluten to 13.5 and 16.5% protein. Substituting soft flour starch or gluten for hard flour starch or gluten increased average crumb firmness but did not affect the firming rate. Starch tailings had no effect on loaf volume or crumb firming rate but this fraction from both hard and soft flour decreased the average crumb firmness. Hard and soft flour water solubles, especially those of rye flour, increased absorption and loaf volume and decreased both average crumb firmness and crumb firming rate. Substitution of any of the starches except rye for 1|3 of the wheat starch decreased loaf volume. The rates of crumb firming for bread containing cassava, rye and oat starch, which had lower transition temperatures than wheat starch, did not differ from that of bread made from the control. Oat starch, but not rye or cassava starches, decreased average crumb firmness. The average crumb firmness and firming rate of breads containing corn, rice, and especially waxy corn and waxy sorghum starch, which have higher transition temperatures than wheat starch, were greater than bread from the control flour. With the exception of a cross-bonded ether derivative of corn starch, in which swelling was markedly inhibited, all the modified starches caused an increase in average crumb firmness and increased the crumb firming rate. *(Author's summary)* I02

1750-1818 CASTAGNINO, G. A. **Conservación de la raíz de mandioca.** *(Cassava root storage).* Campo (Argentina) 27(320):23. 1943. Span.

Cassava. Storage. Tubers. Argentina.

Once harvested, the cassava root is difficult to preserve. As a result of possible oxidation and attack from fungi, it acquires dark vascular streaks and a bitter taste, which consumers find disagreeable. To prolong its fresh state, storage methods using earth and sand are employed; but this increases the price and consumption of the commodity. Because of these problems the school of agriculture at Posadas (Argentina) sought a root storage method that would be both easy and economical and at the same time lightweight for transportation. The method used was paraffin. The roots are washed to remove the soil and dipped (either totally or just the tips) in a container of melted paraffin. The results were as follows: (a) Untreated root deteriorated after 5 days; (b) cassava with waxed ends remained fresh for 15 days; (c) totally waxed cassava roots were perfectly fresh 2 months later. *(Summary by L.C. Trans. by T.M.)* I02

1751-3259 RASPER, V., MAK, HOI—MENG and DeMAN, J. M. **Rheological behavior of doughs from mixtures of wheat flour and modified cassava flours.** Guelph, Ontario, University of Guelph, Department of Food Science, 1972. 20p. Engl., Sum. Engl., [illegible] Refs.

Also in: Cereal Science Today 17(9):264-2[illegible]3. 1972.

Cassava. Fermentation. Gelatinization. Processing. Ash content. Cassava flour. Food products. Cassava pastes. Cassava products. Fibre content. Composite flours. Composition. Wheat flour. Gari. Dried tubers.

The rheological behavior of doughs prepared from composite flours involving mixtures of Canadian HRS wheat flour with modified cassava flours (5 different-sized fractions of "kokonte" and gari and cassava starch) was tested in the tensile mode using an Instron Universal Testing Machine. The rheological characteristics of these doughs, as evaluated from stress-strain curves in terms of constant strain rate modulus, F (t); one-minute isochronal modulus, F (1); and time-independent strain function, (γ) were compared with those of doughs prepared from mixtures of HRS wheat flour, cassava starch and pregelatinized cassava starch, respectively. The extensibility of the doughs, according to their break stress and break strain, were also studied. The finest and purest fraction of kokonte flour did not affect the rheological characteristics in any significant way below concentrations of 30%; on exceeding this concentration, a marked change in both constant strain modulus and extensibility was observed. With an increasing granularity of kokonte flour (which was found to be correlated to ash and fiber content), these changes were detected at much lower concentrations. Fiber content was the most important factor in both kokonte and gari flours; gari behaved very similarly to pregelatinized cassava starch, increasing markedly the values of isochronal modulus. The rheological characteristics of doughs with added calcium stearyl-2-lactylate (CSL) was studied. The emulsifier had a better effect on the viscoelastic properties of the dough at a higher temperature (close to 48°C). *(Summary by T.M.)* 102

1752-3252 SCHOPMEYER, H. H., FELTON, G. E. and FORD, C. L. **Waxy cornstarch as a replacement for tapioca.** Industrial and Engineering Chemistry 35(11):1168-1172. 1943. Engl., Sum. Engl., 16 Refs., Illus.

Cassava. Maize. Industrialization. Processing. Uses. Cassava starch. Industrial starches. Paper industry. Textiles. Analysis.

Waxy corn, which had been developed to a high-yielding hybrid, was grown on a commercial scale and wet processed, with only minor changes in operating procedure. The waxy starch forms a clear, soft, nongelling paste and can replace high-grade cassava in dextrins, adhesives, paper coatings and sizes, textile sizes and finishes, print gums and food products. It is chemically different from other starches in that it is substantially pure amylopectin or the branched-chain portion of starch. It is to be expected that such starch will find special uses where it is more suitable than the present commercial starches. *(Author's summary)* 102

1753-3444 HEIN, R. **Cassave als brotmehl und volksnahrungsmittel fur entwicklungslander.** *(Cassava as bread flour and food for the population of developing countries).* Brot und Gebäck 23(2):33-35. 1969. Germ., 49 Refs.

Cassava. Cassava flour. Composite flours. Potatoes. Wheat flour. Bakery products. Human nutrition. Productivity. Cultivation. Breads. Industrialization. Factories.

The author proposes replacing up to 50% wheat flour by cassava flour in bread for developing countries. Cassava yields (dry matter) are superior to potato and wheat. The composition of cassava flour is comparable to that of wheat and potato flours; but cassava lacks the protein. Due to the rapid deterioration of the roots, a continuous planting schedule should be made. The organization of a cassava flour-based bread factory is discussed. *(Summary by A. van S.)* 102

1754-3333 ROSENTHAL, F. R. T. *et al.* **Industrialização do amido de mandioca. I. Variedades do Estado de Minas Gerais.** *(Cassava starch industrialization. I. Varieties from the state of Minas Gerais).* Rio de Janeiro, Brazil, Ministerio de Industria e do Comercio, Instituto Nacional de Tecnologia, 1970. 126p. Port., Sum. Port., Engl., 30 Refs., Illus.

Cassava. Starch content. Cultivars. Processing. Cassava starch. Composition. Industrialization. Particle size. Gelatinization. Temperature.

Starches from 11 varieties of cassava grown in the state of Minas Gerais (Brazil) were classified for several chemical and physical properties. From these tests the starches were then classified for suitability in various foods and for industrial uses. Tests included Brabender viscosity analyses, solubility studies in water enzymes and DMSO, X-ray diffraction studies of structures, and stability tests of starch pastes under various pH conditions. Amylose contents from the 11 starches ranged from 15.3-17.5%. The varieties Vassourinha SEL 514, Cacau IPEACO, Hibrida IPEACO and Baiana IPEACO had highest viscosities, hot or cold, and should be useful as thickening agents. Pastes from Riquesa IPEACO and Vassourinha IPEACO have viscosities during heating that make them useful for mechanical labeling purposes. Pastes from CN (Clone Novo) 14 Roxa, Cacau IPEACO, Baiana SEL, Riqueza IPEACO, Vassourinha SEL 514 and Baiana IPEACO are whitish or yellowish pink, while pastes of Vassourinha IPEACO, CN 13 Branca, CN 15 Riqueza, Hibrida IPEACO and Gauxupé IPEACO are white. Riqueza IPEACO, Vassourinha SEL 514, and Baiana IPEACO produce a more consistent gel, making them more adequate for puddings and pies. The other more fluid ones are recommended for sauces, soups, baby foods and for textile spinning. Varieties Cacau IPEACO, CN 15 Riqueza and Baiana IPEACO produce starches with the best general characteristics for industrial films. *(Summary by C.B.)* 102

1755-3442 KNUDSEN, F. E. and KARKALAS, J. **Enzymatish hergestellte starkehydrolysate.** *(Starch hydrolysates by means of enzymes.* Starke 21(11):284-291. 1969. Germ., Sum. Germ., Engl., Fr., 7 Refs.

Cassava. Cereals. Starch crops. Food products. Enzymes. Hydrolysis. Composition. Processing. Cassava starch. Biochemistry.

The use of amylolytic enzymes is rapidly expanding in the preparation of a wide variety of starch hydrolysis products. Techniques utilized in the production of hydrolysates are given. Maize, wheat, rice, potato and cassava starches, as well as maize flour, have been liquified by means of enzymes in a continuous pilot plant converter. The products of liquefaction were subsequently saccharified with amyloglucosidase. Experiments suggest that the various starches require individual liquefaction techniques. The same applied to the large-scale purification of the hydrolysis products as suggested by the experimental data. The properties of some special products prepared by means of enzymes are also described. *(Author's summary)* 102.

1756-0521 TAPIOCA CHIPS **processing in West Malaysia.** Kuala Lumpur, Federal Agricultural Marketing Authority, 1970. 31p. Engl., 29 Refs.

Cassava. Cultivation. Processing. Factories. Marketing. Costs. Economics. Animal nutrition. Industrialization. Cassava chips. Processed products. Trade. Malaysia.

A comprehensive picture of the cassava chip processing industry in West Malaysia is presented. Data deal with evaluation of domestic and foreign market opportunities, cassava cultivation, and the feasibility of establishing a modern plant to produce chips on a large scale. The is undoubtedly a market (both export and domestic) for cassava chips, but there are difficulties in quantifying such a demand. Future demand would be strongly related to the growth of the animal industry. The establishment of a modern chip processing plant is not economically feasible because of current prices of cassava tubers, which are grown by small farmers. It may not be advisable to grow cassava as a small holder crop except in marginal soils where other cash crops cannot be grown. *(Summary by H.J.S.)* 102 H03 J00

1757-0536 PACHECO, J. A. DE C. **Alteraçoes de qualidade de fécula durante o armazenamento das raízes de mandioca.** *(Changes in starch quality during the storage of cassava roots).* Bragantia 12(7-9):297-298. 1952. Port., Sum., Engl.

Cassava. Storage. Cassava starch. Analysis. Tubers. Brazil.

Analyses of color, viscosity and rate of sedimentation were made in samples of starch prepared from several varieties of fresh cassava roots and also from roots stored during 24, 48 and 72 hours at field conditions and also at room temperature. It was noted that the stored roots gave progressively worse starch in relation to color and type of sedimentation. Viscosity was also affected, but in a few cases starch quality did not become worse. Changes in starch quality preceded the occurrence of the characteristic blue veins of stored cassava roots. It was concluded that storage of cassava roots longer than 24 hours is not advisable. *(Author's summary)* 102

1758-3227 MOORJANI, M. N. **Extraction of starch from cassava.** Food Technology 24(12):60-63. 1970. Engl., 4 Refs., Illus.

Cassava. Human nutrition. Nutritive value. Proteins. Cassava starch. Food products. Processing.

A considerable amount of work has been carried out in different parts of the world on various aspects of fish protein concentrates (FPC) but it has not been possible to market the product easily. The finished product (deodorized and defatted) is in the form of a fine powder that is insoluble in water. This research was carried out to incorporate FPC with cassava *(Manihot utilissima)* and process it in an attractive and novel form. Cassava was chosen because its starch has certain unique properties that are essential for globule formation. Data given deal with extraction of starch from cassava, processing the starch and FPC, consumer preparation, bleaching some types of FPC, shrimp-flavored wafers, and the way this wafer could improve nutrition. A flow-sheet diagram is given of wafer processing. Two tables are also given dealing with the nutritional value of FPC from oil sardines used in wafer processing and the general appearance, expansion properties and flavor of wafers processed from cassava containing different percentages of FPC or fish muscle. *(Summary by H.J.S.)* 102 H01

1759-5336 HSIEH, P.T. and WU, C.C. **[Manufacture of "mizuame" (a kind of sweet jelly) from cassava or sweet potato starches and sugar].** Formosan Science 3:58-61. 1949. Chin., Sum. Engl.

Cassava. Cassava starch. Confectionaries. Uses. Processing. Taiwan.

The possibility of the large-scale, economical manufacture of "Mizuame" was investigated in Formosa. Best results were obtained with the following procedure: To 300 g of cassava starch (16.6% moisture) or 293 g of sweet potato starch (14.8% moisture), 150 g of cured sugar and 1 liter of 0.084 or 0.042% HCl were added. The mixtures were put in an autoclave at 120°C and hydrolyzed for 1 h 20 min and 2 h 40 min, respectively. The mixtures were neutralized with a 5% sodium carbonate solution. A small amount of diatomaceous earth and activated carbon were then added. The mixture was filtered and the filtrate concentrated at 65°C until the moisture was reduced to 20%. The chemical composition and appearance of Mizuame are given in tables. *(Author's summary)* 102

1760-3326 FREISE, F. W **Über die therapeutisch verwertbaren Inhaltsstoffe von** *Manihot utilissima* **und** *Mercurialis annua* **oder** *M. perennis*. *(On the medically applicable components of Manihot utilissima and Mercurialis annua or M. perennis).* Suddentsche Apotheker-Zeitung 77(104):1007-1008. 1937. Ger.

Cassava. Roots. Uses. Composition. Therapeutants. Human health. Waste utilization.

Both *Manihot utilissima* and *Mercurialis annua* roots are mainly used for human consumption and partly for industrial starch; however, during the grating and pressing processes, 55 to 72% of the liquid content of the fresh roots is extracted and used for medicinal purposes. This liquid contains 1.66% saponins, 2.3% volatile oils, 1.14% gum substances and 3.80% inorganic salts. The oil fraction, containing organic bonds, acts as a diuretic. The saponin fraction causes complete hemolysis of blood. This glycoside splits into glycose, HCN and an unknown compound ($C_{15}H_{10}O_{6}$), which is responsible for the diuretic activity. *(Summary by A. van S.)* 102

1761-5326 CLENDENNING, K.A. and WRIGHT, D.E. **Production of syrup from wheat, potato, tapioca and waxy cereal starches.** Canadian Journal of Research (Section F) 26:284-296. 1948. Engl., Sum. Engl., 16 Refs., Illus.

Cassava. Cassava starch. Food products. Processing. Hydrolysis.

Syrups prepared in semipilot plant equipment from low-protein wheat, corn, waxy corn, cassava and potato starches were almost identical in taste and appearance. Differences in nature and amount of noncarbohydrate constituents did not necessitate modifications of the process. Wheat, corn, and waxy corn slurries hydrolyzed at approx the same rate with 0.2% HCl whereas potato starch hydrolyzed less rapidly. Contamination with 1.6% protein did not depress the hydrolysis rate but promoted foaming, turbidity and bitterness. Loss of insoluble solids on the filter press averaged 1.25% for cereal and 0.3% for potato starch hydrolyzates. Complete decolorization of 14° and 30° Bé. syrup was effected by 0.5% activated carbon, based on the juice weight at each stage. Tap water promoted color development in the evaporator and inhibited color removal by activated carbon. Color and fluorescence development in stored syrups was promoted by protein impurities, light and tap water and was strongly inhibited by sodium bisulfite. Syrups that remained colorless almost indefinitely were prepared from prime quality starches by using distilled water in the process and either acid-extracter carbon or bone char as decolorizing agents. *(Author's summary)* 102

1762-3472 TKATCHENKO, B. **Note technologique complementaire pour les féculeries de Madagascar utilisant les bassins de depôt.** *(Technological notes for Madagascar starch factories using sedimentation ponds).'* Tananarive, IRAM, 1959. 37p. Fr.

Cassava. Processing. Factories. Industrialzation. Industrial machinery. Food products. Processed products. Starch productivity. Productivity. Washing. Rasping. Wastes. Screening. Silting. Silting agents. Drying. Particle size. Viscosity. Tubers. Analysis. Composition. Legal aspects. Development. Malagasy Republic.

Recommendations are made for the establishment and successful operation of starch factories. To assure a satisfactory final product, these factories must adhere to the following operational methods: sanitary conditions, use of homogeneous material, prompt delivery of cassava roots to the factory, use of fresh water, replacement of oxidizable parts of the processing machinery, elimination of fruit juice from macerated roots, fine sieving, strict control of silting agents and sedimentation water, and control of the drying temperature. *(Summary by J.L.S.)* 102

1763-0677 GHOSH, B. N. **Heat and air-flow characteristics in drying crops.** *In* International Symposium on Tropical Root Crops, lst, St. Augustine, Trinidad, 2967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2., sect. 6. pp. 1-27. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Sweet-potatoes. Groundnut. Drying. Temperature. Processing.

The heat- and air-flow characteristics during drying of the 5 materials reported in this paper (cassava, sweet potatoes, groundnuts, cherry coffee, and haricot beans), indicate that the drying rate and temperature rise at the top layers is considerably lower than that at the bottom. In order to ensure even drying in a deep bed, therefore, it is necessary to turn or invert the material well during drying. Higher inlet air velocities for a given drying temperature increase the drying rate to an appreciable degree. The drying characteristics of the 2 root crops, cassava and sweet potatoes, are found to be very similar to each other, but differ somewhat from the other crops studied. The drop in level of the material during drying appears to be related to the initial moisture content. *(Author's summary)* 102

1764-4739 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. FOOD RESEARCH AND DEVELOPMENT UNIT, ACCRA, GHANA. **Crop Storage.** United Nations Development Programme. Food and Agriculture Organization of the United Nations. Technical Report no. 1. 1969. 90p. Engl., Sum. Engl., Illus.

Cassava. Storage. Deterioration. Dried tubers. Solar drying. Fermentation. Moulds. Cassava flour. Industrialization. Ghana.

General principles of crop storage are explained, including the role of relative humidity in deterioration by microorganisms and its relationship to the moisture content of stored foodstuffs and the application of insecticides. The common insect pests of stored foodstuffs in Ghana are given. Considerable losses due to attack by mold occur in oil palm fruit, cassava and plantain kokontes. Annual estimates of postharvest losses in maize, beans, yam, cassava and potatoes are presented. A study on postharvest losses of dried cassava is reported, together with a new method for the preparation of kokonte flour. *(Summary by T.M.)* 102

1765-5343 KIGER, J. **L'examen par fluorescence en lumiére de Wood de la farine de blé et de diverses farines de succédanés.** *(Examination of wheat and other flours by fluorescence in Wood's light).* Annales Pharmaceutiques Francaises 8:788-790. 1950. Fr.

Cassava. Cassava flour. Analysis. Bakery products. Laboratoy experiments. Composite flours. Wheat flour.

Filtered ultraviolet light (Wood's light) has been used previously to study characteristic differences in untreated flours; however, the authors preferred to extract flour with alcohol. The method used is as follows: Extract 2 g of flour with 10 cc of 70% ethanol, filter it and place 5 drops of the filtrate on an ash-free filter paper; let dry at moderate heat. Peanut, defatted soybean, corn, linseed and black mustard flours give characteristic fluorescences, but most other flours do not. One drop of a mixture of Bertrand's solutions A and B (solution of copper hydroxide in sodium hydroxide), added to the drying drops on the filter paper, gives typical fluorescences with peanut, soy, corn, rye, linseed, mustard and millet flours. Exposing 2 cc of the ethanol filtrate with 2 drops of Bertrand reagent to Wood's light in nonfluorescent glass extends the fluorescence to wheat, rape seed, cassava, buckwheat, peas, barley, banana and chestnut. *(Summary by Chemical Abstracts)* 102

1766-1577 SREEKANTIAH, K. R. *et al.* **Hydrolysis of starch from different plant sources by fungal enzymes.** Indian Journal of Microbiology 11(4):69-76. 1971. Engl., 6 Refs., Illus.

Cassava. Cassava starch. Food products. Hydrolysis. Biochemistry. Analysis. Enzymes. India.

Syrups and sugars used to manufacture food products are obtained by partial or complete hydrolysis of root and cereal starches. In tests here, stable amylolytic enzymes produced by *Aspergillus oryzae, A. awamori* and *Rhizopus niveus* are used to study the extent and nature of the hydrolysis of corn, cassava (tapioca), sweet potato and rice starches. Although it has been reported that starch is quantitatively hydrolyzed to glucose by *A. oryzae* and *R. delemer* but not *A. awamori*, it was found that after hydrolysis by *A. awamori* and *R. niveus*, the starch derivates contained glucose only. As *A. oryzae* enzymes produce derivates that contain maltose as well as glucose, they could be used for producing high maltose syrups. If hydrolysis with *A. oryzae* enzymes is maintained for a period of 72-96 hours, the percentage of hydrolyzed starch can also increased. *(Summary by L.C. Trans. by T.M.)* 102

1767-3437 OPFERMANN, E. and FEEDTMANN, G. A. **Verwendungsmoglichkeit brasilianischer Holzarten fur die Zellstoffherstellung.** *(The possibility of using Brazilian woods for pulp).* Papier - Fabrikant 28:461-471. 1930. Germ., Sum. Germ., 12 Refs., Illus.

Cassava. Forestry. Paper industry. Processing. Manihot. Stems. Composition. Cellulose. Uses. Brazil.

For 14 species of wood from Brazil detailed data are given on density, chemical composition and experimental pulping characteristics by the sulfite and sulfate processes, including photomicrographs of the pulps produced. The data are of limited value since the material was insufficient for extended tests; and the conditions used, which were those normally employed for the pulping of spruce, might be changed somewhat to give more satisfactory results. The native and (when known) botanical names of the species used are given. Among then were pao mandioca, Manihot sp; curtica,—; tapiagosu, *Crataera tapia;* figeira, *Ficus doliaria;* mariamol, *Pisonia inermis;* baguasu, *Ilex paraguariensis;* cacheta,—; grandiuva, —; pintaiva, *Xylopia sericea;* pao tosino, —; curtiscao, *Erythrina cristagalli;* caprovu, —; caroba, *Jacaranda caroba;* catuteiro, —. *(Summary by Chemical Abstracts)* 102

1768-3438 VALENZUELA S., G. *et. al.* **Sistemas de manejo, almacenamiento y transporte de productos alimenticios perecederos refrigerados para la exportación.** *(Handling, storage and transportation systems for exporting perishable refrigerated food products.)* IIT tecnología 14(79):33-34. (Concl.). 1972. Span.

Cassava. Packaging. Storage. Distribution. Temperature. Trade. Marketing. Economics. Vegetable crops. Colombia.

Remarks on handling and storage of perishable products, fruits, vegetables, meat, fish, shell fish, chickens, eggs and flowers are presented. Cassava can be safely stored for 30 days at an optimum temperature of 30°C and 90-95% moisture content. Recommendations for the organization of freezing plants located in coastal areas and airports are given, as well as some estimates on the establishment of packing units for fruits and vegetables. For cassava 3 packing units with a capacity of 1.25 ton|h should be located in the Department del Atlántico and Magdalena (major cassava producing areas). Estimated costs are given. *(Summary by J.L.S.)* 102 J00

1769-2089 FOSTER, L. J. **Report on an investigation into a cassava starch project in Nigeria.** Nigeria, Commonwealth Development Corporation, 1966. 46p. Engl., Sum. Engl. 11 Refs., Illus

Cassava. Cassava starch. Industrialization. Processing. Factories. Costs. Legal aspects. Cultivation. Cultivation systems. Rotational crops. Cassava programs. Maps. Nigeria.

Research on the development of cassava starch project in Nigeria is briefly reviewed and relevant reports are listed. No project has yet materialized. It is estimated that Nigeria's main competitor for an export trade would be Thailand. Other enterprises, such as the production of gari and|or fortified food, could be associated with a starch industry. Experiments in Nigeria have not yet been designed to prove that sustained high yields at low cost can be obtained; however, the indications are positive. Three categories of starch processing factories are discussed. Factors determining the suitability of some areas to be developed in the country are enumerated. Indications are made of further agronomic research to be completed before a pilot project or large-scale commercial development can be undertaken. *(Author's summary)* 102

1770-4938 SILLS, V. E. **Cassava starch.** Agricultural Journal (Fiji) 29(1):16-18. 1959. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava starch. Rasping. Sieving. Silting. Steeping. Drying. Screening. Solar drying. Starch productivity. Uses. Factories. Production. Fiji.

Cassava starch or flour is obtained from the roots of the cassava plant *(Manihot utilissima).* There are 2 commonly cultivated varieties (bitter and sweet) although in Fiji it appears that only the sweet variety is grown. The roots contain HCN, but fortunately this poisonous substance is eliminated in cooking and by the starch extraction process. The main starch-producing areas are in Brazil and Indonesia. The yield of roots| acre depends on variety, soil conditions, method of cultivation and so on, the details of which are given in a recent Food and Agricultural Organization Agricultural Development Paper (1956). Yields may vary between 5 and 12 tons|acre on well-managed plantations and may even reach 17 tons under favorable condition. For starch production it is important not to harvest the crop until it has reached maturity (15-20 mo). *(Author's summary)* 102

1771-0490 SHIPMAN, L. **Manufacture of tapioca, arrowroot and sago starches.** *In* Whistler, R. L. and Paschall, E. F., eds. Starch: chemistry and technology. New York, Academic Press, 1967. v. 2. pp.103-119. Engl., 10 Refs.

Cassava. Processed products. Tapiocas. Starch content. Starch crops. Composition. Starch productivity. Productivity. Water requirements (processing). Processing. Industrialization. Peeling. Washing. Grinding. Screening. Silting. Centrifuging. Pulp. Analysis. pH. Viscosity.

Cassava cultivation is described. Root yields are from 12-37 tons| ha; but soil, climate, cultivation, variety, fertilizers, disease and insect pests all affect yield. The composition of roots varies according to age, variety, soil and climate. Starch content varies from 12-33%. Normal root composition at harvest time is starch 22-31%, moisture content 60-75%, cellulose about 2%, proteins 3%, plus fats, minerals and soluble and insoluble carbohydrates. A detailed description is given on cassava processing in Thailand. Machinery and methods of starch extraction in Brazil are also described. The following characteristics of the final product are presented: appearance, mesh, odor, pH, moisture, ash, color, contamination, acid factor, pulp, cold and hot viscosity. Extraction of arrowroot and sago starch is also dealt with. *(Summary by J.L.S.)* 102

1772-2331 LARTEY, B. L. **A prototype cassava grater for use in Ghana, based on studies of existing graters.** Ghana Journal of Agricultural Science 3(1):53-59. 1970. Engl., Sum. Engl., Fr., 5 Refs., Illus.

Cassava. ***Manihot esculenta.*** **Rasping. Processing. Mechanization. Industrial machinery. Industrialization. Ghana.**

The two main types of cassava graters, manual and power operated used in Ghana are described. Of the latter there are two kinds: cylindrical and disc. The performance, constructional details and costs of the two types of powered graters are illustrated and compared. Developed from mechanical concepts inherent in existing cylindrical graters, a prototype grater incorporating new features has been designed and constructed and is also illustrated. Tests indicate that the prototype is sturdier, gives a fairly high rate of production and is easy to operate. *(Author's Summary)* I02

See also *0171 0176 0219 0221 0223 0229 0230 0231 0232 0240 0247 0251 0265 0266 0271 0275 0284 0290 0305 0343 0348 0433 0438 0452 0456 0532 0826 1007 1023 1025 1041 1042 1045 01047 1070 1071 1072 1075 1077 1099 1104 1105 1111 1141 1147 1161 1409 1410 1418 1428 1430 1458 1469 1485 1790 1797 1798 1816 1817 1819 1838 1841 1877 1886 1895 1903 I02*

103 Industrial Microbiology

1773-0164 SPRUNG, D. W. **Improvement of the nutritional value of cassava by the use of high-solids fermentation.** M. Sc. Thesis. Guelph, Ontario, University of Guelph, 1974. 91p. Engl., Sum. Engl., 75 Refs., Illus.

Cassava. Silage. Industrial microbiology. Food enrichment. Rhizopus. Proteins. Fermentation. Fermented products. Culture media. Aspergillus. Cassava starch. Hydrolysis. Storage. Analysis. Animal nutrition. Feeds and feeding. Swine. Domestic animals.

The feasibility of producing cassava silage of improved nutritional value for swine was investigated using nonprotein nitrogen compounds to promote synthesis of microbial protein. Cassava silage was readily produced in laboratory-scale fermentations and possessed a pH of 3.8 after 6 days' incubation at 37°C. Various microorganisms were selected by the application of an extensive screening procedure for possible use as inocula in high-solids fermentations. Initial attempts to increase the protein content by the addition of inorganic salts and selected organisms did not prove successful. In an effort to encourage protein synthesis under these conditions, mixed inocula of the most promising microorganisms were employed. Growth factors and electron acceptors of possible value to organisms growing anaerobically were also tested: Again, resultant protein levels were inadequate. The ensiling of cooked, ground cassava, either fresh or prefermented and subsequently inoculated with *Rhizopus oligosporus*, produced final protein levels of about 3% (trichloroacetic acid precipitated nitrogen x 6.25) after two weeks. However, cooking was not regarded as a practical process. The possibility of using aerobic solid-state fermentations was examined. Surface growth of molds could be induced on layers of ground cassava supplemented with nonprotein nitrogen, but contaminant growth was uncontrollable in simple, practical systems. Protein levels of about 4% were obtained after 6 days' incubation at 37°C. Levels of almost 7% protein could be induced by recycling a mineral salts solution inoculated with *R. oligosporus* through acidic silage in thin layers. It was concluded that none of the effective methods would be of practical use for rural operations in tropical cuntries. *(Author's summary)* 103 H03

1774-0976 **FERMENTATION METHODS with cassava to improve its nutritional value.** *In* London. Tropical Products Institute. Report 1967. London, 1968. pp.10-12. Engl.

Cassava. Fermentation. Proteins. Food products. Rice. Soybean. Groundnut. Enzymes. Minerals. N. P. Human nutrition. Nutritive value. Carbohydrates. Cassava starch. Cassava cheese. ***Rhizopus stolonifer.*** **Yeast production. Food enrichment. Industrial microbiology. England.**

Two methods of protein enrichment and production from cassava, both based on the development of microbiological protein using added cheap mineral supplements are described. The first method, the so-called TPI vegetable cheese process, consists in fermenting a cake of extruded cassava dough, mixed with salts and inoculated with spores of *Rhizopus stolonifer*. The other method subjects the material containing carbohydrate to an aerobic, deep-culture fermentation and subsequently recovers the microbial biomass from the fermented liquor. Work on the improvement of the nutritional value of cassava is being continued. *(Summary by Tropical Abstracts)* 103 H01

1775-0742 STANTON, W. R. and WALLBRIDGE, A. **Fermented food processes.** Process Biochemistry 1969:45-51. April 1969. Engl., 34 Refs.

Cassava. Cassava cheese. Human nutrition. Human health. Fermentation. Gari. Processing. Industrialization. Food enrichment. *Rhizopus stolonifer.* **Industrial microbiology. Proteins.**

Fermentation of starch tubers such as cassava with fungal organisms such as **Rhizopus** can result in a food product with significant increases in protein content. At the Tropical Products Institute (London) these processes have been pioneered and resultant products are being submitted to elaborate nutritional tests. Descriptions are given of the preparation and characteristics of vegetable cheeses, including cassava cheese. The term cheese, although classically applied to milk curds, has been used recently for soybean preparations. *(Summary by H.J.S.)* 103 H01

1776-0331 COLLARD, P. and LEVI, S. **A two-stage fermentation of cassava.** Nature 183(4661):620-621. 1959. Engl., 5 Refs.

Cassava. Fermentation. Gari. Food products. Detoxification processes. Processing. *Geotrichum candidum.* **Corynebacterium. Industrial microbiology. Cyanogenic glycosides. Human nutrition. Detoxification. Palatability. Organoleptic examination.**

One of the staple foods of the people of the rain forest belt in West Africa is gari, a starchy food prepared from the root of the cassava plant *(Manihot utilissima).* The microbiology of the traditional preparation has been investigated to determine the conditions needed for mechanized production in Nigeria. It is suggested that the process of detoxification of the cassava root, which occurs in the preparation of gari, be regarded as a two-stage fermentation. In the first stage the **Corynebacterium** attacks the starch of the root, producing various organic acids; the lowering of the pH causes spontaneous hydrolysis of the cyanogenic glucoside with liberation of gaseous HCN. When sufficient organic acids (including lactic acid) have been produced, conditions become favorable for the growth of the **Geotrichum,** which then proliferates, producing a variety of aldehydes and esters. These appear to be responsible for the characteristic taste and aroma of gari. Acting on the two-stage fermentation hypothesis, gari has been prepared in 24 hours using a mixture of pure cultures of the two organisms mentioned above as starters. This product has been tested by feeding it to volunteers who were unable to tell the difference between the gari produced in 24 hours by the use of a pure culture starter and the traditional product, which takes 4 days to make. *(Summary by P.A.C.)* 103 H04

1777-0719 GRAY, W. D. and ABOU-EL-SEOUD, M. O. **Fungal protein for food and feeds. III. Manioc as potential crude raw material for tropical areas.** Economic Botany 20(3):251-255. 1966. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Industrial microbiology. Human nutrition. Animal nutrition. Supplements. Proteins. Carbohydrate content. Laboratory experiments. Statistical data. Productivity. Food enrichment. Economics. Tubers. Cassava tubers (vegetable).

On the basis of results obtained in the few experiments described, cassava has been shown to have considerable potential as a source of carbohydrate in a process involving the synthesis of protein by fungi. No attempt was made to conduct an exhaustive investigation once feasibility was demonstrated since previous experience leads us to believe that the reported amounts of protein synthesized do not necessarily represent the best obtainable yields and that further manipulation of cultural conditions could result in increased yields. Even on the basis of best yield obtained with fresh roots in the present investigation (14.6 g additional protein|lb), cassava could be used to make significant contributions to the world protein pool in tropical areas. Total world production of cassava root in 1962-63 was 165 x 10^9 pounds, of which only 1.1 x 10^9 pounds were protein. However, if this cassava were processed with I-83, an additional 5.3 x 10^9 pounds of proteine could have been synthetized, making a total yield of 6.4 x 10^9 —approximately a sixfold increase. On the basis of results obtained to date, it would be more economical to use fresh roots rather than crudely ground dry flour since the use of this latter material resulted in a yield reduction of nearly 27%. *(Author's summary)* 103 H01

1778-0941 BROADBENT, J.A. **Gari.** *In* Port Harcourt. Nigerian Stored Products Research Institute. Annual Report 1967. pp 25-28. Engl.

Cassava. Processed products. Gari. Industrial microbiology. Food products. Laboratory experiments. Aspergillus. Nigeria.

Some microbiological studies on gari were started based on results gathered from gari storage studies. The results indicate that microflora of stored gari can vary, but its most important components are members of the *Aspergillus glaucus* group. There are tables giving data on the microorganisms isolated from the samples of gari. *(Summary by H.J.S.)* 103 H01

1779-0974 **ENRICHING CASSAVA with microbes.** New Scientists 45:108. 1970. Engl.

Cassava. Industrial microbiology. Cassava flour. Cassava cheese. Proteins. Food enrichment. Analysis.

Analysis of cassava cheeses produced by TPI indicates that protein concentrations in the final cheese may reach 3.25% as compared with 0.5% in the starting flour. *(Summary by H.J.S.)* 103

1780-0163 LIN KHOR, G. **Nutritional and safety evaluations of microbial proteins grown on cassava.** M. Sc. Thesis. Guelph, Ontario, University of Guelph, 1974. 128p. Engl., Sum. Engl., 118 Refs., Illus.

Cassava. Industrial microbiology. Food enrichment. Proteins. Amino acids. Cystine. Methionine. Supplements. Analysis. Laboratory animals. Tryptophan. Yeast production. Nutritive value. Soluble carbohydrates.

Various strains of yeasts and filamentous fungi grown in a cassava carbohydrate and salts medium were evaluated for their nutritional quality. Safety evaluations of the microbial proteins were carried out also, through feeding them to rats for 90 days. The amino acid contents of the microbial proteins were determined by ion-exchange chromatography after acid hydrolysis. All of the samples were found to be deficient in the sulfur amino acids. In order to reduce loss by acid hydrolysis, cystine and methionine in the microbial proteins were determined also as cysteic acid and methionine sulfone by an oxidation procedure. The sulfur amino acid values obtained by the oxidation method were much higher than those observed before. Microbiological assays using *Leuconostoc mesenteroides* were carried out to obtain an additional estimation of the sulfur amino acids in the microbial proteins. Hydrolysates prepared in an autoclave or an oven yielded comparable results for methionine, which were in good agreement with those obtained by the oxidation method. The cystine values estimated from microbiological assays compared more favorably with published results than those determined as cysteic acid. Biological evaluations of the microbial proteins were based on Protein Efficiency Ratio (PER) and Net Protein Ratio (NPR) methods, using rats. In the first evaluation intended for survey purposes, two strains of fungi and one strain of yeast were selected because they produced better weight gains, feed efficiency and PER results than the other samples tested. No significant differences were observed for the NPR values among the casein control and the test groups. Because the chemical and microbiological analyses had shown the microbial proteins to have a low methionine content, a second series of animal feeding evaluations was undertaken to study the effects of DL-methionine supplementation on the test diets. With 0.6% methionine added, rats fed the fungus proteins produced significantly higher PER and NPR values, as well as better weight gains than rats which consumed the same fungus proteins without any methionine supplement. The addition of methionine to the yeast diet did not improve its nutritive quality, as judged by the criteria mentioned. This could have been due in part to a relatively higher feed intake by the rats fed the yeast diet, and hence they could have been less deficient in methionine. A third rat experiment was included to evaluate the two fungi with the protein level based on their α-amino acid content, rather than on Kjeldhal nitrogen (N x 6.25) as used in the previous evaluations. Both of the fungi produced as good results for NPR and feed efficienty as did casein; however, these fungi still produced statistically lower weight gain and PER values than casein. Since a substantial proportion of the microbial nitrogen is nonprotein nitrogen, calculation of the protein level in microbial proteins should be based on their α-amino nitrogen content. For the safety evaluations, rats were fed the microbial proteins at 0, 20, 30 and 40% of the diet for 90 days. A kidney function test was made just before autopsy. Urine samples were analyzed for their composition; and hematology, biochemical and plasma protein analyses were done on blood samples. Organ weights were taken, and 26 different body tissues were prepared for histopathology. Because of the negative findings in the extensive histopathological examinations, together with the absence of gross lesions and adverse clinical symptoms, it was concluded that the experimental diets were not injurious to the rats when fed for 90 days. *(Author's summary)* I03 H01

1781-2190 STRASSER, J. **Developments in cassava processing.** Tropical Roots and Tuber Crops Newsletter no. 4:50-51. 1971. Engl., 5 Refs.

Cassava. Processing. Proteins. Yeast production. Development. Industrial microbiology. Cassava starch.

For several years, the International Division and the Central Engineering Laboratories of FMC Corporation have been concerned with the agriculture and processing of root and tuber crops. Processing plants for potato flakes, cassava flour, etc. have been built by FMC in different parts of the world. Recently, agricultural development and processing projects for cassava were proposed to several African nations. Specific attention has been paid to the concept of using cassava starch as a carbohydrate source for the propagation of yeasts. Single-cell protein production from carbohydrates has been studied by several researchers and has a promising future. Preliminary experiments indicate that single-cell protein can be produced from cassava on a commercial scale at a cost of 13.5 cent| lb, which would make it competitive with other protein sources. However, before the process can be applied commercially, more research and development work will be necessary. Areas of further investigation must be the reduction of nucleic acid and the obtaining of a nutritional balance of amino acids. Also, more economical techniques should be developed for separating the single-cells from the liquid stream. *(Full text)* I03

1782-2009 SPICER, A. **Protein production by micro-fungi.** Tropical Science 13(4):239-250. 1971. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Proteins. Storage. Human nutrition. Industrial microbiology. Economics. Food enrichment. Nutritive value. Carbohydrate content. Amino acids.

In comparison with yeast and bacteria, microfungi have several advantages. They possess a better protein profile, the recovery from the growth medium is less difficult, and the fungi have a filamentous structure which facilitates their use in the manufacture of textured foodstuffs without extraction and spinning. Also, microfungi are already accepted as foods in many parts of the world. The protein content in the best strains is 45-50% (NPU 70). The raw materials for the substrate are either starch (cassava, potatoes, etc.), sucrose (cane juice or molasses) or lactose (milk whey). Pilot fermenters, both batch and continuous, have been built in different sizes. A 1,000 liter pilot fermenter has been in operation for runs of hundreds of hours. Using the filamentous material, beef-, veal- and chicken-like products have been obtained. Fortification of bread and porridges is also possible without changing the characteristics of the original product. Due to the numbers of raw materials and end products, and the differences in prices from country to country, a general price estimate is not attempted. *(Author's summary)* I03 H01

1783-0432 STRASSER, J., ABBOTT, J.A. and BATTEY, R.F. **Process enriches cassava with protein.** Food Engineering 1970:112-116. May 1970. Engl., 13 Refs., Illus.

Cassava. Human nutrition. Cassava products. Gari. Cassava flour. Cassava starch. Proteins. Processing. Factories. Food enrichment. Industrial microbiology. Costs. Industrial machinery.

Experiments were carried out on the processing of test quantities of enriched cassava. It was found that the enrichment process with single-cell protein would be technically feasible in large-scale applications without using sophisticated equipment and that costs could compete with those of other food proteins. Diagrams of the process are given, as well as three tables concerning costs of materials, equipment and operation. A chart also shows how to incorporate protein into native dishes such as gari and farinha. *(Summary by H.J.S.)* I03 H01

1784-2145 COLLARD, P. **A species of Corynebacterium isolated from fermenting cassava roots.** Journal of Applied Bacteriology 26(2):115-116. 1963. Engl., Sum. Engl., 2 Refs.

Cassava. Corynebacterium. Industrial microbiology. Human nutrition. Gari. Fermentation. Food products. Isolation. Laboratory experiments.

A species of Corynebacterium not described in the 7th edition of Bergey's Manual has been isolated from grated cassava *(Manihot utilissima)* root allowed to ferment for some days during the preparation of gari, a farinaceous food eaten in Nigeria. The organism ferments starch, dextrose, maltose, sucrose, salicin, xylose and arabinose, with the production of acid only, and produces bright yellow colonies of a characteristic form on litmus-lactose agar. It has been suggested that this organism, if accorded specific status, should be named *Corynebacterium manihot. (Author's summary)* 103

1785-0789 JOSEPH, R. and RAMACHANDRA RAO, T.N. **Glutamic acid fermentation employing starchy tubers as raw material.** Journal of Food Science and Technology 10(4):160-164. 1973. Engl., Sum. Engl., 15 Refs.

Cassava. Food products. MSG. Fermentation. Uses. Cassava starch. Industrial microbiology.

The possibility of using starchy tubers (potatoes, sweet potatoes and cassava) as raw materials in glutamic acid fermentation by *Micrococcus glutamicus* is shown. Preliminary work was done with potatoes, which after enzyme hydrolysis and removal of excess biotin enabled the accumulation of extracellular glutamic acid. A simple technique was developed to remove excess biotin by adsorption on activated charcoal; this was necessitated because of the ineffectiveness of the addition of penicillin, isobutyl, isopropyl alcohols and sodium oleate to this system. In a medium containing potato hydrolysate (5% total soluble solids), 0.3% urea, 0.2% peptone, 0.2% meat extract, 0.2% K_2HPO_4, 0.2% KH_2PO_4, a yield of 10.75 mg| ml of glutamic acid was obtained after 72 h in agitated culture (vol 200 ml) at room temperature (28-30°C). *(Author's summary)* 103

1786-0895 WOOLEN, A. H. **What's new in Europe; among advances: boosting protein supply by fermentation, ultrasonic hop extraction, closed-circuit drying of fish-meal effluent vapors, and vacuum-frying of potato chips.** Food Engineering 40(11):98-99. 1968. Engl., Illus.

Cassava. Food products. Fermented products. Cassava cheese. Proteins. Processing. Industrial microbiology. Fermentation. Cassava flour.

The Tropical Products Institute (TPI), London has developed a microbiological method of raising the protein content of cassava. Crude protein levels have been raised from 0.1% to 4% with minimal additives. This should make it possible to produce a palatable product with a dietary protein content above the FAO minimum. A cake of extruded cassava dough containing mineral N, P and other salts is fermented with a selected strain of *Rhizopus stolonifer.* For correct fermentation, the composition, physical structure and moisture content of the dough, the strain of organism, and the ambient temperature and humidity are most important. TPI says that the equipment is simple and that the conditions would not be difficult to achieve in cassava-producing areas. The resulting "vegetable cheese" can be cooked directly or incorporated in foods made with cereal flours. It can be preserved frozen or dried; in the latter form, it is relatively stable against biodeterioration. *(Full text)* 103

1787-0917 BROOK, E. J., STANTON, W. R. and WALLBRIDGE, A. **Fermentation methods for protein enrichment of cassava.** Biotechnology and Bioengineering 11(6):1271-1284. 1969. Engl., 32 Refs., Illus.

Cassava. Fermentation. Cassava cheese. Diets. Food products. Gari. Processing. Aspergillus. Human nutrition. Cassava flour. Proteins. Economics. Food enrichment. Cassava pastes. Cassava meal. N. *Rhizopus stolonifer.* Industrial microbiology.

The idea of the direct incorporation of microbial protein *(Rhizopus oligosporus, R. stolonifer)* into a starchy foodstuff is presented. The development and technology involved in the fermentation itself and in product evaluation are very problematic. The gamut of problems associated with incorporation of this type of foodstuff into particular dietary patterns also has to be investigated. An attempt to minimize these problems was made by keeping in view the possible situation in which these foodstuffs might be used and by confining studies to comparatively unsophisticated fermentation systems in which no problem of undesirable residue or unpleasant flavor would demand extra stages of processing. The cheese process, in particular, lends itself to establishment as a village industry; and the labor and capital required for the process in its simplest form are comparable to that required for the traditional gari and tempeh processes. *(Summary by Biological Abstracts)* I03 H01

1788-0488 AKINRELE, I. A. **Fermentation of cassava.** Journal of the Science of Food and Agriculture 15:589-594. 1964. Engl., Sum. Engl., 6 Refs.

Cassava. Fermentation. Temperature. Gari. pH. Corynebacterium. *Geotrichum candidum.* **Lactic acid. Industrial microbiology. Detoxification.** *Manihot esculenta.*

During the preparation of gari, cassava (*Manihot utilissima* Pohl) is usually fermented; during this process it becomes detoxified, developing a characteristic flavor. An experiment was designed to elucidate the nature of biochemical reactions taking place during fermentation and to establish the optimum condition that could be utilized in a modern industry. It was found that the fermentation proceeds in 2 stages during which the mash is gradually sterilized against adventitious microbial growth. During the first phase, bacteria attack the starch, producing lactic and formic acids, a reaction accompanied by the evolution of heat. When the pH of the medium has fallen to about 4.25, a mold proliferates rapidly, bringing about further acidification and the production of the characteristic aroma of gari. The HCN is liberated through the spontaneous hydrolysis of the cyanogenic glucoside of cassava at low pH. It is also believed that some of the formic acid breaks down to form C02 and H. These gases tend to render the medium anaerobic. Fermentation seems to proceed best at a temperature of about 36°C; and with pulp inoculated with fermented cassava juice, a satisfactory product has been produced under 15 h. A continuous system is possible and gives better fermentation than does the batch. Exposure to air or oxygen and contact with iron should be reduced to a minimum to avoid discoloration. *(Summary by T.M.)* I03 H04

1789-3363 CODNER, R. **Protein boost to enrich cassava.** Food Industries Journal 4(9):12-13. 1972. Engl., Illus.

Cassava. Human nutrition. Proteins. Yeast production. Fermented products. Cassava cheese. Industrial microbiology. Food enrichment.

Protein content can be increased by growing microbes on cassava flour. At the TPI (London), the flour is pasteurized at a low temperature, the nitrogen source is added as a mineral salt solution, together with a suitable fungus. The end product is called "cheese." Proteins have built up from 0.5% to 3.25% in the cheese. By the addition of casein, the protein was brought up to 8.5%. Rats fed on the mixture made a slow, but steady gain in weight. The fermentation will be studied further probably using a yeast. *(Summary by H.J.S.)* I03

1790-0981 HAO, P. L. C. **Production of butanol and acetone from sweet potato, cassava and black strap molasses.** *In* Pacific Science Congress, 9th., Bangkok, 1957. Proceedings. Bangkok, Department of Science, 1958. v.5, pp.15-19. Engl., 14 Refs.

Cassava. Molasses. Fermentation. Industrial microbiology. Alcohol. Industrialization. Cassava starch. Cassava chips. Sweet-potatoes. Production. Processing.

Sweet potato and cassava chips have been used successfully in the industrial production of butanol and acetone. Ten to 12 tons of these raw materials were charged to each fermentor holding 150 liters of mash. Optimum sugar concentration of mash was around 5%. Total solvent yields of 33-34% based on sugar were obtained from cassava mashes, while yields from sweet potato mashes ran from 30-33%. Mixed mashes containing 55.4% blackstrap molasses on weight basis or 47% molasses on sugar basis could be fermented successfully with microorganisms of the *Clostridium acetobutylicum* type. Total solvent yields from mixed mashes were around 33%. Blackstrap molasses mashes of 5-6% sugar concentration gave total solvent yields of 24-26% based on sugar using microorganisms of the *Clostridium saccharo-acetobutylicum* type. Range of fluctuation of solvent yields obtained from molasses mashes was much greater than that obtained from starchy mashes or mixed mashes. Vegetable oil cakes such as soybean cake, cottonseed cake, rapeseed cake and peanut cake, as well as rice bran, have been used satisfactorily as nutrient materials in butyl-acetonic fermentation. The selection of nutrient supplements depends primarily on the sources of supply and the relative costs of the nutrient materials. *(Author's summary)* 103 102

1791-2169 AKINRELE, I. A. **Further studies on the fermentation of cassava.** Nigeria. Federal Institute of Industrial Research. Research Report no. 20. 1963. 13p. Engl., Sum. Engl., 6 Refs.

Cassava. Fermentation. Industrial microbiology. Corynebacterium. Processing. Lactic acid. Formic acid. pH. ***Geotrichum candidum.*** **Gari. Food products. HCN. Hydrolysis. Temperature.**

An attempt has been made to elucidate the nature of biochemical reactions that take place during fermentation and to establish optimum conditions that could be utilized in a modern industry based on this process. Cassava ferments by a two-stage process, during which it is gradually sterilized against undesirable microbial growth. During the first phase, cassava bacteria *Corynebacterium manihot* attack the starch with the production of lactic and formic acids, a reaction accompanied by the evolution of heat. When the pH of the medium has fallen to about 4.25, a fungus *(Geotrichum candida)* begins to proliferate rapidly, bringing about further acidification and the production of the characteristic aroma of gari. Hydrogen cyanide is liberated during fermentation through the spontaneous hydrolysis of the cyanogenic glucoside of cassava at a low pH. It is also believed that some of the formic acid breaks down by a hydrogenylase system to give off CO_2 and H. All these gases tend to render the medium anaerobic. Fermentation seems to proceed best at a temperature of about 35°C; and with a fresh pulp seeded with fermented cassava juice, a satisfactory product has been produced in less than 15 hours. Sunlight and frequent mixing of mash appear to accelerate fermentation, particularly during the second stage. A continuous system is possible and, in fact, promotes fermentation better than the batch process. Exposure to air or oxygen and contact with iron should be reduced to a minimum to avoid discoloration. *(Author's summary)* 103

1792-0817 HARRIS, R. V. **Effect of Rhizopus fermentation on the lipid composition of cassava flour.** Journal of the Science of Food and Agriculture 21(12):626-627. 1970. Engl., Sum. Engl., 26 Refs.

Cassava. Cassava cheese. Food enrichment. Industrial microbiology. Cassava flour. Proteins. Human nutrition. Composition. Fermentation. Processing. Supplements. Food products.

Studies were made on the complex lipid and fatty acid compositions of commercial cassava flour before and after nutritional "upgrading" with *Rhizopus arrhizus*. The flour lipids closely resemble those found in other plant tissues, except for a lower content of polyunsaturated acids and a higher content of free fatty acids. This can be accounted for by degradation during processing. Rhizopus fermentation leads to the appearance of y-linolenic acid and changes in the percentage of other acids. The total lipid content falls, and the typical plant glycolipids disappear to be replaced by mold phospholipids. Sterol glycoside present in the original flour is not metabolized and becomes a major component of the final material. *(Author's summary)* 103

1793-4854 TREVELYAN, W. E. **The enrichment of cassava with protein by moist-solids fermentation.** Tropical Science 16(4):179-194. 1974. Engl., Sum. Engl., Fr., Span., 39 Refs.

Cassava. Food enrichment. Proteins. Fermentation. Industrial microbiology. Moulds. N. pH. Temperature. Aspergillus. ***Rhizopus stolonifer.*** **Cassava flour. Composition. Analysis.**

The suggestion that cassava, supplemented with sources of nonprotein N, such as ammonium salts or urea, could be converted by village-level technology into a nutritious, protein-rich food of attractive texture and taste by fermenting the mixture with molds derived from oriental fermented foods as "tempeh" is criticized on several grounds. It is considered that a mold that was dominant in its original habitat would not necessarily be so under changed conditions. The distribution of spore inoculum, and of nonprotein N sources to widely-scattered villages presents difficulties. Residues of nonassimilated ammonium salts, etc. could not simply be left in the product. Doubt exists about the level of protein that could be established by the fermentation of moist solids and about the efficiency of conversion of carbohydrate to fungal protein. The last 2 points were investigated experimentally. When fermenting cassava flour with *Rhizopus oryzae*, it was found that growth stopped when a mixture of cassava with urea and ammonium phosphate, originally containing 100 g solids and 0.6 g protein, reached a protein content of 4.3 g. About 26% of the dried weight was lost by conversion to carbon dioxide. The conversion of carbohydrate to fungal protein was as efficient as batch liquid culture but only half as efficient as continuous culture. The fermentation was susceptible to infection by fungi and bacteria. *(Author's summary)* I03

1794-1665 STANTON, W. R. and WALLBRIDGE, A. J. **Improvements relating to the fermentation of cassava and other vegetable substances.** British Patent 1,277,002. 1972. 4p. Engl.

Cassava. Cassava flour. Fermentation. Industrial microbiology. Cassava cheese. Food enrichment. Proteins. *Rhizopus stolonifer.* **Patents.**

The reported process utilizes a mucoraceous fungus of the genera **Rhizopus, Mucor** or **Actinomucor,** or a fungus of the genus **Monilia** to ferment a solid or pastelike substrate consisting of (1) an edible, protein-deficient vegetable material (like cassava), of which the carbohydrate is mainly starch, and (2) a mixture containing N in a nonproteinaceous form. The fungus assimilates N to synthesize protein. With cassava (*Manihor esculenta* or *M. utilissima*), the tubers are peeled, dried and ground into flour. The N source is prepared by dissolving 45.8 g of ammonium nitrate and 8 g of potassium dihydrogen phosphate in 200-300 ml of distilled water; to this is added the inoculum (15 ml of a spore suspension of *R. stolonifer*). The inoculated N mixture is stirred into 1 kg of milled cassava flour; 300 ml of water is added to bring the final moisture level to 45 ± 3%. The pH should be 4.5-6.7. This dough is then machine mixed for 10-12 min to form a thick paste, which is then extruded as a spaghetti, 3-5 mm in diameter. The strands are cut into 10-cm lengths and packed into shallow, aluminum fermentation trays. Trays are covered with loose-fitting aluminum lids and placed in the fermentor. Temperature and RH are maintained at 30°C and 95-97% for 72 h. Fermentation may be stopped by cooking or deep-freezing the product. The protein content of cassava is raised from about 0.2 to 4%; initial toxicity of the cassava is also reduced. *(Summary by Chemical Abstracts)* I03

1795-0074 STRASSER, J. **Accelerated protein production from low-grade carbohydrates.** Santa Clara, Calif., FMC Corporation, Central Engineering Laboratories, 1968. 19p. Engl., 47 Refs., Illus.

Cassava. *Manihot esculenta.* **Processing. Proteins. Protein deficiencies. Food enrichment. Yeast production. Fermented products. Industrial microbiology. Composition. Soluble carbohydrates. Carbohydrate content. USA.**

This project proposal from the Central Engineering Laboratories of the FMC Corporation (California) discusses experimental work carried out on the technical and economic possibilities of enriching protein-deficient diets by growing torula yeast on processed cassava, *Manihot esculenta* Crantz. It includes a discussion of single-cell microorganisms which grow on carbohydrates (yeasts, bacteria and fungi), different sources of carbohydrates, special yeast processing for the enrichment of cassava and proposed development program. *(Summary by P.A.C.)* I03

See also 1054 1056 1423 1508 1658 I03

J00 ECONOMICS AND DEVELOPMENT

1796-2356 BARROS, M. DE S. **Custos agrícolas em São Paulo; safra de 1961| 62.** *(Costs of agricultural production in São Paulo; harvest of 1961-62).* Agricultura em São Paulo 9(2):21-32. 1962. Port.

Cassava. Costs. Economics. Maize. Rice. Production. Cultivation. Brazil.

Calculations of cost prices are given for some of the most important agricultural products in the state of São Paulo (Brazil). Data were prepared for the orientation of the producers when drawing up their budgets and as an aid to the government in the formulation of agrarian policies. Calculations are made for the growing of maize, rice, cotton, groundnuts, castor-oil plant, cassava, beans, and sugar cane. *(Summary by Tropical Abastracts)* J00

1797-2352 TEULIERES, R. **Economie du manioc au Sud-Vietnam.** *(Economic importance of cassava in South Vietnam).* Bulletin de la Société des Etudes Indochinoises 38(3-4):559-579. 1963. Fr., 15 Refs. Illus.

Cassava. Economics. Soil fertility. Cassava flour. Industrialization. Processing. Cultivation. Production. Vietnam.

African and American cassava varieties were introduced in South Viet Nam around 1900. Although production is only 5-6 ton| ha, total production rose to 255,000 tons in 1951. A description is presented of the soil types on which cassava is cultivated, cultural practices and the semimechanical production of cassava flour. *(Summary by Tropical Abstracts)* J00 I02

1798-0894 **THAILAND'S TAPIOCA industry helps earn vital foreign exchange.** Foreign Agriculture 24(3):7. 1960. Engl., Illus.

Cassava. Industrial machinery. Cassava flour. Processed products. Trade. Marketing. Economics. Thailand.

Although cassava is not considered one of Thailand's major crops, its by-product —cassava flour— is becoming an increasingly important foreign exchange earner. It is only in the last few years that modern machinery for the processing of the flour for the export market (mainly U.S.A.) has been brought into operation. There are, however, still hundreds of small mills scattered throughout the area along the southeast coast of the Gulf of Siam. *(Summary by Tropical Abstracts)* J00 I02

1799-2355 JUNQUEIRA, A.A.B. **Custos Agrícolas em São Paulo na safra 1962| 63; milho, arroz, feijão, amendoim, mandioca.** *(Costs of agricultural production in São Paulo in the 1962-63 harvest: millet, rice, common bean, groundnut, cassava).* Agricultura em São Paulo 9(12):31-42. 1962. Port.

Cassava. Economics. Development. Maize. Rice. Beans. Groundnut. Cultivation. Production. Costs. Brazil.

The work contains calculations of cost prices of some of the most important agricultural products in the state of São Paulo (Brazil), prepared to aid producers in preparing their budgets and the gorvernment to formulate agrarian policies. Calculations are presented for the cultivation of maize, rice, beans, groundnuts and cassava. Results are given as tables. *(Summary by Tropical Abstracts)* J00

1800-2210 CLEMENT, R. **La situation du marché malgache du tapioca, de la fécule et du manioc sec.** *(The situation of the tapioca, cassava flour and dried cassava market in Madagascar).* Marchés Coloniaux du Monde 6(245):1677-1679. 1950. Fr., Illus.

Cassava. Marketing. Economics. Distribution. Trade. Development. Tapiocas. Cassava flour. Dried tubers. Malagasy Republic.

Starch crop production and industrial processing are activities which play an important role in Madagascar. The international marketing of these products has been a problem for several years. The causes of this situation are briefly discussed. It is quite possible that the tapioca market will recover its former commercial position. *(Summary by H.J.S.)* J00

1801-2354 LONGUET, P. **L'extension de competence de l'Institut Françals du Tapioca a l'ensemble de la Communauté Européenne.** *(The extension of the activities of l'Institut Français du Tapioca with the European Economic Community).* Marchés Tropicaux du Monde 14(660):1634-1635. 1958. Fr.

Cassava. Industrialization. Tapiocas. Development. Togo. Malagasy Republic.

The production of cassava and cassava products as substitutes for other industrial starches and sago will be fomented by the creation of the European Economic Community. The Institut Français du Tapioca was created in 1954 to stimulate the consumption of tapioca in France. Fiscal, financial and administrative aspects that would permit the institute's incorporation into the EEC, as well as a tax to be levied on tapioca consumed in France, were studied. *(Summary by T.M.)* J00

1802-0124 STEPPLER, H. A. **Cassava; proposed program.** Palmira, Colombia, CIAT-IDRC, 1971. 7p. Engl.

Cassava. Animal nutrition. Human nutrition. Cassava programs. Uses. Industrialization. Development. Colombia.

This preliminary program proposed for research work in cassava (*Manihot esculenta* Crantz) at the Centro Internacional de Agricultura Tropical (CIAT) includes (1) a definition of the role or roles which cassava would be expected to fill in the future; (2) identification of the limiting factors for its utilization and improvement with respect to achieving the roles defined; (3) identification of those areas of investigation which lie within the area of CIAT's responsibility, and the elaboration of a program to research these areas; (4) identification of the staffing requirements and phasing of that staff in order to meet the time schedule of this research program; (5) preparation of budgets and budget projections. *(Summary by P.A.C.)* J00

1803-3642 DELCASSO, M. and SILVESTRE, P. **Economic problems encountered in the intensive cultivation of cassava by IRAT/TOGO.** Nogent-sur-Marne, France, IRAT, 1971. 22p. Engl., Sum. Engl., Illus.

Paper presented at The Conference Centre, Ibadan, 1971.

Cassava. Cultivation. Climatic requirements. Cultivation systems. Inter-cropping. Cultivars. Economics. Prices. Gari. Cassava starch. Productivity. Composition. Starch content. Timing. Water requirements (plant). Starch productivity. Fertilizers. Harvesting. Maize. Research. Togo.

Because of strong demographic pressures, land has been exhausted. Maize and cassava have been traditionally intercropped, but production of the latter has increased because of its ability to grow on exhausted soils. Most cassava is destined for human consumption, but an increasing proportion is being used for industrial purposes (1|5 of the total production will be processed for starch in 1975). Since 1966, cassava and maize production have been intensified, emphasis being placed on enlarging the starch factory. Experiments are being carried out on varieties, cultural techniques and soil fertility. Research on planting and harvesting dates within a framework of an optimal production cycle should allow the definition of conditions for the qualitative improvement of starch content and the quantitative improvement of root yield. Cassava and maize intercropping has also been studied from the point of view of more rapid crop rotation. *(Author's summary)* J00 D02 K01

1804 3307 KOHLMANN, R.F. **Some short considerations about economic feasibility of marketing enriched food.** São Paulo, Sanbra, 1972. 5p. Engl.

Paper presented at the III Meeting about Enrichment of Cassava Flour, Rio de Janeiro, 1972.

Cassava. Proteins. Methionine. Supplements. Economics. Cassava flour. Food enrichment. Marketing. Brazil.

Proteimax 90 is an isolated soybean protein containing 90 % protein and enriched with 1% methionine. It has been used to enrich cassava flour. Three tables are given concerning the following items: incidence of taxes on enriched foods, costs of proteins for the consumer and sales prices to the consumer. The large-scale enrichment of cassava flour will be economically feasible only if total tax exemption is granted. It is recommended that any sizable future program for food enrichment must be considered from this angle. *(Summary by H.J.S.)* J00

1805-1899 ANDERSEN, P. P. and DIAZ, R. O. **Present and potential labor absorption in cassava production in Colombia.** Palmira, Colombia, CIAT, 1973. 21p. Engl., 7 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd. Ibadan Nigeria, 1973.

Cassava. Labour. Economics. Productivity. Production. Colombia.

Present labor use in cassava production in Colombia is estimated by productive activity. Labor absorption in cassava production is compared to that found in the production of the other basic crops. The impact of mechanization and the adoption of improved biological technology on labor use is estimated. The analysis considers micro (farm level) as well as macro aspects (sector level) of potential labor absorption in cassava production. *(Summary by D.H. and L.J.)* J00

1806-2246 DAUVRIN, A. **Le manioc et ses possibilités au Congo Belge.** *(Cassava and its possibilities in the Belgian Congo).* Bulletin de l'Office Colonial du Ministere des Colonies (Bruxelles) 1:301-303. 1938. Fr., 3 Refs.

Cassava. Tapiocas. Economics. Cassava starch. Cassava flour. Production. Marketing. Development. Zaire.

A general review is made of the characteristics of some cassava products and possibilities for developing large, commercial cassava plantations in the country. Also, the economic aspects related to cassava production and commerce are discussed. It is concluded that cassava could become an important export crop. *(Summary by H.J.S.)* J00

1807-2115 ZIMMERMANN, A. **Zur Beurteilung der Rentabilitat des Maniok-Anbaues zum Export nach Europa.** *(Economic feasibility of cassava cultivation for export to Europe).* Pflanzer no. 5(13-14):192-201. 1909. Germ., 9 Refs.

Cassava. Industrialization. Economics. Distribution. Costs. Production. Paper industry. Industrial starches. Cassava starch. Trade. Europe.

The European paper industry could possibly use cassava starch instead of potato starch. Transportation costs of dried cassava, cost of potato starch, starch content of cassava and production costs of cassava per hectare are compared to the competitiveness of cassava starch. *(Summary by H.J.S)* J00

1808-2153 TAPIOCA. Tropical Agriculture (Trinidad) 3:142. 192C. Engl.

Cassava. Tapiocas. Processed products. Tapioca pearls. Tapioca Flakes. Trade. Cassava flour. England.

Brief notes are given on tapioca. Figures are presented about England's importations of cassava flakes, pearls and flour. *(Summary by H.J.S.)* J00

1809-2162 BERGER-ARDOUIN, G. **Le probleme du tapioca.** *(Tapioca problems).* Marchés Tropicaux no. 782:2401. 1960. Fr.

Cassava. Trade. Marketing. Tapiocas. Economics. Cassava programs. France. Malagasy Republic.

Tax dispositions on tapioca exportations unfavorable for Madagascar and Togo and favorable for France were established. The author proposes correctives for the situation. *(Summary by H.J.S.)* J00

1810-2102 CAVLE, M. G. **Le manioc á Madagascar.** *(Cassava in Madagascar).* Journal d'Agriculture Tropicale no. 124:300-303. 1911. Fr.

Cassava. Cultivation. Economics. Costs. Prices. Productivity. Malagasy Republic.

Brief notes on cassava production are given. Data refer mainly to present status of a plantation on the Eastern Coast, net costs of cultivation and productivity. *(Summary by H.J.S.)* J00

1811-2176 BONAME, P. **Importations de poudre de manioc a l'Ile Maurice.** *(Maurice Island importation of coarse cassava meal).* Agriculture Pratique des Pays Chauds 9:339-340. 1909. Fr.

Cassava. Economics. Prices. Feeds and feeding. Cassava meal. Processed products. Animal nutrition. Trade. Marketing. Cassava products.

Notes are given on importations of cassava from China and Singapore to Maurice Island. Prices of cassava meal for animal feeding vary widely according to the amount of importations. Suggestions are made to correct this situation. *(Summary by H.J.S.)* J00 H03

1812-3290 **LES RESOURCES naturelles d'exportation.** *(Natural resources for exportation). In* Le Marché de la Malaysia. Marchés Tropicaux et Méditerranees no. 1028:1796-1802. 1965. Fr., Illus.

Cassava. Economics. Trade. Tapiocas. Cassava starch. Marketing. Productivity. Malaysia.

A study of natural vegetable resources in Malaysia. Agronomic description, yields and marketing possibilities of the following crops are given: rubber, oil palm, tropical fruits, tea, pepper, Manila hemp, cacao, cassava, sago and wood. In 1964, 20,000 tons of cassava starch and tapioca were exported. *(Summary by J.L.S.)* J00

1813-0122 ESTRADA R., N. **Aumento de la productividad en la yuca; bases para solicitar la ayuda de técnicos holandeses.** *(Increasing the productivity of cassava; basis for applying for assistance from Dutch scientists).* Instituto Colombiano Agropecuario. Programa de Tuberosas. Documento no. 5. 1969. 13p. Span.

Cassava. ***Manihot esculenta.*** **Productivity. Plant breeding. Genetics. Cultivation. Field experiments. Cassava programs. Colombia.**

This project proposal reports on work now being done by the Tuber Roots Program of the Instituto Colombiano Agropecuario (ICA) with cassava (*Manihot esculenta* Crantz), as well as proposed general areas of further research with the assistance of Dutch scientists. *(Summary by P.A.C.)* J00

1814-2256 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. **Cassava.** *In*________. Production yearbook. Rome, 1971. v.23., pp. 116-120. Engl.

Cassava. Production. Productivity. Statistical data. Economics. South America. Africa. Asia. Australia. Caribbean.

The table gives yearly statistical data on area planted, production and yield from 1966-70, for most tropical countries. In addition, combined figures for the same items are given for the periods 1948-52 and 1961-65. World totals were 9.2 million hectares, 82.2 million metric tons and 8.9 ton|ha in 1966, and 9.8, 92.2, 9.4, respectively, in 1970. *(Summary by H.J.S.)* J00

1815-0182 **MANDIOCA, "O pao brasileiro".** *(Cassava, "Brazilian bread").* Cojuntura Económica (Brasil) 14(6):47-54. 1967. Port., Illus.

Cassava. Production. Productivity. Prices. Consumption. Economics. Brazil.

Brazil's cassava production has reached 25.5 million tons, grown on 1.9 million ha,thus averaging some 13 tons per hectare. Although productivity in relation to area is relatively low, production has doubled over the last 20 years. This remarkable leap is due to a good increase in area planted and also to a slight improvement in productivity per hectare, which has increased at on average rate of 23 kg per year. This expansion has been encouraged by improved real prices obtained by growers. *(Summary by Field Crop Abstracts).* J00

1816-2154 **PREPARATION DU manioc pour l'exportation.** *(Cassava processing for exportation).* Journal d'Agriculture Tropicale no. 93:79-80. 1909. Fr.

Cassava. Cassava chips. Processing. Packaging. Trade. Marketing. Legal aspects. Economics. Processed products. Industrial machinery. Malagasy Republic. Malaysia.

Manufacturers of cassava chips in Madagascar peel the tubers whereas those in Indochina do not. Chips from Madagascar are more uniform in size than those from Indochina. Peeling is not important for French consumers. Thus, the author recommends tha tubers not be peeled and explains different methods for manufacturing uniform chips. *(Summary by H.J.S.)* J00 102

1817-0291 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. INDUSTRY COOPERATIVE PROGRAMME. **Joint ICP|FAO Bankers' Programme reconnaissance mission to Colombia.** Report 1974. Rome, 1974. 22p. Engl., Sum. Engl.

Cassava. Economics. Prices. Production. Industrialization. Consumption. Factories. Processing. Cassava starch. Legal aspects. Cassava programs. Development. Colombia.

A joint ICP|FAO Bankers' Programme mission was invited to Colombia by PROMOVER, the promotional body for small and medium industries supported by FEDECAFE, as well as agencies and institutions in the fields of agrarian and agro-industrial credit (Caja de Crédito Agrario) and technological studies (Instituto de Investigaciones Tecnológicas). The mission visited a substantial number of small- and medium-sized agro-industrial enterprises in the fields of silk, mushrooms, "panela", cassava, fruit and vegetables, flowers and citronella production and processing, which were in part very efficiently organized, well managed and profitable. The mission believes that although the overall impact of these developments in the framework of the national economy will be relatively limited in the short run, such enterprises deserve active promotion and support in view of the social implications and long-term development potential. The major constraints which these industries face are the following: (a) In the food sector, their rate of growth is largely determined by the low level of consumer demand for processed products. Although consumer demand is growing at an estimated rate of 6%, the starting base in many cases is too small to permit operations of economically sized units. (b) Export marketing of processed products is favored by Colombia's good location with respect to the demanding markets of Venezuela, the Caribbean and the USA. However, if exports should become truly competitive, continuous investments in infrastructural development, especially in transport and cold storage, are required. (c) Raw material supply is a major bottleneck in agro-industrial development. This is due to the lack of agro-industrial integration. Industries tend to be geared to utilization of agricultural supplies instead of agriculture specializing in growing for industrial needs. (d) Monopolistic practices prevent in some cases, the emergence of new industries and restrict competition. Although small- and medium-scale agro-industries can make significant contributions to Colombia's agricultural development within the limits indicated, the main thrust will come from the country's major resources and potentials such as coffee, timber, livestock, cereals and sugar. These fields equally require support, and it is believed that FAO| ICP and FAO| Bankers' Programme can play a significant role in this development. The mission recommends the following project areas for follow-up with inputs from either program. FAO| Bankers' Programme: (i) the development of a cold chain for food with the newly founded company ENCOPER (outstanding issues: review of results of first phase investment program under way in 1974); (ii) the launching of the industrial complex based on the forest resources of the Serranía de San Lucas (outstanding issues: identification of potential technical partners in a joint venture with government agencies); (iii) the setting up of a fisheries company COLPESCA on the Atlantic Coast (outstanding issues: review of INDERENA proposal by fisheries specialist and fish marketing arrangements). FAO| Industry Cooperative Programme. (i) agro-industrial complexes, in which several small, but high value products can be produced and processed in the same area; (ii) cassava processing: a small-scale demonstration unit should be set up, financed locally and backed by ICP technical and marketing assistance; (iii) "panela": technical assistance in packaging and processing is required. In addition the mission recommends that a diagnostic study be carried out which would focus on all agro-industrial activities which could not be covered by the joint ICP| BP mission. The proposal to complete this under an FAO| UNDP project should be pursued. *(Author's summary)* J00 I02

1818-1900 PHILLIPS, T. P. **Potential supply of and demand for cassava in the '70's and '80's.** Ontario, Canada, University of Guelph, 1973. 14p. Engl., 12 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. *Manihot esculenta.* **Consumption. Cassava products. Economics. Trade. Marketing. Human nutrition. Animal nutrition.**

During the past decade demand for cassava as a human food has increased; demand as an industrial starch has stabilized; and demand as an animal feed ingredient in the European Economic Community (EEC) has developed. Analysis of each of these markets reveals that there will be substantial growth in all markets, with that of the EEC increasing threefold by 1980. Comparison of projected supply (based on 1960 trends) and markets indicates that the export potential of cassava will not be realized unless greater emphasis is placed on production and processing. The paper concludes that export markets have transformed cassava from a subsistence to a diversification crop. *(Summary by D.H. and L.J.)* J00 H00 H03

1819-0159 CULTURA E **Industrialização da mandioca.** *(Cultivation and industrialization of cassava).* Lavoura 14:12-21. 1942. Port.

Cassava. Cultivation. Industrialization. Factories. Cassava starch. Cassava chips. Economics. Costs. Brazil.

An economic study on cassava industrialization was carried out by the Foreign Trade Brazilian Council and owners of cassava starch factories. The cost per ton of starch, prices FOB and CIF, minimum prices, sea freight and production of alcohol from cassava roots are discussed and reported. Conclusions and recommendations are as follows: (1) The demand for cassava starch will probably grow significantly after the end of World War II; (2) a cooperative or cassava institution should be formed to support cassava research; (3) to control starch quality, the marketing and industrialization of cassava starch should be federally supervised; (4) official standards and commercial requirements for cassava starch should be adopted; (5) because of a significant quality decrease, it is not advisable to produce starch using cassava chips as the raw material; and (6) 11 new starch factories should be created in the states of Bahia, São Paulo, Rio de Janeiro, Santa Catarina, Rio Grande do Sul, Minas and Pernambuco. *(Summary by A.N.)* J00 D00 I02.

1820-3173 FERRAO, J. E. M. **Realidades agrícolas de Angola.** *(Agricultural facts from Angola).* Agros (Portugal) 47(6):469-473. 1964. Port., Sum. Port., Fr., Engl.

Cassava. Trade. Marketing. Production. Angola.

Data are given on area, population and main agricultural zones. Recent trends in the production of some important export products (coffee, sisal, maize and cassava) are analyzed. *(Author's summary)* J00

1821-2290 GROULT, P. B. **Le manioc.** *(Cassava).* Marchés Tropicaux de la Méditeranée 15(736):2873-2876. 1959. Fr., Illus.

Cassava. Production. Economics. Trade. Marketing. Consumption. Cassava chips. Cassava starch. Tapiocas. Europe. USA.

Brief notes are given on cassava production and export of its by-products. Consumption of cassava products (chips, starch, tapioca), market potentiality and policies are discussed, particularly in relation to the European Common Market and the United States. *(Summary by J.L.S.)* J00

1822-3656 HRISHI, N. **Problems and prospects in cassava production in India.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.59-62. Engl., Sum. Engl., Fr., 1 Ref.

Cassava. ***Manihot esculenta.*** **Production. Productivity. Cassava programs. Development. India.**

The problems concerning cassava cultivation in India and possibilities for increasing production in the future are discussed. The necessity of developing a processing technology is emphasized. *(Author's summary)* J00

1823-3654 MATHOT, P. J. **Production and export control in Thailand and the marketing in Europe of tapioca pellets.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.27-42. Engl., Sum. Engl., Fr.

Cassava. Pellets. Processing. Economics. Marketing. Trade. Legal aspects. Animal nutrition. Feeds and feeding. Thailand. Netherlands.

This is a review of the most important results and conclusions of an investigation into the production, export control, and marketing of dried and subsequently pressed cassava roots. The Government of Thailand wanted to find possible ways of improving the quality of cassava pellets, both technically and nutritionally. The International Technical Assistance Department of the Netherlands Ministry of Foreign Affairs assigned this investigation to Cchave n.v., Veghel (Holland), a large cattle feed factory. It was found that the quality and the cost price of the cassava pellets could be greatly improved by making alterations in the drying and pressing processes and by introducing some new techniques. Cutting the roots to strips will considerably shorten the drying time and will result in a dried product that can be pressed with much greater ease and less wear on the machinery. Also it will open the way to effectively using steam during pressing and predrying before pressing. The use of steam during pressing will increase the capacity even more and will mean a great improvement in pellet quality. Further investigations in this area with on-the-spot experiments and pilot production are recommended. However, it is not to be expected that all opportune measures will be taken if the marketing of the native pellets remains unchanged, especially because the minimum quality control will probably not achieve the desired effect. Therefore, a good solution would be for the 10 or so large exporters to follow the example of European shippers by supplying a product under their own name, so as to benefit directly from the price advantages of a better quality product. This method of marketing should be initiated by the Thai exporters, and it is recommended that they be advised by experts in this area. In regard to quality control, recommendations are given for improving the existing standards, as well as the control of the storage plant and the physical properties of the product. *(Author's summary)* J00 H03 I02

1824-0222 POLVILHO DE mandioca. *(Cassava flour).* Brasil Rural 142(217):54-56. 1960. Port.

Cassava. Cassava flour. Processed products. Marketing. Cassava products. Economics. Brazil.

The value of cassava flour exports from Brazil to the U.S.A. has increased to some US$ 2 million in recent years. Brazil thus ranks second after Thailand, which exports nearly 3 times as much cassava to the U. S. market. According to a survey made by the Brazilian Commercial Bureau in New York, the quality of Brazilian cassava flour is satisfactory. The buyers prefer it to be packed in 100-lb (45.4 kg) paper or cotton bags. The best types of cassava flour imported into the U.S.A. come from Thailand and Mexico. *(Summary by Tropical Abstracts)* J00

1825-1981 STRAUCH, D. **Tapioca, eine starkereiches Futtermittel.** *(Cassava, a feed rich in starch).* Ubersicht 12(8):359-361. 1960. Germ., Illus.

Cassava. Economics. Trade. Animal nutrition.

In 1960, Germany imported 295,000 tons of cassava, mainly from Thailand and Indonesia, but also some from Brazil, the Congo and Tanganyika. Cassava and tapioca and its composition and processing are described. The color of the flour, as related to postharvest deterioration, is considered of little importance. Because of its starch content, low crude fiber and good taste, it is an excellent feed for calves and swine. However, cassava flour should not exceed 25% of the dry feed quantity. Swine have to eat cassava flour dry. It can also be used in dairy cattle rations. *(Summary by A. van S.)* J00 H03

1826-3655 TULANANDA, D. **Problems of the Thai tapioca trade.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.51-57. Engl., Sum. Engl., Fr., Illus.

Cassava. Cassava products. Processed products. Wastes. Cassava meal. Cassava chips. Pellets. Cassava flour. Economics. Marketing. Trade. Statistical data. Prices. Thailand.

Most cassava consumed as animal feed in Europe comes from Thailand, which is the largest supplier of cassava on the world market. Yet, because of a lack of technological improvement of production capacity, a lack of government support and a lack of experience in foreign trade, the Thai cassava trade is not quite as successful as it should be. Recommendations are made for land reform, technological improvement, better irrigation and transportation systems and reorganization of local trade. It is also suggested that all pelletizing plants be set up with standard machinery and controlled by the authorities and that cassava roots be categorized according to their starch content before being processed. *(Author's summary)* J00

1827-0683 LESLIE, K. A. **The significance of root crops in the tropics.** *In* International Symposium on Tropical Root Crops, Ist, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2, pp. 1-17. Engl., Sum. Engl., 15 Refs.

Cassava. Yams. Taro. Sweet-potatoes. Potatoes. Cereals. Rice Wheat. Consumption. Production. Plant breeding. Maize. Cassava meal. Processed products. Composition. Economics. Marketing. Human nutrition. South America. Africa. Malaysia.

The significance of root crops in terms of food supply, resource allocation, national product and trade has been briefly presented. Against a background of widespread consumptiom of roots and tropical food deficiency, 3 problem areas are of particular interest: Root crops are deficient in important food elements; yields are low; in the abscence of proper processing and storage arrangements, periods of glut and scarcity alternate, depending upon the "in" and "out" season of the crop. None of these problems has an easy solution; they involve technical as well as economic, social and political issues. For instance, raising the nutritional level of roots—either by breeding new varieties or by enriching during processing — presents certain technical problems, but that is not all; there is also the likely problem of consumer acceptance. In addition, attempts at raising yields in some areas might involve land reform with its financial and political implications. What needs to be done seems clear; what is still vague is how it should or, indeed, may be done. *(Author's summary)* J00 H00.

1828-2275 **LES IMPORTATIONS françaises de produits tropicaux: 1er semestre 1964.** *(French importation of tropical products: first semester, 1964).* Marchés Tropicaux no. 978:1930-1932. 1964. Fr.

Cassava. Tapiocas. Marketing. Trade. Economics. France.

A total of 3,853 tons of tapioca were exported to France from Madagascar, Togo and Malaysia. A total of 6,912 tons of cassava roots were imported from Madagascar and Angola. *(Summary by H.J.S.)* J00

1829-2408 POPE, F. T. **World trade in cassava, tapioca, and other farinaceous substances.** Commerce Reports 50:678-680. 1929. Engl.

Cassava. Cassava products. Trade. Marketing. Gaplek meal. Tapiocas. Economics. Java. USA.

Definitions of some terms related to cassava products are given. Figures are given about United States cassava imports,exportations by Java, production of cassava flour in Brazil, uses of tapioca and cassava flour imported by the United States, and commerce of gaplek meal. *(Summary by H.J.S.)* J00

1830-3390 **CASSAVA STARCH as possible export.** Proceedings of the Agricultural Society of Trinidad and Tobago 33:248-250. 1953. Engl.

Cassava. Economics. Food products. Trade. Prices. Costs. Production. Cassava starch. Canada.

Canada imports approximately 6,000 tons of cassava products per year, mostly from Java. Cassava starch competes with potato starch; the demand for the former should increase in the near future. Costs, prices and other economical aspects are discussed, encouraging cassava growers in the British West Indies to enter into the international trade of cassava and its products. *(Summary by H.J.S.)* J00.

1831-3230 **CASSAVA AS a source of industrial starch and alcohol.** Bulletin of the Imperial Institute 17:571-576. 1919. Engl.

Cassava. Industrialization. Industrial starches. Uses. Cassava starch. Trade. Marketing. Fermented products. Cassava flour. Alcohol. Economics.

Notes are given on cassava imports and industrial uses of cassava in the U. K. Data given concerns trade in cassava products and other farinaceous materials (tables); cassava as a source of starch, flour, alcohol and by-products of these materials. *(Summary by H.J.S.)* J00 I01

1832-2011 VALENZUELA S., G. *et al.* **Sistemas de manejo, almacenamiento y transporte de productos alimenticios perecederos refrigerados para la exportación.** *(Handling, storage and transportation systems for exporting refrigerated perishable food products).* IIT Tecnología 14(78):26-38 (Cont.). 1972. Span.

Cassava. Production. Trade. Marketing. Economics. Colombia.

Studies were carried out by the Instituto de Investigaciones Tecnológicas, IIT (Colombia) to gather basic data that would lead to the promotion and establishment of freezing units for the export of perishable products. These products include vegetables, cassava, fruits, shellfish, fish, meat and flowers. Yield, market potentiality and export prospectives are reviewed, as well as the feasibility of establishing packing units in major producing areas. *(Summary by J.L.S.)* J00

1833-2037 BOXSER, D. **Cassava. A future export earner.** Kenya Farmer 157:11. 1969. Engl., Illus.

Cassava. Animal nutrition. Cattle. Swine. Poultry. Trade. Costs. Production. Harvesting. Processing. Kenya. Germany. Netherlands.

Discussions are presented on the marketing of cassava from Kenya in some European countries. This market is growing because the use of compound animal feeds in Europe is increasing. Nevertheless, price competition with grains used in animal feeding is still a problem. Problems concerning cassava cultivation and harvesting are also discussed. *(Summary by H.J.S.)* J00 H03

1834-0733 **FARINHA DE mandioca.** *(Cassava flour).* Boletim da Comissão de Planejamento Econômico 5(1):13-17. 1959. Port.

Cassava. Cassava flour. Processed products. Production. Economics. Trade. Distribution. Brazil.

In the state of Bahia (Brazil), cassava flour is produced in practically all municipalities, but mostly in Cacule, Barra da Estiva, Piritiba, Mundo Novo, which export part of their production to the state capital, to other states, etc. Production in Bahia surpasses consumption and amounted to some 380,000 tons in 1957. There are prospects for a slow increase in production. The transportation of cassava flour to domestic markets is dealt with in detail; tables are included. *(Summary by Tropical Abstracts)* J00

1835-2440 TARDIEU, L. **Le manioc. La fécule et le tapioca.** *(Cassava: starch and tapioca). In* —— Congrés des Produits Spécifiquement Coloniaux, Paris, 1931. pp. 1-13. Fr.

Cassava. Cultivation. Economics. Prices. Distribution. Cassava starch. Tapiocas. Trade. Marketing. Development. Cultivars. Productivity. Malagasy Republic.

Descriptions are given of the status of cassava in Madagascar. Data deal with cassava cultivation, the cassava industry and commerce, maritime transport, prices, the economic importance of tapioca and starch for France and the French colonies, and proposals for cassava cultivation development. *(Summary H.J.S.)* J00

1836-2015 BARROS, M. DE S. **Custos agricolas. I. Milho, arroz, amendoim e mandioca.** *(Agricultural costs. I. Maize, rice, groundnuts and cassava).* Agricultura em São Paulo 8(6):33-38. 1961. Port.

Cassava. Production. Costs. Economics. Maize. Rice. Groundnut. Brazil.

An analysis is made of production costs in terms of man-days and quantities per hectare for nonirrigated farms in the state of São Paulo (Brazil), using animal-drawn implements. *(Summary by Tropical Abstracts)* J00

1837-2255 EDWARDS, D. T. and CROPPER, J. **An economic view of the development of new production systems; with particular reference to root crops in the West Indies.** *In* International Symposium on Tropical Root Crops, 1st., St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2. pp.57-66. Engl., 14 Refs.

Cassava. Cultivation. Economics. Costs. Development. Productivity. Marketing. Trinidad and Tobago.

The author discusses the range of decisions and considerations involved in the development of new production systems. Examples of some means by which marketable yields and product prices may be increased are given, and conditions under which a new system of production can be applied are discussed. The aggregate effects of widespread introduction of a new system are analyzed from an economic point of view. The article emphasizes the importance of analyzing all the conditions under which a system of production would be operating before substantial resources are committed. *(Summary by L.A.)* J00

1838-2036 ACENA, B. and SALON, D. **An economic study of the cassava industry.** Plant Industry Digest 22(9-10):6-7,14. 1959. Engl., Illus.

Cassava. Industrialization. Cassava flour. Cassava starch. Development. Factories. Economics. Philippines.

The Philippine Government is stimulating the cassava flour and starch industry with apparently good results. Data are given on estimated costs of planting one hectare and of establishing a small cassava flour and starch processing plant, as well as general information on the cassava industry, including area planted and labor and investment inputs needed. *(Summary by H.J.S.)* J00 102

1839-0896 LEE, S. Y. **Thailand's tapioca.** Far Eastern Economic Review 41(4):233-235. 1963. Engl., Illus.

Cassava. Cassava flour. Trade. Cassava meal. Uses. Thailand.

Cassava flour is exported mainly to the United States (only in small quantities to Singapore, Malaya and Hong Kong) for food and for other industrial uses, while cassava meal is shipped to Germany, Belgium and the Netherlands for feeding cattle, pigs and other animals. From 1957-62, Thailand's cassava exports increased from 43,339 to 382,676 metric tons. Data are given on Thailand's monthly cassava meal and flour exports for the period 1957-63. *(Summary by J.L.S.)* J00

1840-2272 **LES IMPORTATIONS en France de produits tropicaux: 1er. trimestre 1965.** *(French importation of tropical products in the first trimester of 1965).* Marchés Tropicaux et Mediterranéens no. 1018:1160-1162. 1965. Fr.

Cassava. Trade. Marketing. Tapiocas. Tubers. Economics. France.

Figures on French importation of several crops are given. For cassava, figures concern tapioca from Madagascar and Togo and cassava tubers from Madagascar, Martinique, China and Angola. *(Summary by H.J.S.)* J00

1841-2058 SCHMIDT, H. D. **Erfahrungen in der Thailandischen Tapiocastärke- und Tapiocamehlindustrie.** *(The cassava starch and flour industry in Thailand).* Stärke 17(11):351-354. 1965. Germ., Sum. Germ., Engl., Fr., 3 Refs. Illus.

Cassava. Industrialization. Analysis. Cassava starch. Cassava meal. Marketing. Economics. Human nutrition. Industrial machinery. Processing. Thailand.

The importance of cassava in human nutrition is described. It was found that the starch content fluctuated according to season. Moreover, the standards of quality of the U.S. starch market are commented in detail. A survey is given about the industrial possibilities of cassava. *(Author's summary)* J00 102 H01

1842-1860 VENUGOPALAN, S., SINGH, J. and LAVANIA, G. S. **A study of marketing of tapioca in Trivandrum District (Kerala) India.** Journal of Scientific Research of the Banaras Hindu University. 11(2):335-341. 1960|61. Engl., Sum. Engl., 4 Refs.

Cassava. Cultivation. Productivity. Trade. Costs. Labour. Production. Income. Economics. Marketing. India.

Cassava yields are quite low in Trivandrum (Kerala). Better manuring and improved varieties will increase the yields by a minimum of 40%. The producer's share out of one rupee paid by the consumer can be increased from 66 nP to 80 nP through regulated markets, cheap transport and financial assistance to the growers. Cassava cultivation should be developed, and its supply needs to be regulated in this areas. *(Author's summary)* J00

1843-2012 CORREA DE M., B. C. **Comentário do mapa de densidade de produção da mandioca no sudeste do Planalto Central do Brasil.** *(Comments on the map of cassava production density in the southeastern area of the Brazilian Central Plateau).* Boletim Geográfico 10(109):433-439. 1952. Port., 26 Refs., Illus.

Cassava. Maps. History. Production. Plant geography. Spacing. Cultivation. Human nutrition. Distribution. Economics. Ecology. Brazil.

Cassava growing and its distribution in Brazil are described. Cassava is not important as a cash crop, but it is important for the population in the southeastern area of the Central Plains. *(Summary by Tropical Abstracts)* J00 D03

1844-3175 DIAS, C. A. DE C **Cultura da mandioca; diagnóstico da situação; medias corretivas.** *(Cassava cultivation: a diagnosis of present status; corrective regulations).* Campinas, Brasil, Coordinadoria de Assitencia Técnica Integral, 1970. 18p. Port., 8 Refs.

Cassava. Production. Economics. Industrialization. Cultivation. Marketing. Productivity. Prices. Trade. Brazil.

Notes about cassava are presented and discussed. Data refer to world productivity, economic aspects of Brazilian cassava production such as yields, prices, starch and other by-products, exportation and factors limiting its cultivation and commercialization. Corrective regulations refer to low productivity, industrial technology and market stability. *(Summary by H.J.S.)* J00 D00

1845-3382 WERNIMONT, K. **The world manioc (cassava) situation.** Ceylon Trade Journal 12(1): 22-24. 1947. Engl.

Cassava. Economics. Cassava products. Tapiocas. Trade. Uses. Industrialization. Brazil. USA.

The economic value of cassava as a source for starch (yields average about 25%), alcohol, adhesives, explosives, syrups, tapioca, meal, flours, etc. is discussed. The Dutch East Indies and other Asiatic countries, Brazil and Dominican Republic are the only countries exporting cassava products. In 1946, Brazilian growers enjoyed the greatest boom in demand and prices they had ever experienced. Cassava industrial products, mainly referring to Brazil, are discussed. *(Summary by H.J.S.)* J00

1846-2204 BRUEL, G. **Les cultures indigenes a développer en A. E. F.: le tabac et le manioc Batéké, l'huile de palme, les fermes-écoles à créer.** *(Local crops to be developed in French Equatorial Africa: tobacco and cassava from Bateke, oil-palm, agricultural schools to be created).* *In.* Congrés d'Agriculture Coloniale, Paris, 1918. v.4, pp.116-147. Fr.

Cassava. Cassava programs. Developmental research. Congo.

Cassava is a product used intensively by several tribes settled along the rivers. Suggestions are presented for programs to stimulate the improvement of cassava and other crops. Among these, the most significant is the establishment of agricultural schools which will teach new techniques to local habitants, select new and better varieties, and gather basic-data on diseases, climates and soils, thus encouraging the development of agriculture. *(Summary by H.J.S.)* J00

1847-3404 NESTEL, B. **Current utilization and future potential for cassava.** *In* Chronic Cassava Toxicity; proceedings of an interdisciplinary workshop, London, 1973. Ottawa, Canada, International Development Research Centre, 1973, pp.11-26. Engl., Sum. Engl., Fr., 14 Refs., Illus.

Cassava. Production. Human nutrition. Animal nutrition. Industrial Starches. HCN. Uses. Food products. Trade. Marketing. Research. Economics. Toxicity.

Current annual world production of cassava totals over 90 million tons, most of which is consumed by people living under close to subsistence conditions in tropical areas. There is also a long-standing trade in cassava starch, which has viscosity and tensile characteristics of particular value for certain processes in the textile, paper and food industries. In the last decade, a growing trade has developed from the use of dried cassava chips or pellets as an animal feed component. This trade is principally between Indonesia and Thailand, on the one hand, and Belgium, Holland, and West Germany on the other, and is worth about U.S.$70 million a year to the exporting countries. Under current systems of husbandry, the production costs of cassava are such that it appears to be highly competitive in cost terms with other types of energy foods grown in the lowland tropics. Because of the limited alternatives in many cassava-producing areas, the facility of growing the crop and the demographic trends, it is expected that food use will grow at 2.5-3% yearly and that by the end of this century, the number of people deriving a major calorie intake from cassava (currently between 200 and 300 million) will have doubled. Because of the complexity and competitiveness of the international starch market, growth prospects in this sector are difficult to predict; however, in the animal feed sector the growth potential appears very promising. The expanded EEC is projected to absorb three times its current level of 1.5 million tons of cassava (equivalent to 5 million tons of fresh roots) by 1980, provided tariff changes and production costs do not change significantly. In the cassava-producing countries themselves, both feed grains and animal proteins are generally in short supply and there appear to be very good prospects for developing cassava-based compound livestock feeds. These prospects are heightened by the recent initiation of a well-financed, major international research effort to study cassava from the standpoint of increasing its yield, improving its quality and lowering production costs. Bearing in mind the fact that chronic toxicity in humans and animals on high cassava diets is already a well-recognized problem, it would appear that unless effective steps can be taken to reduce this toxicity, it could become a problem of increasing significance from the standpoint of both nutrition and retarded domestic and export earnings in producing countries. *(Author's summary)* J00 H00.

1848-0151 L'AVVENIRE DELLA **manioca nella Comunità Europea.** *(The prospects of cassava in the European Common Market).* Agri Forum 10(2):57-58. 1969. Ital., Illus.

Cassava. Trade. Marketing. Economics. Germany. Netherlands. Belgium.

The actual status and future prospects of the import of cassava to western Europe and its use in compound animal feeds are analyzed. The situation of West Germany is compared to those of the Netherlands and Belgium. The cassava imports of these 3 countries doubled to 800,000 tons from 1962-1967. Factors largely responsible for this are (1) the increased numbers of cattle, pigs and poultry and the resulting demand for more animal products and (2) the rapid development of an animal feed industry and an increased use of coumpound feeds in which cereals are partly substituted by cassava, which is cheaper. The imports are expected to rise to a level of up to 1 million tons| year, as cassava may be used in a still larger proportion in feeds and prices will probably remain competitive. *(Summary by Tropical Abstracts)* J00

1849-0678 ALEXANDER, M. N. **Some factors affecting the demand for starchy roots and tubers in Trinidad.** *In* International Symposium on Tropical Root Crops, 1st, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969 v. 2 pp. 45-56. Engl., 5 Refs.

Cassava. Yams. Sweet-potatoes. Consumption. Economics. Tubers. Human nutrition. Prices. Starch crops. Trinidad and Tobago.

A concerted effort to increase root crop production is being made in Trinidad. The author feels that economic planners have not placed sufficient emphasis on the fact that income and satisfactory prices for root crop farmers depend to a great extent on the nature and level of the demand for these crops. Little reliable information is available on the subject. Tastes and preferences may have as important an influence on the demand for starchy roots as prices and incomes. A consumer preference survey conducted in 1967 indicated the following preferences in descending order: Irish potatoes, sweet potatoes, dasheen, cassava, yams and cush-cush. Demand for starchy roots may also be indirectly affected by limited methods of preparation; methods of marketing and merchandizing; uncertainty about product quality; and highwastage in preparation. There is a low level of demand for starch roots in rural areas where plantains, bananas or rice are consumed because they are more economical. To increase demand, it is very important to have an improved product. Increases in edible yield will result in more favorable price relationships; uniformity in size and shape of tubers will facilitate packing and merchandizing, an improved appearance and a greater degree of reliability in product quality. New and improved ways of using starchy roots must also be developed; at present they are being promoted and marketed as snack foods. New uses must include the potentials of starchy roots as raw materials in livestock feedstuffs. *(Summary by T.M.)* J00 H00

1850-2035 TROPICAL PRODUCTS INSTITUTE. **The market for cassava with particular reference to the United Kingdom.** *In* ______. Report no. 6. 1962. 32 p. Engl., Sum. Engl.

Cassava. Marketing. Food products. Consumption. Cassava flour. Trade. Uses. Economics. Industrialization. Cassava starch. Prices. Tapioca pearls. Tapiocas. United Kindgom.

Cassava is grown in most tropical areas, but the major sources of cassava for export are Thailand, Brazil, Indonesia, Taiwan, Hong Kong, Malaya, Madagascar and Togoland. It is exported in its unprocessed form (whole or sliced, dried roots) and in its processed form (cassava starch and grocery tapioca). Cassava is used for industrial purposes, such as the manufacture of adhesives and also as an animal feedstuff. Cassava starch is used for a variety of industrial purposes and also in foodstuffs; grocery tapioca is used solely as a foodstuff. The principal markets for cassava and tapioca are the United States and Europe. The United States is the largest single market for tapioca starch, importing about 100,000 tons|year, the bulk of which originates from Thailand. West Germany, Belgium, France and the Netherlands are all substantial markets for cassava. The United Kingdom is a comparatively small market. Annual average imports of cassava amount to about 1,000-2,000 tons; of tapioca starch, about 2,000 tons; and of grocery tapioca, 5,000-6,000 tons. Cassava starch accounts for only 1-2% of the total starch consumption in the United Kingdom. It has to compete with other starches, principally maize, potato and sago. The main factors limiting the expansion of the cassava starch market are its price and quality. Postwar shipments are not first quality, often containing dirt, grit and other extraneous matter; whereas shipments of potato starch are extremely reliable in their uniformity and cleanliness. Prices for the former are not competitive either. As a result of the development of starch chemistry in the United Kingdom, potato starch is largely preferred to any but a good-quality cassava starch for those purposes where cassava was used prior to World War II. There is little prospect of any significant increase in imports unless regular shipments of a first-class grade of cassava starch are available at a much cheaper price (at least £10| ton). *(Author's summary)* J00

1851-0653 COLOMBIA. MINISTERIO DE AGRICULTURA. **Plan inmediato para aumentar la producción y productividad de la yuca 1967-70.** *(Inmediate plan to increase cassava production and productivity 1967-70).* Bogotá, 1966. 8p. Span., Illus.

Cassava. Productivity. Production. Economics. Cassava programs. Development. Colombia.

The establishing of demonstrative cultivation plots and giving technical assistance and credit are proposed to increase cassava production and productivity in Colombia. Data given concern regions to be developed, capital investments, personnel rrequirements, problems affecting cassava production, general solutions to solve these problems and the institutions involved in the implementation of the plan. *(Summary by H.J.S.)* J00

1852-2389 ETTORI, O. J. T. and PELLEGRINI, L. M. **Aspectos econômicos da produção de mandioca industrial em São Paulo.** *(Economic aspects of industrial cassava production in São Paulo).* Agricultura em São Paulo 12(11-12): 1-22. 1965. Port., Illus.

Cassava. Economics. Production. Productivity. Prices. Industrialization. Cultivation. Costs. Brazil.

Cassava production in the state of São Paulo (Brazil) has tripled since 1950; the area planted and production show fairly large annual fluctuations while yield has remained at an average level of about 17 tons|ha since

1954. The 1964 production was 2.56 million tons from 144,000 ha. Cassava contributes 2-3% of the total value of agricultural products and is the 5th or 6th most important food product of the state. The crop is cultivated throughout the state on a moderate scale for direct consumption and on a large scale for industrial processing. More attention should be paid to the selection of new varieties, but meanwhile yields could be considerably increased by better farming practices. An analysis is presented of labor requirements and production costs. *(Summary by Tropical Abstracts)* J00

1853-2192 BOOTH, R. H. and WHOLEY, D. W. **Report on a visit to the Instituto de Investigaciones Tecnológicas and the Programa de Desarrollo y Diversificación de Zonas cafeteras, Bogotá 16-18 January, 1973.** Cali, Centro Internacional de Agricultura Tropical, 1973. 6p. En;l

Cassava. Storage. Marketing. Cassava starch. Economics. Cassava programs. Colombia.

Root storage: IIT offers laboratory analysis on reducing sugars and starch and an organoleptic panel for consumer acceptance studies. The Cafeteros offer a large supply of roots for further storage work, three farm sites to place the silos, and maketing outlets (already operating) to study transportation and marketing of stored roots. Storage of planting material: IIT offered useful information on techniques, additives and alternative waxing materials. The Cafeteros offered complete cooperation in obtaining data and performing experimental work on the farms under their jurisdiction. *(Author's summary)* J00

1854-1655 MONTADO, A. **Importancia de la yuca en el mundo actual con especial referencia a Venezuela.** *(The importance of cassava in the world, with special reference to Venezuela).* Seminario Nacional sobre Yuca, Tacarigua, Venezuela, 1973. Revista de la Facultad de Agronomía. Alcance no. 22:17-40. 1973. Span., 15 Refs., Illus.

Cassava. Production. Productivity. Energy productivity. Composition. Costs. Venezuela.

Figures on world production of cassava in countries cultivating more than 20,000 ha are given, with special reference to Venezuela. Brazil, with 2,025,000 ha planted to cassava (20% of world total) and yields of 29,464,000 tons (30% of world total) ranks first. Indonesia, Nigeria and Zaire follow in order of importance. Venezuela plants only 39,000 ha, yielding an average of 8.1 tons| ha. *(Summary by L.C. Trans. by T.M.)* J00 D03

1855-1723 CATAMBAY, A. B. and YANGO, C. E. **Cost of harvesting cassava with animal drawn plow.** Philippine Agriculturist 23:662-665. 1935. Engl., Sum. Engl., 1 Ref., Illus.

Cassava. Harvesting. Costs. Economics. Agricultural equipment. Philippines.

A comparative cost study was made of harvesting cassava with a 2-animal team and a plow and with a tractor-drawn plow. The former method was somewhat cheaper and much cheaper than harvesting cassava manually. There was little breakage of the roots plowed up because of the depth of plowing (25 cm) and the type of plow used. Plowing up roots eliminates replowing for the next crop. The field from which the cassava roots were plowed up was more comfortable for the animals to walk on in the following field operation than the field where the cassava roots were hand dug, as this method left holes. *(Author's summary)* J00 D02

1856-1720 CATAMBAY, A. B. **Cost of harvesting cassava with a plow.** Philippine Agriculturists 21:277-280. 1932. Engl., Sum. Engl., Illus.

Cassava. Harvesting. Costs. Economics. Agricultural equipment. Mechanization. Philippines.

A comparative cost study was made of harvesting cassava manually and plowing the roots out with a tractor-drawn plow. The latter method was much cheaper and required less man-hours. There was no marked difference in loss through root breakage. Digging cassava made the field uneven which interfered with the next plowing whereas the field from which the roots were plowed out presented a clean and level surface because the weeds and trash were plowed under. Thus the field did not need to be replowed for the next crop. *(Author's summary)* J00 D02

1857-3268 **HONDURAS; PROYECTO para el fomento del cultivo de yuca.** *(Project for the promotion of cassava cultivation).* Tegucigalpa, Honduras. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Informe Técnico no. 5. 1972. 27p. Span., Illus.

Cassava. Developmental research. Development. Production. Trade. Marketing. Economics. Development costs. Research. ***Manihot esculenta.*** **Honduras.**

This project was prepared by the Project for the Development and Diversification of Agricultural Production, sponsored by the United Nations. Data are based on feasibility studies carried out by a team of technicians from the Ministry of Natural Resources (Honduras) and by FAO. Agronomic and marketing studies indicate that this project is feasible. The economic commission concluded that the execution of the original project is economically convenient for the country and is in agreement with the objectives for agricultural development. *(Author's summary)* J00

1858-2446 TARDIEU, L. **Le manioc. I. Production, exportation, propriétés.** *(Cassava. I. Production, exportation, properties).* Revue Internationale des Produits Coloniaux 4: 84-89. 1929. Fr.

Cassava. Human nutrition. Animal nutrition. Nutritive value. Economics. Production. Trade. Marketing. Composition. Malagasy Republic.

A brief description is given of cassava cultivation in Madagascar. Data refer to cultivation, production and nutritive value for both humans and animals. *(Summary by H.J.S.)* J00 H00

1859-0202 DUSSEL, L. **Produits malgaches; manioc.** *(Products of Madagascar, cassava).* Bulletin de Madagascar 12(193):465-480. 1962. Fr., Illus.

Cassava. Production. Trade. Economics. Cassava meal. Tapiocas. Consumption. Cassava products. Uses. Human nutrition. Cassava starch. Processed products. Malagasy Republic.

A brief description of the development of cassava growing in Madagascar is followed by a statement on distribution and uses in the cassava-growing provinces. Exports reached a high of 46,500 tons of dry cassava in 1924, after wich they declined to 8,900 tons in 1960. Exports of cassava meal and starch decreased in like proportion. It will therefore be necessary to find new outlets. Increasing imports of wheat meal indicate a rise in the nutritional level of the population, especially urban. *(Summary by Tropical Abstracts)* J00 I00

1860-0317 **MANIOC; ASIAN exports to European countries could reach 1.1 million tons by 1970.** Far East Trade and Development 24(4):238-239. 1969. Engl.

Cassava. Production. Trade. Marketing. Economics. Composition. Legal aspects. Animal nutrition.

The most important market for cassava is the European Economic Community; it has been estimated that in 1969-70, West Germany, the Netherlands and Belgium will import 690, 250 and 190 thousand tons, respectively, for the production of mixed feeds. Principal competitive commodities are barley and maize and probably sweet potatoes from China, depending on quality and price. A survey conducted by the International Trade Centre at Geneva suggests that cassava products for export should contain more than 70% starch and less than 5% raw fibre, 3% ash and 13% moisture. It was found that dried cassava roots are preferred to cassava meal. Although they are exported in the form of chips at present, the trend is toward pellets although more modern equipment, such as storage silos, is required. *(Summary by T.M.)* J00

1861-0628 TAVARES, M. **Exportações de mandioca; actualidade e perspectivas.** *(Cassava exportations; present status and perspectives). In* Reunião da Comissão Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1971. pp. 63-68. Port.

Cassava. Human nutrition. Cassava starch. Bakery products. Tapiocas. Cassava flour. Food products. Trade. Marketing. Economics. Brazil.

Present perspectives for cassava export in Brazil are based on cassava products such as pellets and starch used as feedstuffs and raw industrial material. Potential markets for starch are Japan and the United States; for chips, the European Economic Community (EEC), especially West Germany, Belgium and the Netherlands. Characteristics of products for export are given. Flour for human consumption is generally exported in small quantities to Uruguay, Portugal, Canada and the United States. Tapioca is classified in 2 groups: granules and pearls. Chip flour, which is a product resulting from milling and screening, is used in Brazil; when mixed with wheat flour for baking purposes, it is exported to Canada and the United States. *(Summary by J.L.S.)* J00.

1862-0778 ARNOULD, J. P. **Le marché allemand du manioc.** *(The German market for cassava).* Agronomie Tropicale 25(6-7):606-612. 1970. Fr.

Cassava. Trade. Marketing. Economics. Feeds and feeding. Animal nutrition. Cassava meal. Processed products. Cattle. Swine. Poultry. Feed constituents. Roots. Legal aspects. Composition. Germany.

World production of compound feedstuffs has shown a significant increase. In Germany these feedstuffs represent 50-60% of total animal consumption. Cassava ranks fifth among certain cereals and their by-products, oil, meals, etc. The utilization of cassava has doubled in the years 1960-1968. Rate of utilization of cassava in animal feeding is as follows: 10-40% for swine; 20-25% for cattle and 10-20% for poultry. Germany imported 317,000 tons in 1960 (7% roots and 93% flour) and 480,000 tons in 1968 (79% roots and 21% flour). The cassava market may be developed easily if cassava prices are competitive with those of cereals. The main suppliers of the German market are Africa (Angola, Malawi, Tanzania) and Thailand. Brazilian cassava is preferred for its high starch content. *(Summary by J.L.S.)* J00 H03

1863-0829 TONDEUR, R. **Le marché de la fécule de manioc et du tapioca aux Etats-Unis.** *(The market for cassava flour and tapioca in the U. S. A.)* Bulletin Agricole du Congo Belge 49 (1-3):225-226. 1958. Fr., Illus.

Cassava. Cassava flour. Tapiocas. Trade. Marketing. Economics. USA.

In 1956 the total imports of cassava flour and tapioca in the U.S.A. amounted to 69,015 tons, as compared with 59,140 tons in 1955. The most important suppliers in 1956 were Brazil (28.500 tons) and Thailand (36,003 tons). Since 1954, imports from Indonesia have decreased and those from Thailand increased. Consumption in the U. S. A. corresponds approximately to imports. Cassava flour is imported for industrial purposes; e.g.,in the paper industry, for sizing textiles, dextrin (for stamps), adhesives, and also in the wood and furniture industries. "Minute" tapioca is manufactured in a large plant in Massachusetts. Details are given regarding consumption, quality and prices, customs duties payable on tapioca and cassava flour from the French overseas territories, etc.*(Summary by Tropical Abstracts)* J00.

1864-2117 BAILLAUD, M. E. **Le prix de revient du manioc et du tapioca.** *(Net costs of dry cassava and tapioca).* Journal d'Agriculture Tropicale no. 120:169-172. 1911. Fr.

Cassava. Production. Income. Productivity. Cassava programs. Development. Factories. Prices. Costs. Economics. Cassava products.

Data are given on production costs of fresh and dried cassava tubers and tapioca on the island of Reunion and in Madagascar. *(Summary by H.J.S.)* J00

1865-3209 LES EXPORTATIONS **de farine de manioc du Brésil.** *(Brazilian exports of cassava flour).* Cahiers Coloniaux no. 379:200. 1926. Fr.

Cassava. Cassava flour. Trade. Marketing. Economics. Brazil.

Figures are given on Brazilian exports of cassava from 1913-25. The oldest clients are Argentina and Uruguay. After World War I, France, England and Portugal also became clients. *(Summary by H.J.S.)* J00

1866-4416 THOMAS, W. G. **Considerations for commercialization of cassava as the chief energy source in swine diets.** Urbana, Ill., University of Illinois, 1974. 23p. Engl., Sum., Engl., 22 Refs.

Cassava. Animal nutrition. Nutritive value. Dietary value. Composition. Analysis. Diets. Food energy. Swine. Production. Trade. Marketing. Domestic animals. Cassava chips. Dried tubers. Cassava programs. Development.

Commercial cassava production and livestock feeding could be unlimited growth industries in many nations. Although cassava is the 7th ranking staple crop in the world, little research has been done on developing the commodity economically. Although it has lower nutrient contents than cereal grains, it does yield well, particularly where poor soils and adverse climatic conditions limit cereal grain production. The European Economic Community has greatly increased imports of cassava for animal feedstuffs over the past two decades, and Western Germany leads the world in imports of dried cassava chips. European feed manufacturers believe cassava can be competitive with some cereals under certain conditions. Programs based on developing pilot-size, cooperative industries to produce and process cassava for animal feedstuffs are discussed. Cassava-producing countries with active swine industries would seem to be the best locations to develop and test the manufacture of these feedstuffs. Cassava supplies are sufficient in several countries to begin operations that would require only limited capital outlays. South Vietnam and Colombia are suggested as 2 countries where programs might be initiated. *(Summary by C.B.)* J00 H03

1867-2046 FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS. **The EEC tapioca market; possibilities and limits.** Rome, 1971? 50p. Engl., Sum. Engl.

Cassava. Cassava meal. Cassava chips. Pellets. Cassava starch. Trade. Distribution. Legal aspects. Animal nutrition. Poultry. Swine. Cattle. Prices. Consumption. Europe.

Cassava is a native crop and a staple food in many parts of Asia, Africa and South America; however, only a few countries have been able to develop production for export (Thailand, Indonesia, People's Republic of China, Brazil, Malawi, Tanzania and Angola). Export prospects for cassava starch are limited, owing to competition from maize starch. Cassava feedstuffs are easily digested by all animals and are recognized as a rich, nutritious and valuable energy component. Cassava has improved its competitive position as a feedstuff vis-a-vis feedgrains in the European Economic Community (EEC) with the introduction of the common agricultural policy. The demand is concentrated in Germany, the Netherlands and Belgium. With the rapid growth of the compound feed industry of these countries during the sixties, imports of cassava products rose from 0.3 million tons in 1960 to 0.7 in 1965 and 1.4 million tons in 1970. Although the future expansion of this industry is probably slowing down, the demand for cassava products is projected to rise to 1.8-2.2 million tons in 1975. Assuming that Great Britain's and Denmark's compound feed industries may show a similar trend after their entrance into the EEC, the demand for cassava products may increase further to about 2.4-2.8 million tons. Those countries exporting cassava at present are well aware of this growth potential and may therefore be expected to increase area planted to cassava and improve yields. Recommendations are given in detail to potential cassava exporters as regards prices, quality control, processing in chips or pellets (preferred today), freight, trading methods, regular supplies, etc. The import of cassava into the EEC is not restricted as to quantity or origin. Under pressure from farmers to ensure absorption of EEC cereals, the EEC Commission may be expected to take measures to improve the competitive position by placing higher levies on imported feedstuffs. Such measures could restrict imports considerably, but they will certainly not have a prohibitive effect. *(Summary by T.M.)* J00 H03

1868-3246 INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. **Root and tuber programme.** Ibadan, Nigeria, 1972. 9p. Engl.

Cassava. Human nutrition. Animal nutrition. Development. Cassava programs. Nigeria.

The IITA root crop improvement program, emphasizes the elimination or minimization of factors limiting production, trying to develop a plant type suitable for modern cultivation techniques. Quality-improvement work will focus on human rather than livestock consumption. *(Summary by H.J.S.)* J00

1869-1652 GUILLEN, R. D. and QUINTERO, F. **Costos de producción. Mercadeo del producto fresco y elaborado.** *(Production costs and marketing of fresh and processed cassava).* Seminario Nacional sobre Yuca, Tacarigua, Venezuela, 1973. Revista de la Facultad de Agronomía de la Universidad Central de Venezuela Alcance no. 22:75-86. 1973. Span., 3 Refs.

Cassava. Costs. Production. Marketing. Productivity. Cocoyams. Potatoes. Maize. Rice. Sorghums. Venezuela.

The economic problem arising out of the scarcity of grains and their substitution by cassava and other tropical tubers is analyzed, and tentative production costs are calculated for cereals and tubers. On the basis that 3 kg of fresh cassava produces 1kg of dried cassava with a 12% moisture content, cassava produced with even very elementary techniques (8 ton| ha) costs less (Bs 233.50| ton) than corn produced under the best conditions (2.0 ton| ha) at a cost of Bs 433| ha. The same conclusion is reached when comparing figures for cassava with those for rice and sorghum. Better industrialization is recommended, and middlemen should be avoided in the marketing of cassava. *(Summary by L.C. Trans. by T.M.)* J00

1870-0112 DIAZ, R.O., ANDERSEN, P.P. and ESTRADA, R. D. **Cost and use of inputs in cassava production in Colombia: A brief description.** Cali, Colombia. Centro Internacional de Agricultura Tropical. Series EE-no.5. 1974. 40p. Engl., Sum. Engl., Illus.

Cassava. Economics. Labour. Productions. Cultivation. Costs. Marketing. Prices. Income. Colombia.

This preliminary report gives a brief description of the cassava process in Colombia. Emphasis is placed on production practices, input use and costs. The results from this study provided guidelines for a more comprehensive analysis of factors limiting cassava production and productivity now in progress. Data for the analysis reported here were obtained from 300 farms in 17 "Departments" in Colombia. The level of technology in cassava production was found to be low. Use of fertilizers and insecticides was limited, and no herbicides were applied. None of the sample farmers applied irrigation. The use of credit and technical assistance for cassava production was limited.On the average, farmers using mechanical land preparation spent 88 man-days| ha while 110 man-days| ha were used where land was prepared manually. Weeding was the most labor-consuming activity followed by harvesting| packing, land preparation and planting. Average yield of cassava was estimated at 11 ton| ha, with considerable variation among farms. No definite relationship between price level and farm size is particularly marked on the North Coast, where farmers with less than 2 ha received about 60% of the price received by farmers with 10 ha or more. With respect to approximate magnitudes rather than exact figures. The reliability of the estimates will be tested on the basis of results from the more comprenhensive on-going study. Prices received by farmers vary considerably; the relationship between price level and farm size is particularly marked on the Noorth Coast, where farmers with less than 2| ha. received about 60% of the price received by farmers with 10| ha or more. With respect to economies of scale in cassava production in Colombia, it appears that price differentials are more important than cost and yield differentials. On the basis of this analysis, additional research is recommended on the following subjects: (1) factors explaining yield differences among farms and regions; (2) the role of intercropping; (3) the relationships between farm size and prices received by farmers. It is not the purpose of this study to suggest priorities in biological research related to cassava; however, results suggest that research be carried out (1) to estimate the relationship between level of weeds and cassava; (2) to identify inexpensive means of weed control in cassava; (3) to estimate the impact of alternative degrees of land preparation on cassava yields. *(Summary by T.M.)* J00

1871-0550 INTERNATIONAL TRADE CENTRE UNCTAD-GATT. **The markets for manioc as a raw material for the manufacture of compound animal feeding stuffs in the Federal Republic of Germany, the Netherlands, and Belgium.** Geneva, 1968. 94p. Engl., 25 Refs.

Cassava. Marketing. Animal nutrition. Feeds and feeding. Consumption. Swine. Production. Trade. Prices. Economics. Distribution. Legal aspects. Cassava products. West Germany.

In 1967 total imports of cassava into EEC countries reached 850,000 tons and may surpass 1.1 million tons in 1970. At present West Germany accounts for 70% of total imports, but this predominant position may be lost in future due to the adverse effects of the Common Agricultural Policy. However, import levels have been set at 6% since January, 1968, as a result of the Kennedy Round of tariff agreements. This, coupled with the announcement of higher grain prices for 1968-69, tends to favor an increase in the consumption of cassava products. The increase in the swine population in the Netherlands and Belgium, as well as the rapid increase of consumption per head of livestock in West Germany, also shows a promising market for cassava products as a fattening agent. Compound feedstuff industries in EEC countries are continuing to look for new ways to reduce costs and substitute raw materials. If cassava prices remain competitive and quality is maintained, there appears to be great scope for exporters of cassava products to Europe. *(Summary by World Agricultural Economics and Rural Sociology Abstracts)* J00 H03

1872-3652 PHILLIPS, T. P. **World market prospects for cassava and its products.** *In* Cassava Processing and Storage; proceedings of an interdisciplinary workshop, Pattaya, Thailand, 1974. Ottawa, Canada. International Development Research Centre, 1974. pp.13-19. Engl., Sum. Engl., Fr., 6 Refs.

Cassava. Cassava products. Cassava starch. Feeds and feeding. Economics. Marketing. Trade. Consumption. Prices. Animal nutrition. Human nutrition. Developmental research. Research.

There are many intangibles associated with the projection of future demand for cassava. By definition, these are unquantifiable; nevertheless, the overriding impression is that cassava and cassava products will be used in larger quantities in nonproducing countries. General livestock and industrial production trends suggest that there could be an increasing need for cassava products. Furthermore, the expected growth in demand in nonproducing countries suggests that cassava will also be used more in the industrial starch and animal feed industries of the producing countries. Both the industrial starch and animal feed markets require processed cassava; however, research in this area is very fragmented. *(Author's summary)* J00

1873-3244 **CASSAVE—PRODUCTIE of Formosa.** *(Cassava production in Formosa).* Bergcultures 12:1918. 1938. Dutch.

Cassava. Production. Economics. Costs. Prices. Trade. Marketing. Formosa. Japan.

In 1937, a total of 6,924 koh (1 koh = 0.96992 ha) planted to cassava yielded 22,241 kin (1 kin = 0.6 kg) per koh. Total production was 154,017,978 kin. In 1938 only 4,947 koh were planted to cassava because of the decreased industrial demand in Japan. *(Summary by A. van S.)* J00

1874-3219 **BRAZIL ENCOURAGES the production of manioc.** Foreign Crops and Markets 42(17):608-612. 1941. Engl.

Cassava. Production. Cassava starch. Cassava flour. Cassava meal. Processed products. Trade. Marketing. Economics. Brazil.

It is estimated that about 1/7 of the total agricultural area of Brazil is devoted to cassava but it is consumed locally and therefore has not been important as an export crop. There has been an increase in domestic production resulting from governmental decrees that required the mixing of cassava flour with wheat flour in order to lower imports of the latter. Figures are given on production of cassava roots and meal from 1936-38. Comments on the preparation and exportation of meal, flour and starch are presented. *(Summary by H.J.S.)* J00

1875-2091 INDIA. DIRECTORATE OF MARKETING AND INSPECTION. **Agricultural marketing in India.** Report on the marketing of tapioca in India. New Delhi, 1955. 72p. (Marketing Series no. 88). Engl., Illus.

Cassava. Marketing. Consumption. Trade. Costs. Labour. Prices. Factories. Processing. Cassava chips. Cassava flour. Cassava starch. Tapioca macaroni. Cassava tubers (vegetable). Leaf aspects. Packaging. Distribution. Storage. Cassava programs. Tapiocas. Production. India.

A comprehensive study of cassava marketing in India is presented. The main aspects dealt with are the following: (1) supply, demand and practices; (2) preparation for the market (harvesting, packing, processing, prices, grading and standardization); (3) assembling and storage; (4) transportation;(5) distribution; (6) finance and associations; (7) research in improvement of quality and introduction of better varieties. Recommendations concern gathering of statistical data, increasing tuber productivity (higher yields are around 15 tons| ha), eliminating poor-yielding varieties,standardization of weight units and product quality, development of cooperative societies and the establishment of regulated markets. *(Summary by H.J.S.)* J00

1876-2087 MARKET PROSPECTS **for Malaysian tapioca products in the Netherlands.** Kuala Lumpur, Malaysia, 1970. Engl.

Cassava. Cassava flour. Dried tubers. Cassava meal. Trade. Consumption. Legal aspects. Prices. Animal nutrition. Malaysia. Netherlands.

The principal markets for cassava products are Europe, particularly the EEC (European Common Market) countries and Japan. The increasing demand in the EEC is the result of higher food grain prices and the development of compound animal feed industries. In the Netherlands the consumption of cassava products has shown a phenomenal growth, from 1,211 tons (US$67,000) in 1962 to 236,638 tons (US$13.52 millions) in 1968. Most cassava imported to the Netherlands is in the form of chips and pellets, where cassava products are replacing barley and maize. Cassava is used mostly for growing-finishing and reproductive sows, it is also used to a certain extent for dairy cows and poultry. Some recommendations and standards for the manufactures and exporters are also included. *(Summary by J.L.S.)* J00

1877-2103 BOURDET. **Le manioc et ses debóuchés actuels.** *(Cassava and its present market sales).* Bulletin Economique de Madagascar. 8:225-231. 1908. Fr.

Cassava. Marketing. Processing. Legal aspects. Prices. Economics. Distribution. Malagasy Republic.

Tax dispositions for cassava products imported to France are discussed from the viewpoint of the French colonies. Potato growers in France will be favored by these measures.Cassava could become a competitor for potatoes, both crops being sources of carbohydrates for industrial use and animal feeding. The author urges that the situation be corrected. Processing of cassava products in the Andovoranto region (Madagascar) are briefly described. *(Summary by H.J.S.)* J00 102

1878-2375 MENDES, L. G. **Aspectos econômicos da mandioca na Bahia.** *(Economic aspects of cassava in Bahia).* Brasil. Instituto de Pesquisas Agropecuarias do Leste. Serie Pesquisa no. 2. 1972. 15p. Port., 10 Refs.

Cassava. Marketing. Economics. Prices. Production. Costs. Trade. Productivity. Brazil.

Cassava cultivation is done in a traditional way, thus yields are lower (17 tons| ha) than they could be if new technology were adopted. Tables are given on basic economic data concerning production, costs and profits in the state of Bahia. It compares these items to those of the rest of the country. Credit is given to cassava growers, but there is no minimum price established for the products. Since prices fluctuate during the year, losses seriously affect some growers. Data are given on the marketing of cassava products in Bahia and the rest of the country and between Brazil and other countries. *(Summary by H.J.S.)* J00

1879-2230 FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS. **Consumption of cereals and starchy roots; statistical supplement.** Roma, FAO—CCP. Grains-Rice Session Paper no. 3. 1974. 15p. Engl., 6 Refs.

Cassava. Consumption. Food energy. Prices. Cereals. Starch crops. Cassava flour.

Three tables are given dealing with (1) consumption estimates of cereals, starchy roots and tubers. Three-year averages are used to smooth out year-to-year statistical fluctuations resulting from the methods of calculation. Figures are mainly compiled from FAO Food Balance Sheets (18 countries), with some revisions in accordance with up-to-date data. Unofficial estimates have been made for the following: the United Arab Republic, Burma, Cuba, Dominican Republic, Guatemala, Hong Kong, Iran, Iraq, Indonesia, Korea Republic, Madagascar, Malaya-Singapore, Tanganyika, Thailand, Vietnam, former French West Africa. Figures are calculated from production, plus imports and minus exports, changes in stocks (where known), less estimated amounts used for feed, seed, industry, or wasted. Starchy roots and tubers are eaten in a variety of forms and are shown as actual weight of fresh roots. Calorie values and population figures are mainly national estimates; (2) retail prices of selected cereals and starchy roots; (3) expenditure on or consumption of starchy foods at different income levels according to household surveys. Data are given for the period 1950-62. *(Summary by H.J.C.)* J00

1880-2053 AFFRAN, D. K. **Cassava and its economic importance.** Ghana Farmer 12(4):172-178. 1968. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. History. Food products. Gari. Harvesting. Economics. Soil fertility. Climatic requirements. Tapiocas. Dried tubers. Processed products. Foofoo. Human nutrition. Food energy. Cultivation. Diseases and pathogens. Pests. Ghana. Africa.

Like most root crops such as sweet potatoes, yams and Irish potatoes, cassava is primarily a source of carbohydrates. It contains 34.2% carbohydrate and 1.2% proteins. Even though it contains very little fat and protein, it contains more calories than all other root crops. Cassava contains 147 cal| 100 g while yams contain 108 cal| 100 g. It is relatively rich in Ca and ascorbic acid (Vitamin C) and contains significant amounts of thiamin (Vitamin B), riboflavin (Vitamin B_2) and niacin. Both the nutritional value and the palatability of cassava compare very favorably to all the other root crops, especially potatoes. Virtually no part of the cassava plant is wasted; every part has a specific function to perform in satisfying human wants. The plant is therefore well counted upon as an economic crop. Marketing of cassava is the main problem for farmers since the crop does not store well, but with increasing demand and establishment of cassava processing factories in the country, the farmer would be assured of a good market for his crop. *(Author's summary)* J00.

1881-0413 HENNINGSEN, H. F. and BALINT, A. B. **Notas sobre las posibilidades de exportación de yuca seca en trozos y nódulos de yuca.** *(Notes on the possibilities of exporting dried cassava chips and slices).* Tegucigalpa, Honduras, Instituto Nacional Agrario, 1970. 11p. Span.

Cassava. Trade. Economics. Cassava chips. Dried tubers. Processed products. Development. Cultivars. Productivity. Production. Costs. Processing. Marketing. Honduras.

Possibilities of exporting dry cassava *(Manihot esculenta)* chips and slices from Honduras to Central Europe were studied. Preliminary market data on c.i.f., f.o.b., and producer prices are presented. A review of European Common Market policies on cassava importation is given, along with principal supplier countries. Common cultural practices are summarized. Per hectare production costs are compared for Honduras and Malaysia, as well as costs of processing fresh cassava roots in Honduras, Malaysia and Thailand. Estimates are made of investments necessary to reduce processing costs in Honduras. In conclusion, production of dry cassava chips in Honduras for exportation to Central Europe appears feasible if c.i.f. prices for European ports of US$75.00| metric ton can be obtained and if minimum yields of 25 metric tons of fresh roots per hectare can be achieved in the field. *(Summary by P.A.C.)* J00

1882-0496 WALKER, H. **The market for cassava.** Tropical Products Institute Report no. G21. 1966. 57p. Engl., Sum. Engl.

Cassava. Uses. Industrialization. Marketing. Production. Cassava starch. Cassava meal. Cassava chips. Economics. Industrial starches. Cassava flour. Trade.

Cassava is grown in most tropical areas, but the major export sources are Thailand, Brazil, Indonesia, Madagascar, Togo and Malaysia. It is exported either in the form of dried roots or after processing as starch and grocery tapioca. Cassava roots are used for industrial purposes (adhesives) and also as an animal feedstuff. Cassava starch is used for a variety of industrial purposes and also in foodstuffs; grocery tapioca is used solely as a foodstuff. The principal market for cassava roots is in Europe. Over 600,000 metric tons are imported annually, almost entirely for use as animal feedstuffs. The market in the German Federal Republic accounts for over 80% of the total market for cassava roots in Europe; this market has increased steadily during the last 10 years. The market for cassava roots in both the United States and the United Kingdom is normally very small. The United States is the largest single market for cassava starch, importing over 100,000 metric tons a year, the bulk of which originates in Thailand. Approximately 70% of these imports is consumed by the paper and paper box manufacturing industries. The markets for cassava starch in Europe and the United Kingdom are small. Cassava starch accounts for less than 1% of total starch consumption in the United Kingdom, where it competes with maize starch, potato starch and sago. All starches are, for most purposes, interchangeable; and the main factors preventing an extension of the cassava starch market in the United Kingdom are its price and quality. The latter has, during postwar years, been poor; and supplies have not been available at competitive prices. The development of starch chemistry in the United Kingdom has led to potato starch being preferred to anything but a first-class quality cassava starch for those purposes where cassava was used before World War II. However, during the last year, supplies of high-quality cassava starch have been available from China at very competitive prices. No predictions can yet be made on the course that future trading patterns with China may take. *(Author's summary)* J00

1883-3115 ORSHAN, J. **Desarrollo del cultivo de yuca y la producción de yuca seca para cebo animal en Honduras.** *(The development of cassava cultivation and the production of dried cassava for feeds in Honduras).* Tel Aviv, Israel General Trading Co., 1972. 102p. Span.

Cassava. Production. Cultivation. Land preparation. Planting. Cultivars. Productivity. Composition. Nutritive value. Protein content. Fat content. Ca. Iron. Vitamin A. Vitamin content. Thiamin. Riboflavin. Starch content. Composition. Economics. Fertilizers. N. P. K. Costs. Prices. Cassava products. Cassava chips. Pellets. Feeds and feeding. Animal nutrition. Cassava meal. Gari. Processed products. Leaves. Trade. Marketing. Industrialization. Development. Dried tubers. Honduras.

The development of cassava cultivation on a commercial scale to be used as a raw material in the industry of mixed feeds was included in a diversification program for agricultural development in Honduras. Topics in this feasibility study include the present status of cassava, conditions for its cultivation, and export potentiality of dried cassava for animal feed, the investment requirements, production costs for both fresh and dried roots, plan of operations. *(Summary by J.L.S.)* J00 H03 .

1884-0207 GALLO C., A., GUTIERREZ, N. and GARTNER, J. **Importancia económica del cultivo de la yuca.** *(The economic importance of cassava).* *In* Instituto Colombiano Agropecuario. Curso intensivo del cultivo de yuca. Palmira, Colombia, Centro Nacional de Investigaciones Agropecuarias, 1972. pp.30-39. Span.

Cassava. *Manihot esculenta.* **Economics. Marketing. Prices. Production. Costs. Productivity. Consumption. Colombia.**

Analysis of certain variables shows the future prospects of growing cassava, not only in the Departamentos de Cauca and Valle del Cauca but also at a national level. Variables studied were: regional and national production, price trends, consumption and rentability of the crop. Figures are givenof the areaplantedto cassava and yields for the years 1966-1971. *(Summary by J.L.S.)* J00

1885-2394 BRASIL. DIVISAO DE INFORMAÇAO DE MERCADO AGRICOLA. **Preços medios em Cruzeiro no mercado atacadista.** *(Average prices in Cruzeiros on the wholesale market). In*______. Boletim mensal 1972. pp.15-16. Port.

Cassava. Cassava flour. Prices. Brazil.

A table is given for cassava meal. Data deal with types of meal, origin, average prices and variation of prices in Brazil in August and September, 1972. *(Summary by H.J.S.)* J00

1886-0529 DINA, J. A. and AKINRELE, I. A. **An economic feasibility study for the establishment of a glucose industry in Nigeria.** Nigeria. Federal Institute of Industrial Research. Technical Memorandum no. 25. 1970. 30p. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Industrial machinery. Costs. Consumption. Hydrolysis. Cassava starch. Glucose industry. Economics. Industrial starches. Marketing. Composition. Industrialization. Factories. Nigeria.

Detailed estimated costs of production are proposed for a factory to produce 3,000 tons of liquid glucose or 1,500 tons of crystalline glucose a year, using either cassava starch or corn starch as the raw material. It is concluded that only liquid glucose using cassava starch as the raw material can be profitably produced. For this, a capital investment of £ 118,000 is required to give a 16% return before taxation. High capital outlay and the high cost of corn starch are the two important factors that militate against profitability in the production of crystalline glucose. *(Author's summary)* J00 I02

1887-1757 PHILLIPS, T. P. **Cassava utilization and potential markets.** Ottawa, Canada, International Development Research Centre, 1971. 182p. Engl., Sum. Engl., Fr.,54 Refs., Illus.

Cassava. *Manihot esculenta.* **Economics. Marketing. Trade. Prices. Consumption. Cassava products. Uses. Animal nutrition. Human nutrition. Cassava programs. Development.**

On behalf of CIAT (Centro Internacional de Agricultura Tropical, Cali, Colombia) and with the funding of IDRC (International Development Research Centre, Ottawa, Canada),this study was undertaken (a) to assess the potential of the human, animal and industrial starch markets for cassava; (b) to relate these markets to producing countries in general, and Brazil and Thailand in particular; (c) to derive from the analyses economically based priorities for the cassava research program being mounted by CIAT. The methodology of the report is to apply those techniques of analysis, be they descriptive or quantitative, which appear to be best suited to the problem at hand and to the data available. Quantitative results are, whenever possible, validated by the best information available. If the results are shown to be untenable, adjustments are made to the data and|or techniques in order to produce an analysis which approximates a priori expectations. Where quantitative results are considered to be fallacious, they are dropped. The report is divided into 3 parts: (a) the analyses of the 3 distinct markets for cassava which are reconciled with supply of cassava, (b) brief case studies of the position of cassava in the Brazilian, Thai and Indian economies, and (c) a catalogue of some areas requiring research. Chapter 2 treats the analysis of the human food market and the global supply of cassava. Chapter 3 considers the industrial starch market for cassava, primarily the United States, Canada and Japan. Chapter 4 presents the analysis of the European animal feed market. Attempts are made to assess the demand effects of cassava price and quality changes, as well as high protein feed price changes. Chapter 5 contains a summary of the supply and demand projections of Chapters 2-4 and an interpretation of these projections. Chapters 6, 7 and 8 present country-specific studies of the role of cassava in the economies of Brazil, Thailand and India. Chapter 9 presents research recommendations that resulted from this study. The qualified findings of the study are that the demand for cassava will grow in the 1970's. The greatest relative increase is expected to occur in the EEC animal feed market, with the human food and industrial starch markets displaying slower rates of growth. The indications are that future supply will be sufficient to meet these demands. It was, however, not possible within the scope of the study to assess the potential demand for cassava in the nonhuman food markets of producing countries. These markets coupled with other potential new markets may imply that future supply will not be sufficient to meet all demands if new varieties, production practices and|or policies are not introduced. *(Author's summary)* J00

1888-2338 LE MARCHE de la fécule de manioc et du tapioca aux Etats-Unis. *(The market for cassava flour and tapioca in the United States).* Marchés Tropicaux du Monde 13(608):1668-1669. 1957. Fr.

Cassava. Cassava flour. Tapiocas. Trade. Economics. Consumption. Industrialization. Uses. Food products. Prices. Brazil. Thailand.

In 1956 total imports of cassava flour and tapioca in the U.S. amounted to 69,015 tons, as compared with 59,140 tons in 1955. The most important suppliers were Brazil (28,500 tons) and Thailand (36,000 tons). Since 1954 imports from Indonesia have decreased and those from Thailand increased. Cassava flour is imported for industrial purposes; e.g., in the paper industry, for sizing textiles, dextrin (for stamps), adhesives and also in the wood and furniture industries. Minute tapioca is manufactured in a large plant in Massachusetts. Details are given on consumption, quality and prices, customs duties payable on tapioca and cassava flour from the French overseas territories, etc. *(Summary by Tropical Abstracts)* J00

1889-2191 **INFORME SOBRE el mercadeo de la yuca en Bogotá.** *(Report on the market for cassava in Bogotá).* Bogotá, Colombia, 1972. 20p. Span. Illus.

Cassava. Marketing. Economics. Prices. Consumption. Colombia.

Information given deals with varieties, harvesting season, volume and price fluctuations, packing, wholesale merchants, production regions, factors influencing fluctuation of volume, and systems of buying and selling. *(Summary by H.J.S.)* J00

1890-0589 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Improvement of cassava, a tropical root crop.** Palmira, Colombia, 1971. 27p. Engl.

Cassava. Production. Productivity. Germplasm. Cultivars. Cassava programs. Development. Economics. Colombia.

This is an overview of the present status of cassava as regards production and yields, nutritional value and international research programs. A cassava research program to be developed by CIAT is presented. The program covers the following areas: varietal improvement, production systems, international testing, plant protection, research on utilization, agricultural engineering, agricultural economics, training and lit erature. A five-year budget (1972-76) is included. *(Summary by H.J.S.)* J00

1891-3374 **LA PRODUCTION agricole de Madagascar; Manioc.** *(Agricultural production in Madagascar; Cassava).* Revue Internationale des Produits Coloniaux 6:340-341. 1931. Fr.

Cassava. Economics. Trade. Dried tubers. Processed products. Productivity. Malagasy Republic.

Yearly figures are given on dried cassava tubers, starch, meal and tapioca exported from Madagascar between 1921 and 1930. Small producers dry the tubers, losing about 50-60% of weight. Material occupies 2.3 m^3| ton. Large producers transform the tubers into dried slices. Tuber yields range from 8-15 tons| ha depending upon the type of soil under cultivation. *(Summary by H.J.S.)* J00

1892-0498 COLOMBIA. MINISTERIO DE AGRICULTURA. OFICINA DE PLANEAMIENTO DEL SECTOR AGROPECUARIO. **Yuca.** *(Cassava). In* ________. Programas agrícolas 1972. Bogotá, 1972. pp.122-125. Span.

Cassava. Cassava programs. Development. Colombia.

A new program in Colombia dealing with production, storage, financing, transport and exportation of cassava is described. *(Summary by H.J.S.)* J00

1893-0587 COLOMBIA. MINISTERIO DE AGRICULTURA . OFICINA DE PLANEAMIENTO DEL SECTOR AGROPECUARIO. **Yuca.** *(Cassava). In*______.Programas agrícolas 1973. Bogotá, 1972. pp. 140-146. Span.

Cassava. Cassava programs. Economics. Production. Costs. Development. Colombia.

In 1972, 160,000 hectares in Colombia were cultivated with cassava, an increase of 15% over 1971. Production costs are subjected to levels of technology, as in the case of Cauca and Nariño, where traditional methods are still employed and costs are substantially less per hectare; whereas in other zones such as the Coast and Valle, costs are higher but yields double. Technical assistance is given by ICA. Reference is made to the possibility of exporting fresh cassava (waxed roots) to the U.S.A. Future prospects are reviewed. Agricultural economic policies undertaken by leading institutions for 1972-74 are outlined. *(Summary by J.L.S.)* J00

1894-0500 ANGLADETTE, A. **La situation et l'avenir de la production du manioc dans les territoires d'outre-mer de l'Union Francaise.** *(The present and future state of cassava production in the French overseas territories). In* Congress du Manioc et des Plantes Féculentes Tropicales, Marseille, 1949. Compte-rendu. Marseille, Institut Colonial, 1949. pp.63-68. Fr.

Cassava. Production. Trade. Marketing. Economics. Development.

Figures are given of the area planted to cassava, yield per hectare and annual totals for the years 1946-48. Production for the year 1948 was 3,000,000 tons of fresh tubers, of which 2,930,000 (94.4%) were consumed locally; 170,000 tons (5.6%) were transformed into different export products. General considerations on potentials for exporting different forms of cassava are presented, along with some agronomic recommendations. *(Summary by J.L.S.)* J00

1895-2014 HOLLEMAN, L. W. J. **Report to the Government of the Dominican Republic on a survey on cassava production and processing.** Rome, FAO, 1964. 25p. Engl., Sum. Engl.

Cassava. Production. Food products. Tapiocas. Processing. Costs. Uses. Marketing. Cultivars. Cassava chips. Processed products. Cassava starch. Industrialization. Cultivation. Trade. Economics. Human nutrition. Development. Dominican Republic.

As cassava forms an integral part of the diet of the Dominican people and is the cheapest source of carbohydrate available, an extension of the area planted to it should be encouraged; and yields should be increased by the use of improved agricultural methods. In promoting cassava, it should be made quite clear that as a food, cassava needs to be supplemented by other foodstuffs because of its low protein and vitamin content. Present selection work on cassava, as carried out in various Agrarian Reform Settlements, should be extended in view of the quality of the roots for human consumption and in view of their starch content. The method of preparing "casabe" should be improved, both with regard to efficiency and to hygienic requirements, and should eventually be organized on a cooperative basis. The manufacture of cassava chips should be introduced as a rural industry, with the purpose of creating a stock of basic material, both for the manufacture of cassava flour and for animal husbandry as a supplemental feed. A medium-sized cassava starch factory with modern equipment should be established, producing a starch of constant and high quality. Cassava starch produced domestically should be introduced as a substitute for other starches in the following industries: beer, bread, paper (including special papers; e.g., made by machine coating), manufacture of paper bags and textiles. An experiment station (or a division of such) should be created for the investigation of problems arising in connection with the aforementioned points. A laboratory should be established for the analysis of cassava and its products and for the investigation of the problems arising in connection with the industrial uses of cassava starch. A central Cassava and Starch Institute should be created to direct and coordinate all the work connected with the foregoing points, in addition to the study of other starches (like arrowroot). At the same time, it should supervise the general economic situation of the product and the marketing conditions prevailing in the country. *(Author's summary)* J00 D00 102

1896-0831 ARNOULD, J. P. **Note sur le marché du manioc dans la CEE, débouché potentiel pour les Etats Africains et Malgaches Associés.** *(Notes on the cassava market in the EEC: marketing potential for the associated African countries and Madagascar).* Agronomie Tropicale 24(10):959-969. 1969. Fr., 5 Refs., Illus.

Cassava. Prices. Production. Cassava products. Economics. Marketing. Trade. Distribution. Africa. Malagasy Republic.

The situation of world cassava production and trade, the marketing situation in the EEC countries, including market structure, distribution, quality requirements and price problems are described. The favorable prospects for associated African countries to market their cassava products in EEC countries, because of the rising demand by feed concentrate industries, are pointed out. Tables present statistics on world production, imports in EEC countries (1960-68) and exports by producing countries (1962-67) into EEC countries. *(Summary by Tropical Abstracts)* J00

1897-0544 LEITAO, A. B. **Um mercado para a mandioca; a Comunidade Económica Europeia.** *(A market for cassava; the European Economic Community).* Gazeta do Agricultor (Moçambique) 21(238):66-71. 1969. Port., 3 Refs.

Cassava. Marketing. Trade. Economics. Legal aspects. Composition. Netherlands. Germany. Mozambique.

The importing of cassava products into the European Economic Community is discussed with particular reference to the export possibilities for Mozambique. Data are presented on the use of cassava products in the EEC and the proportion which is used in concentrates for animal feedstuffs. Quality requirements imposed by various countries and marketing practices are discussed as well. *(Summary by Tropical Abstracts)* J00

1898-0821 ROGERS, D. J. **Manihot report.** n.i. 1968. 37p. Engl., 10 Refs.

Cassava. ***Manihot esculenta.*** **Taxonomy. Plant geography. Production. Nutritive value. Human nutrition. Plant breeding. Cassava programs. Developmental research. Economics.**

This report gives a broad picture of the problems related to improving cassava. The first part deals with the economic importance and nutritional value of cassava. The second part includes research work done in cassava and future needs. General aspects dealing with needed facilities to accomplish these efforts are also discussed. *(Author's summary)* J00

1899-0494 CALVO, A., A. *et al.* **Yuca.** *(Cassava).* *In* Caja de Crédito Agrario, Industrial y Minero. Manual de Costos. Bogotá, 1967. pp.102-105. Span., 6 Refs.

Cassava. Economics. Costs. Prices. Marketing. Development. Colombia.

In this study data are given on cassava production areas, costs of cultivation, market prices and funds devoted to credit in all the "departamentos" (political divisions) of Colombia between 1960 and 1966. *(Summary by H.J.S.)* J00

1900-0910 **THE USE of tapioca starch by cotton mills; views of Mills' Federation.** Indian Textile Journal 76(902):77-79. 1965. Engl.

Cassava. Industrial starches. Maize. Economics. Development. Textiles. Uses. India.

The general situation of maize and cassava production and consumption are discussed according to considerations made by Indian industry and Government. Data are given on price differences for maize and cassava starch and on quality of cassava starch. *(Summary by H.J.S.)* J00

1901-3196 DIAZ, R.O. **Brazil's travel report December 3-23, 1972.** Cali, Colombia, Centro Internacional de Agricultura Tropical. 1972. 72p. Engl., 74 Refs., Illus.

Cassava. Economics. Trade. Marketing. Costs. Prices. Production. Cassava flour. Cassava chips. Cassava starch. Tapiocas. Brazil.

This report compiles people and institutions involved in cassava production and processing in Brazil and lists bibliographical references of literature found in some libraries and documentation centers. Statistical data obtained from these publications are given on production costs, area planted, yields, exports, uses, labor inputs, current prices and future tendencies. *(Author's summary)* J00

1902-3323 **CULTIVO DE la yuca.** *(Cassava cultivation).* Colombia. Ministerio de Agricultura. Boletín de Información no. 105. 1961. pp.18-21. Span.

Cassava. Cassava programs. Colombia.

A program is described to increase the area planted to cassava in the Atlantic Coast region of Colombia and to develop several aspects concerning cassava cultivation and its uses. The program will be conducted by the Servicio Técnico Agrícola Colombiano Americano and the Colombian Ministry of Agriculture. *(Summary by H.J.S.)* J00

1903-0906 TANGANYIKA. MINISTRY OF COMMERCE AND INDUSTRY. **Manufacture of starch from cassava.** *In* U. S. Agency for International Development. 1961? pp. 1-2 Engl.

Cassava. Industrialization. Factories. Production. Cassava starch. Trade. Marketing. Economics.

The establishment of a cassava starch manufacturing industry in southern Tanganyika is considered. Data about domestic cassava production, as well as cassava flour exports and the best location for the factory, are given. *(Summary by H.J.S.)* J00 102

1904-4783 BUTLER, E.J., BROWN, E.E. and DAVIS, L.H. **An economic analysis of the production, consumption, and marketing of cassava (tapioca).** University of Georgia. College of Agricultural Experiment Stations. Research Bulletin no. 97: 1971. 54p. Engl., Sum. Engl., 151 Refs., Illus.

Cassava. Production. Consumption. Marketing. Trade. Productivity. Cassava products. Costs. Labour.

This study examines the relative position of cassava as a food and a feed crop in the tropical areas of the world. Cassava production has been increasing in Africa, Asia and Latin America, primarily because of expanded acreage planted and only secondarily because of increased yields per hectare. Total domestic consumption in producing countries, as well as exports to temperate climate countries, has risen. The 2 main importers are the U.S.A. and the EEC. On the average, yields were found to be especially low in Africa, but there is definitely a potential for intensifying production. As regards labor requirements for producing cassava and other starchy staples, cassava requires less labor on a weight and a per caloric basis. The most costly requirements are for weeding and harvesting. Herbicides tend to reduce the weeding requirements of hand labor substantially. Harvesting is still a problem because of decreased yields due to root damage from harvesting machines. Cassava not only produces more calories than maize (in Nigeria there was a difference of about 38.4 million calories on a per hectare basis) but also requires less labor to produce than either maize or rice. This cheap source of calories makes cassava an inexpensive livestock feed as well. Studies have shown weight gains with pigs to be as good or better than for maize-fed pigs, and the cost/kg gain was less. The EEC imports cassava almost exclusively for use in livestock rations; no harmful results are reported with cassava is used up to 40%. The price of cassava is such that it can compete with maize and barley, when are grown locally in the EEC countries. Supplies must be dependable or users will use a competitive crop. The leaves have a high protein content, and leaf meal is almost as nutritions as alfalfa leaf meal. The leaves are eaten as a vegetable in some countries. *(Author's summary)* J00

1905-0257 THE CASSAVA industry in Jamaica. Caribbean Agriculture 1(1):34-41. 1962. Engl., Sum. Fr., Span.

Cassava. Starch productivity. Productivity. Prices. Trade. Economics. Costs. Cultivars. Cassava starch. Jamaica.

The Jamaican Ministry of Agriculture has undertaken the classification of local cassava varieties, importation and trials of foreign material, analysis of starch content and selection based on maximum starch yield per acre. Tables give data on starch imports from 1954-60. In Jamaica, cassava is grown principally in regions with poor rainfall. Data are also included on area planted to cassava, total production figures and amounts sold and consumed by the producer in 1954 and 1958. *(Author's summary)* J00

1906-0814 MANDIOCA DOBROU em 20 anos. *(Cassava doubles in 20 years).* Gleba 15(166):42-44. 1969. Port., Illus.

Cassava. Production. Consumption. Industrialization. Uses. Cultivation. Economics.

Brazil is first in cassava production in the world, with 30% of the total world production. In 1966 Brazil produced 25,500,000 tons. Brief historical notes are given on the distribution of cassava from Brazil to other countries in America, Africa and Asia. Data about cultivation, uses, industrialization and consumption are presented as well. *(Summary by H.J.S.)* J00.

1907-0816 LIMA, H. G. DE. **Barometro da agricultura paulista.** *(The barometer of agriculture in São Paulo).* Gleba 15(176):13. 1969. Port., Illus.

Cassava. Development. Economics. Industrialization. Brazil.

Brief discussions are presented on problems in agricultural production, industry and commerce faced by the state of São Paulo from 1966-68. As regards cassava, the problems are utilization of low-fertility soils, non- or inadequate fertilization, lack of intercropping, wrong selection of cuttings, low prices and too many small industries using old techniques. *(Summary by H.J.S.)* J00.

1908-2074 UNIVERSIDAD CENTRAL DE VENEZUELA, MARACAY. FACULTAD DE AGRONOMIA. **Proyectos y tareas 1971.** *(Works and projects, 1971).* Maracay, Venezuela, 1971. v. 2. 65p. Span.

Cassava. Cassava programs. Developmental research. Venezuela.

This report describes several research programs and surveys that will be carried out by the Universidad Central de Venezuela (Maracay) on agronomic problems such as the behavior of different varieties in different regions of Venezuela, the correlation between TDM and the specific weight of cassava, a cassava germplasm bank, and soil surveys studying cassava planting and harvesting, cultural practices, pests and diseases and use of herbicides. *(Summary by S.S. de S.)* J00

1909-3460 CASSAVE-MEEL en ampas uit Surinam. *(Cassava flour and processed residues from Surinam).* Mededelingen van het Koloniaal Instituut te Amsterdam 26(8):179-181. 1929. Dutch.

Cassava. Cassava flour. Processed products. Wastes. Marketing. Prices. Economics. Surinam.

The small farmer in Surinam produces inexpensive, good-quality cassava flour and cassava residues that are processed for export to Curação. There are potential markets for these products in England and Holland, where the price compares very favorably to that being paid for Javanese products; however, the quantities available for export are too small. Export figures for cassava flour from Java for 1926-29 are given in a table. *(Summary by L. Y. Y.)* J00.

1910-0387 ROBERTS, J. **Verbouw en export van tapioca in Brazilie.** *(Cultivation and export of cassava in Brazil).* Gravenhage, Ministerie van Landbouw, Visserij en Voedselvoorziening, Directie van de Landbouw, 1955. 4p. Dutch.

Cassava. Production. Trade. Marketing. Economics. Cassava products. Brazil.

Aspects are given of production and export of cassava and other cassava products from Brazil. Export figures of cassava flour, starch and tapioca to other countries are tabulated, as well as a production forecast for 1954 per Brazilian state. Brazilian terminology for cassava products is also explained. *(Summary by Chemical Abstracts)* J00

1911-3189 NUSBAUM, S. J. **Development-oriented integrated cassava projects.** Tropical Root and Tuber Crops Newsletter no. 6:24-26. 1972. Engl.

Cassava. Animal nutrition. Human nutrition. Cassava programs. Development.

The need of organizing integrated cassava projects to satisfy modern necessities of cassava production and utilization is discussed. An outline of a comprehensive project is presented. The author is convinced that integrated projects will play a vital role in the solution of the agricultural, food and livestock problems of many developing countries. *(Summary by H.J.S.)* J00 H00

1912-2457 RAMASUBBAN, S. C. **Sago manufacture in India.** Indian Export Trade Journal 11(4):38-39. 1957. Engl.

Cassava. Tapioca pearls. Tapiocas. Production. Trade. Marketing. Consumption. Economics. India.

Cassava tubers,which form the principal raw material of the sago industry in India, are grown extensively in Kerala and certain districts of Madras State, including Salem, where the sago industry is concentrated. The production of 96 manufacturers was reported to be 18,086 tons in 1954-55; 22,045 tons in 1955-56; and 18,461 tons in the first 11 months of 1956-57.*(Summary by Tropical Abstracts)* J00

1913-0833 CORREA, H. **Cooperação internacional para pesquisas em mandioca.** *(International cooperation for cassava research).* Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuaria do Centro-Oeste, 1972.,11p. Port.

Cassava. Development. Productivity. Trade. Diseases and pathogens. Marketing. Pests. Germplasm. Cassava programs. Production. Composition. Fertilizers. Brazil.

The world status of cassava is discussed. Guidelines are given for international cooperation in cassava research. Topics reviewed are productivity, commerce, cassava as an energy source, factors limiting productivity, fertilization, diseases and pathogens, establishment of the international germplasm bank at CIAT, and the specialized documentation services offered by CIAT's Library to cassava research workers. *(Summary by J.L.S.)* J00

1914-3339 SCHARENGUIVEL, A. G. **An evaluation of the returns to investment of planting 20,000 acres of jungle land with tapioca.** Review of Agricultural Economics Malaysia 4(1):1-10. 1970. Engl., 1 Ref.

Cassava. Cultivation. Economics. Costs. Income. Labour. Prices. Production. Malaysia.

The size of the cassava plantation was taken at 20,000 acres, planted at the rate of 4,000 acres | year over 5 years. The cassava should be processed as pellets for the following reasons: the quality of the pellets is uniform and pellets absorb less moisture. Handling and loading charges are lower in the case of pellets. Storing of pellets is easier and saves 20%-25% in storage space. The salvage value of capital assets and estimated rates of return are included. *(Summary by T.M.)* J00 D00

1915-3180 JANLEKHA, K. and CHOTIKANONT, S. **Cassava.** *In* ______. Principal Agricultural Exports of Thailand, Laguna, Philippines, Southeast Asian Regional Center for Graduate Study and Research in Agriculture, 1971. pp:48-57. Engl.

Cassava. Trade. Marketing. Economics. Productivity. Consumption. Belgium. Thailand. USA. Japan. Germany. Netherlands.

Three tables are given: One shows planted areas, production and product values of cassava and their respective shares in all crops from 1950-68; the second shows production, export and amounts retained for domestic consumption of cassava for the same period; the third shows that the principal markets for cassava are the U.S.A., Japan, the Netherlands, West Germany and Belgium. *(Summary by H.J.S.)* J00

1916-2456 **MAUS PRECOS na raiz da crise.** *(Low prices,the cause of c crisis).* Coopercotia 26(238):21-24. 1969. Port., Illus.

Cassava. Cassava flour. Production. Prices. Economics. Cultivation. Income. Brazil.

The socioeconomic situation in various cassava-growing regions of the state of Santa Catharina (Brazil) is discussed. The prices of cassava roots and flour have not changed since 1957. Considering the total area planted to each crop,cassava ranks second; and the low income earned by this crop is reflected by a low standard of living in the cassava growing-regions. The cultivation practices, the processing industry, marketing, land ownership and social conditions are briefly discussed. *(Summary by Tropical Abstracts)* J00

See also *0007 0227 0232 0233 0239 0252 0253 0254 0273 0274 0299 0301 0348 0421 0485 0545 0568 0569 0898 1011 1012 1032 1087 1098 1250 1255 1263 1264 1414 1435 1496 1537 1539 1555 1557 1558 1561 1562 1567 1588 1589 1597 1600 1618 1620 1623 1630 1643 1659 1661 1677 1696 1703 1714 1721 1756 1768 J00*

K00 OTHER ASSOCIATED COMMODITIES

1917-0534 JANSSENS, P. **La culture du *Manihot glaziovii* dans l'Afrique Orientale.** *(The cultivation of Manihot glaziovii in East Africa).* n.p., n.d. Fr., Illus.

Manihot glaziovii. **Cultivation. Africa.**

Manihot glaziovii has been widely planted in East Africa since 1893. Data in this paper deal with soil and climatic requirements, cultivation, methods for extracting, drying and packing the rubber, manpower needed to manage the plantations and diseases and pests. *(Summary by H.J.S.)* K00

K01 Rotational Schemes and Intercropping

1918-2095 BASSETT, I.G. and THOMSON, K.W. **Land use and agrarian change on Aitutaki, Cook Islands.** South Pacific Bulletin 18(1):25-26. 1968. Engl., Sum. Engl., 5 Refs. Illus.

Cassava. Cultivation systems. Cultivation. Human nutrition. Dietary value. Developmental research. Shifting cultivation. Taro. Foresty. New Zealand.

Land use on Aitutaki is closely related to the island's social organization. Changes in the land-use system have therefore affected almost all aspects of island life. This is particularly apparent in the two changes that have gathered momentum since 1945: the introduction of commercialized agriculture and the emigration of much of the island's labor force. Because these changes occurred in association, considerable tensions have resulted within Aitutakian society and these, in turn, have had considerable influence upon the present land-use system. The most common food crop is arrowroot or cassava, which occupies 63% of the area planted to food crops. *(Author's summary)* K01

1919-1887 NWOSU, N. A. **Some indigenous cropping systems of Eastern Nigeria.** Umudike, Ibeku, Federal Agricultural Research and Training Station, 1973. 17p. Engl.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Cultivation systems. Developmental research. Rotational crops. Inter-cropping. Fallowing. Shifting cultivation.

The cropping systems in use by the peasant farmers in the Southeastern region of Nigeria have been briefly reviewed. A basic traditional rotational cropping system with a 2-year arable phase, followed by one or more years of natural bush fallow, is postulated. In this part of Nigeria, which lies in the rain forest zone, tuberous root crops dominate the cropping systems; all other crops, grains and vegetables occupy a secondary position. Because of a combination of several factors, the immutability of the traditional arable rotation has been challenged and numerous variants have been developed and are in use in the different agricultural zones of the region. *(Summary by D.H. and L.J.)* K01

1920-0706 PUSHPARAJAH, E. and YEOK, T. S. **Tapioca as an intercrop in rubber.** *In* Blencowe, E. K. and J. W. Blencowe, ed. Crop diversification in Malaysia, Incorporated Society of Planters, 1970. pp. 128-138. Engl., Sum. Engl., 4 Refs.

Cassava. Cultivation systems. Inter-cropping. Spacing. Productivity. Fertilizers. Cultivation. Rubber. Malaysia.

The effect of fertilizers on yield in 2 areas (one on Munchong and the other on Bungor series soil) are reported. The effect of plant age on the starch content of tubers is shown. After a brief consideration of the suitability of the top and bottom half of the stem as planting material, the costs of production and returns from a 10-acre unit are presented. Profitability based on sale as tubers and as chips are considered in detail. The chipping of tubers and drying of chips are also discussed. The effect of cassava planted at various distances from rubber, on growth of seedling rubber, field budding success and subsequent growth of these buddings is studied. Nutritional status of the rubber is also considered. Based on the above and on observations in other areas where cassava is grown as an intercrop, a suitable cultural system for intercropping rubber with tapioca is projected. *(Author's summary)* K01

1921-1585 GODFREY-SAM-AGGREY, W. **Effects of fertilizers on harvest time and yield of cowpeas (*Vigna unguiculata*) in Sierra Leone.** Experimental Agriculture 9(4):315-320. 1973. Engl., Sum. Engl., 9 Refs.

Cassava. Cultivation systems. Rotational crops. Cowpeas. Sierra Leone.

Effects of fertilizers on harvest time and yield of cowpeas were studied on upland soils in Sierra Leone. In a factorial trial on soil that had been cropped successively 2 years for Smooth Cayenne pineapples and for 14 months with cassava, the treatments did not affect harvest time significantly; but N, P and NPMg produced very favorable effects on grain yields. In a randomized complete block experiment on soil previously cropped with 2 successive cassava crops, there was a significant difference in total yield of dry pods between the control and most treatments. *(Author's summary)* K01

1922-0727 IGBOZURIKE, M. U. **Ecological balance in tropical agriculture.** Geographical Review 61(4):519-529. 1971. Engl., 17 Refs. Illus.

Cassava. Cultivation systems. Inter-cropping. Productivity. Ecology.

Present land use is demonstrably unsound. With a rapidly multiplying population and an agricultural system which from an ecological standpoint is not stable enough to accommodate the expanding population base, what is now a relatively mild nutritional problem will soon become a major disaster. Mixed cropping, a dominant agricultural system of the tropics, is the deliberate cultivation of more than one type of plant in one field at the same time. It has so many socioeconomic merits and, more importantly, such significant ecological implications that it is surprising researchers and development planners have hitherto considered it as an obstacle to progress. Implications and advantages of mixed cropping are discussed. *(Summary by J.L.S.)* K01

1923-3097 MAY, L. C. **Não plante mandioca em associacao com** *Pinus elliottii. (Do not plant cassava in association with Pinus elliottii).* Silvicultura 1(1):189-190. 1962. Port., 2 Refs.

Cassava. Diseases and pathogens. Mycoses. Inter-cropping. Forestry. Pests. Brazil.

Armillaria mellea causes root rotting in *Pinus elliottii* and in a great number of other tree species from both the broad leaf and the needle leaf group; tuber plants such as cassava could serve as excellent media for the development of the fungus. *Pinus elliottii* planted in combination with cassava, was seriously infested by the fungus in the state of Santa Catarina (Brazil). *(Summary by H.J.S.)* K01 E03

1924-0708 RAO, B. S. **Pest problems of intercropping in plantations.** *In* Blencowe, E. K. and Blencowe, J. W. eds. Crop Diversification in Malaysia. Kuala lumpur, Malaysia Incorporated Society of Planters, 1970; pp. 245-252. Engl., Sum. Engl., 7 Refs.

Cassava. Groundnut. Entomology. Maize. Pests. Inter-cropping. Cultivation systems. Injurious insects. Noxious animals. Malaysia.

New pest outbreaks have occurred in the intercropping of the two major plantation crops of Malaya (rubber and oil palm) with economic or food plants (largely annuals) and points to the need for new approaches to pest control. Some major pests of the commonly grown crops (maize, dry paddy rice, soybean, groundnut, castor-oil plant and cassava) that have shown promise. Much of the trouble has been from caterpillars; those that feed in concealment by boring, mining or within leaf folds are the most difficult to control. *(Author's summary)* K01 F00

1925-0466 WILLIAMS, L. **Forest and agricultural resources of Dahomey, West Africa.** Economic Botany 23(4):352-373. 1969. Engl., 39 Refs., Illus.

Cassava. Rotational crops. Cultivation systems. Dahomey.

A documented description is given of the present status of forest and agricultural resources in Dahomey. Most of the paper is devoted to crops other than cassava. A list is given of subsistence and commercial crops currently grown in the country. Cassava, maize and other roots and grains are recommended to be rotated with industrial crops such as cotton, peanuts and tobacco. *(Summary by H.J.S.)* K01

1926-2121 MATHIEU, E. **Tapioca cultivation; practicability of combining with Pará rubber.** Tropical Agriculturist 32:305-311. 1908. Engl.

Cassava. Cultivation. Rubber. Cultivation systems. Inter-cropping. Economics. Costs.

The possibility was studied of interplanting cassava with Pará rubber *(Hevea brasiliensis)*, which grows very slowly and gives no prompt return. Also included are some remarks on the starch extraction. Estimates of costs and returns on 1,000 acres of cassava interplanted with Pará rubber are given. *(Summary by J.L.S.)* K01

1927-3254 **L'ARACHIDE et le manioc au Sénégal.** *(Groundnut and cassava in Senegal).* Revue de Botanique Appliquée 8:170-173. 1928. Fr.

Cassava. Cultivation. Inter-cropping. Cultivation systems. Groundnut. Senegal.

Groundnut was for a long time the only crop grown in Senegal. Since yields were only 1.5 tons|ha, the population could scarcely survive. Therefore, the Government initiated a program that included the intercropping of groundnut and cassava. The objectives pursued were (1) to introduce an export product (cassava), (2) to triple groundnut production, (3) to improve crop quality (selecting seeds and rotating crops), and (4) to improve the natives' standard of living. *(Summary by S.S. de S.)* K01

1928-3274 UZOZIE, L. C. **Patterns of crops combination in the three eastern states of Nigeria.** Journal of Tropical Geography 33:62-72. 1971. Engl.,Sum. Engl., 13 Refs., Illus.

Cassava. Yams. Banana-plantains. Inter-cropping. Soil fertility. Ecology. Development. Nigeria.

In terms of acreage, yam, the indigenous staple, is losing ground to a number of exotic food crops, particularly cassava, cocoyam and plantain. In parts of the Calabar, Uyo, Ikot Ekpene and Annang districts, cassava, which does well on poorer soils, is practically the only crop grown there. Yam, however, still dominate the food-crop economy of the northern half of the region, where fertile alluvial soils continue to give good yields. *(Summary by Biological Abstracts)* K01

1929-2066 HARRIS, D. R. **The ecology of swidden cultivation in the upper Orinoco rain forest, Venezuela.** Geographical Review 61(4):475-495. 1971. Engl. 18 Refs., Illus.

Cassava. Shifting cultivation. Ecology. Soil requirements. Climatic requirements. Nutritional requirements. Venezuela.

In the Upper Orinoco rain forest, Amerindians practice a vegecultural form of shifting or swidden cultivation. Information was collected on the crops, secondary flora, and soils in minifundia and fallow plots and on tracts of mature secondary forest. Three types of swidden coexist in the area: polycultural minufundia, monocultural minifundia devoted to cassava or bananas and monocultural maize minifundia associated with non-Amerindian influence. Two early stages of forest regeneration in fallow plots are described; and the nutrient status of minifundia, fallow plots and forest soils is compared. It is concluded that vegecultural swidden may depend less on burning to provide nutrients than is commonly supposed and that the failure of the maize-dominated seed-crop complex to spread far into tropical lowland South America in prehistoric and historic times may be due largely to the superior ecological fitness of vegeculture. *(Summary by Biological Abstracts)* K01

1930-3669 SCHOONNEVELDT, J.C. VAN. **Cassave als tussengewas bij jonge hevea.** *(Cassava intercropped with rubber).* Bergcultures 17:6-8. 1948. Dutch., Sum. Engl., 2 Refs.

Cassava. *Manihot esculenta.* **Cultivation systems. Inter-cropping. Rubber. Field experiments. Cultivation. Java.**

A report is given of an experiment interplanting rubber (**Hevea**) with cassava (*Manihot esculenta* Crantz) as compared with other methods of soil management on the Kedeoeng Badak estate near Buitenzorg. The experiment was carried out in plots containing LCB 1320-buddings, planted as high stumped buddings; it covers 3 treatments in 5 replications. The treatments are (1) rubber without interplanting or soil cover (clean weeding), (2) rubber with cassava interplanting,(3) rubber with a soil cover of grasses initially, followed by **Calopogonium.** It was found that the cassava catch crop caused considerable retardation in the growth of the **Hevea.** In treatment 1, the rubber grew most rapidly; the development in the cover crop treatment 3 was intermediate, as compared to the others; treatment differences were significant. Serious losses occurred because of drought and white root fungus attack. Observations suggest that cassava as a catch crop promotes the spreading of white root fungus in this instance. The economic benefits of interplanting young rubber with cassava cannot be evaluated because it was impossible to collect data on the yield of the tubers. *(Author's summary)* K01

1931-*2209* **LA CULTURE combinée des arachides et du manioc au Sénégal.** *(The combined cultivation of groundnut and cassava in Senegal).* Revue de Botanique Appliquée et d'Agriculture Tropicale 8:583-*584. 1928. Fr.*

Cassava. Groundnut. Inter-cropping. Cultivation systems. Senegal.

Groundnut is cultivated on a small scale by local people in Senegal. Apparently, these people are not willing to improve groundnut cultivation practices or to extend the areas under cultivation. The large cassava plantations need manpower. The season for cassava cultivation is different from that of groundnut. Crop rotation of cassava and groundnut is proposed. *(Summary by H.J.S.)* K01

See also 0267 0277 0327 0339 0345 0357 0374 0399 0419 0455 472 0502 0505 0669 1803

K02 Descriptive and Comparative Studies

1932-0693 MENON, M. K. and RAMAN KUTTY, N. N. **Wild rubber as green-leaf manure.** Rice News Teller 10(2-3):43-44. 1962. Engl.

***Manihot glaziovii*. Uses. India.**

An experiment was conducted to evaluate the performance of wild rubber *(Manihot glaziovii)* leaves as compared to **Sesbania** leaves, as a green manure (6,000 lb|acre) to increase rice yields. The plant is propagated easily and is generally not grazed by cattle. Two cuttings (50 lb green leaves tree) can be taken yearly. Statistical analysis showed that both treatments were equally good. *(Summary by T.M.)* K02

1933-0664 SILVESTRE, P. **Research on root crops by IRAT in Africa and Madagascar.** *In* International Symposium on Tropical Root Crops, 1st., St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v.2., Sect. 3,pp. 84-87. Engl.

Cassava. Developmental research. Taro. Yams. Malagasy Republic. Senegal. Dahomey. Niger. Gabon. Starch crops.

This paper deals with plant breeding, plant pathology, plant diversification and cultural practices. Investigations are described by means of qualitative data. *(Summary by H.J.S.)* K02

1934-1896 CHANDRA, S., EVENSON, J. P. and DE BOER, A. J. **Root crop production in a Fijian village.** St. Lucia, Australia, University of Queensland, 1973. 10p. Engl., 7 Refs.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Yams. Sweet-potatoes. Production. Cultivation. Productivity. Costs. Labour. Economics. Rainfall data. Starch crops.

This paper summarizes a 1970-71 study of 9 farms in the Sigatoka Valley (Fiji). Analysis was made of land productivity, labor utilization, energy relations and the economic-energy efficiency link. A brief description of data collection procedures, the ecological setting and crop cultural practices is followed by an analysis of crop production in which root crops play a major part. The influence of root crops on labor utilization is stressed. Next, energy input-output ratios are derived and the analysis extended to economic factors influencing changes in the ratio. *(Summary by D.H. and L.J.)* K02

Z00 GENERAL

1935-1969 MONGE, F. **The cassava information center at CIAT.** Palmira, Colombia, Centro Internacional de Agricultura Tropical, 1973. Engl., 4 Refs., Illus.

Paper presented at International Symposium on Tropical Root Crops, 3rd, Ibadan, Nigeria, 1973.

Cassava. Manihot. Cassava programs. Development. Colombia.

The paper presents an analysis of the cassava literature produced in the world and describes a joint CIAT-IDRC project whereby this literature is collected, analyzed and processed for information retrieval. Cards (3" x 5") containing the bibliographic citation, descriptors and an abstract of each article are produced and distributed selectively, according to individual interest profiles. Specific topic searches are also provided. Xerox copies of articles can be purchased at cost from the CIAT library. A preliminary version of the bibliography in book form is also available and its final comprehensive version will be finished in 1975. The paper also presents additional bibliographic subprojects to be carried out at the Center. *(Summary by D.H. and L.J.)* Z00

1936-0673 DOKU, E. V. **Cassava in Ghana.** Accra, Ghana Universities Press, 1969. 44p. Engl., 42 Refs., Illus.

Cassava. Plant breeding. Uses. Taxonomy. Plant geography. Cultivars. Plant anatomy. Identification. Selection. *Manihot glaziovii. Manihot saxicola. Manihot melanobasis. Manihot dichotoma. Manihot esculenta.* **Hybridizing. Crossbreeding. Pests. Diseases and pathogens. Cassava mosaic virus. Mycoses.** *Fomes lignosus. Cercospora heningsii. Glomerella cingulata.* **Cultivation. Sweet cassava. Bitter cassava. Human nutrition. Viroses. Ghana.**

This monograph discusses the following aspects of cassava: origin and dissemination, classification, botany, life history, local varieties, breeding and selection, pests and diseases, cassava in Ghanaian agriculture, uses, and nutritional considerations. A total of 42 references are given, appendices give common names of 55 and 91 cv. collected in Ghana in 1930 and 1960, respectively; and there are 33 photographs and 4 line drawings. *(Field Crop Abstracts)* Z00

1937-0100 KAY, D. E. **Root crops.** London, Tropical Products Institute. Crop and Product Digest no. 2. 1973. 266p. Engl., 617 Refs.

Cassava. *Manihot esculenta.* **Cultivation. Pests. Diseases and pathogens. Injurious insects. Noxious animals. Uses. Processing. Production. Economics.**

This book has gathered basic data on root crops in order to assist in the selection of possible crops for cultivation in a given set of geographic and economic circumstances. The information includes nomenclature, cultivation conditions, planting procedures, pests and diseases, harvesting, yield, products and their uses, processing, and trends in world supply, demand and prices. Root crops covered are the African yam bean, anu, arracacha, arrowhead, cassava, chavar, Chinese water chestnut, chufa, East Indian arrowroot, elephant yam, false yam, giant taro, hausa potato, Jerusalem artichoke, kudzu, lotus root, maca, oca, potato, Queensland arrowroot, radish, shoti, swamp taro, sweet potato, tannia, taro, topee tambo, ullucu, yacon, yams (**Dioscorea** spp.) and yam bean. *(Summary by Food Science and Technology Abstracts)* Z00

1938-2011 NORMANHA, E. S. and PEREIRA, A. S. **Cultura da mandioca.** *(Cassava cultivation).* Campinas, Brasil. Instituto Agronómico. Boletím no. 124. 1964. 29p. Port.

Also in: Agronómico 15(9-10):9-35. 1963.

Cassava. Fertilizers. Cassava common mosaic virus. Pests. Cultivation. Injurious insects. Toxicity. Cultivation systems. Entomology. Diseases and pathogens. ***Xanthomonas manihotis. Erinnyis ello.*** **Viroses. Bacterioses. Noxious animals.**

The characteristics of 8 industrial and 6 edible and forage varieties are tabulated. On the basis of their resistance to certain diseases several varieties are recommended for cultivation in São Paulo. *(Summary by Field Crop Abstracts)* Z00.

1939-2116 ZIMMERMANN, A. **Einige Bemerkungen über; Maniok, Kassave (mhogo).** *(Some remarks on cassava).* Pflanzer 2(17):257-272. 1906. Germ.

Cassava. HCN. Tubers. Cultivation. Uses. Cooking. Diseases and pathogens. Pests. Injurious insects. Noxious animals. Disease control. Pest control. Entomology.

The author doubts that there is a taxonomic difference in species between sweet and bitter cassava. In sweet cassava, HCN is mostly found in the outer layers of the roots; in bitter varieties, it is found throughout the roots. HCN levels depend on growing conditions. A description is given of 4 locally grown varieties. Cassava is grown from the coast to the inland mountains and is drought tolerant. Cultivation methods are described. Some varieties mature in 6 months. The roots are consumed raw or cooked or eaten as flour after sun drying. Some flour-based recipes, as well as recipes for leaf consumption, are given. The disease *Septogloeum manihotis* (brown spots on leaves) is described, and a leaf miner is mentioned. A leaf curl disease is also described as being serious. *(Summary by A. van S.)* Z00

1940-2078 NORMANHA, E. S. and PEREIRA, A. S. **Alimenta mais do que parece.** *(It feeds more than it seems).* Guia Rural (Brazil) 1965-1966:187-189. 1965-1966. Port. Illus.

Cassava. Planting. Soil fertility. Climatic requirements. Cultivation. Diseases and pathogens. Disease control. Pest control. Pests.

Brief notes are given on cassava. Information refers to soils and climate, planting season, soil preparation, cultural practices, harvesting, diseases and their control. *(Summary by H.J.S.)* Z00

1941-0658 JENNINGS, D. L. **Cassava in East Africa.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd, Honolulu and Kapaa, Kauai, Hawaii, 1970. Tropical root and tuber crops tomorrow. Honolulu, University of Hawaii, 1970. v.l, pp.64-65. Engl., 25 Refs.

Cassava. Cultivation. Diseases and pathogens. Pests. Hybrids. Resistance. Plant breeding. Kenya.

Agronomical procedures, plant pathology, research carried out in East Africa and the nutritive value of cassava are briefly discussed. *(Summary by H.J.S.)* Z00

1942-2373 BLOCH, T. **La yuca y su bibliografía.** *(Cassava and its bibliography).* **Boletín para Bibliotecas** Agrícolas 9(3):161-166. 1972. Span., Sum Engl., 8 Refs., Illus.

Cassava. Development. Cassava programs.

Recently, interest has grown in the potential that cassava could have in meeting the growing demand upon the world food supply. The literature of cassava, essential for the scientific study of the plant, is widely dispersed and can be hard to obtain. A list of the principal bibliographies of cassava literature is presented, followed by libraries having important resources in this area. *(Author's summary)* Z00

1943-2124 INSTITUTE DE RECHERCHES AGRONOMIQUES TROPICALES ET DE CULTURES VIVRIERES. **Le manioc; fiche technique.** *(Cassava; tecnical data).* **Cahiers d'Agriculture Pratique des Pays Chauds 24(4):177-184. 1969. Fr., Illus.**

Cassava. Plant anatomy. Plant development. Soil requirements. Climatic requirements. Diseases and pathogens. Cultivation. Pests. Viroses. Bacterioses. Injurious insects.

Botanical, agronomical, edaphological and plant health characteristics of cassava are briefly described. *(Summary by H.J_S.)* Z00

1944-3378 SOEHARDJAN, M. **A simple method for rearing *Drosophila melanogaster* Mg.** Entomologische Berichten 29:40. 1969. Engl., 1 Ref.

Cassava. Laboratory experiments. Culture media. Fermented products. Entomology. Uses.

Three pieces (30 g each) of fermented cassava were enough for approximately 600 adult flies, reared in jars at a temperature which varied daily between 26°C-29°C. Pupation of the fly larvae took place on the surface of the fermented cassava without adding special equipment. Fresh fermented cassava or honey solution appeared to be a good food supply for the adults. The average duration of the life cycle of about 5,000 flies was 10 days. *(Summary by H.J.S.)* Z00

1945-0609 **LES TUBERCULES; le manioc.** *(The tuber crops; cassava).* Agronomie Tropicale 26(1):101-104. 1971. Fr., Illus.

Cassava. Clones. Productivity. Human nutrition. Maize. Inter-cropping. Cultivation systems. Hybrids. Selection. Togo. Ivory Coast. Malagasy Republic.

Brief descriptions are given of projects on cassava carried out in Togo, the Ivory Coast and Madagascar. Projects deal with clone crossing, yield tests, resistance of clones to virus and intercropping of cassava with corn. *(Summary by H.J.S.)* Z00

1946-2016 COURS, G. and FRITZ, J. **Le manioc.** *(Cassava).* Bulletin de Madagascar 11(178):203-224. 1961. Fr., Illus.

Cassava. Cultivars. Resistance. Pests. Diseases and pathogens. Cultivation. Climatic requirements. Soil fertility. Rotational crops. Inter-cropping. Cultivation systems. Fertilizers. Green manures. Manures. Productivity. Mycoses. Cassava mosaic virus. Cassava products. Legal aspects. Economics. Viroses. Malagasy Republic.

Cassava cultivation and the use of its roots in Madagascar are discussed. The following aspects are dealt with: a botanical description of the plant; a detailed review of the many varieties used on different soils and altitudes, with some data on their resistance against mosaic disease; the percentage of starch; crop rotation; the use of leguminous plants; fertilizers; instructions for planting; diseases and pests. Finally some data are given on the use of fresh and dried cassava roots. A list containing a description of the official standard grades for cassava flour and dried root chips is also included. *(Summary by Tropical Abstracts)* Z00

1947-2402 MODRIN, G. **Les produits Malagaches; le manioc.** *(Madagascar products; cassava).* Revue de Madagascar no. 4:9-31. 1933. Fr., Illus.

Cassava. Cultivation. Development. Industrialization. Trade. Economics. Prices. Plant breeding. Malagasy Republic.

Brief notes are given on planting seasons cultivation, harvesting, exports, cassava breeding, industrialization and aspects of agricultural development. *(Summary by H.J.S.)* Z00

1948-2129 POLLOCK, N. A. R. **Cassava - manioc or tapioca.** Queensland Agricultural Journal 23: 336-338. 1925. Engl., Illus.

Cassava. Cultivation. Cuttings. Economics. Animal nutrition. Uses.

Brief notes are given on cassava, cultivation, habitat, economic value, and use in animal feeds. *(Summary by H.J.S.)* Z00

1949-0293 RIOS R., M. **Anotaciones sobre yuca, ñame, batata.** *(Notes on cassava, yam, sweet potatoes).* Montería, Colombia, Centro Nacional de Investigaciones Agropecuarias, n.d. 8p. Span.

Cassava. Yams. Sweet-potatoes. History.

This article presents a general history of the sweet potato *(Ipomoea batatas)*, cassava (*Manihot esculenta* Crantz) and yams (Dioscorea spp.). *(Summary by P.A.C.)* Z00

1950-0478 CASSERES, E. **La yuca.** *(Cassava). In* ______. Producción de Hortalizas. 2 ed. Mexico, Herrero, 1971. pp. 259-267. Span., Illus.

Cassava. Taxonomy. HCN. Cultivation. Storage. Harvesting. Germplasm. Cultivars. Production.

The origin of cassava, its taxonomy, uses, HCN content, varieties, classification, clone collections, factors of production, diseases and pests, harvesting and storage are described briefly. *(Summary by H.J.S.)* Z00

1951-0617 VARGAS C., C. **Phytomorphic representations of the ancient Peruvians.** Economic Botany 16(2):106-115. 1962. Engl., Illus.

Cassava. Peru. History.

The Chimú artist preferred to use the form of cassava roots on vessels, sometimes single, sometimes in bunches. The Nasca artesans likewise produced excellent representations of the roots of that plant. A photograph is presented. The above text is the only reference to cassava in this paper, the rest is devoted to about 40 other plants. *(Summary by H.J.S.)* Z00

1952-2288 FRANCOIS, E. **Le manioc, sa production et son utilisation.** *(Cassava, its production and utilization).* Revue de Botanique Appliquée et d'Agriculture Tropicale 18(204-205):533-573. (Cont.). 1938. Fr.

Cassava. Cultivation. Uses. Human nutrition. Animal nutrition. HCN content. Composition. Productivity. Plant anatomy. Taxonomy. Fertilizers. Harvesting. France. Malagasy Republic.

This part deals mainly with Madagascar and the origin of its cassava, chemical composition, utilization in animal feeding, and in human nutrition, HCN content, morphology, taxonomy, varieties, cultivation, fertilization and manures, land preparation, harvesting and yields. *(Summary by H.J.S.)* Z00

1953-0751 CONGAZALEZ VALDES, A. **Cassava.** n.p., n.d. 25p. Engl., 19 Refs.

Cassava. Cultivation. Harvesting. Productivity. HCN. Toxicity. Uses. *Manihot esculenta.* Plant anatomy. Climatic requirements. Soil fertility. Stems. Leaves. Flowers. Ovaries. Tubers. Cultivars. Composition. Amino acids. Protein deficiencies. Cassava products. Food enrichment. Fermentation.

General information is given on cassava based on a literature review. Data presented deal with morphological varieties, climatic and edaphic requirements, cultivation, harvesting, yields, toxicity and uses. *(Summary by H.J.S.)* Z00

1954-2164 LES BIENS de consommation du Gabon; les tubercules: manioc surtout. *(Food products in Gabon; the tubers, especially cassava).* *In* Le marché Gabonais 1968. Marchés Tropicaux et Mediterranéens no. 1202:2869-2870. 1968. Fr.

Cassava. Starch crops. Cereals. Human nutrition.

Brief notes are given on cassava in relation to rice, taro, yams and sweet potatoes. Information deals with area cultivated, food consumption habits and food preparation. *(Summary by H.J.S.)* Z00

1955-0616 DUKE, J. A. **Ethnobotanical observations on the Chocó Indians.** Economic Botany 24:344-366. 1970. Engl., 18 Refs., Illus.

Cassava. Human nutrition. Consumption. Diets. Tubers. Composition. Panama.

The relationships between the ethnic groups and their environment in Darien (Panamá) were studied, and numerous botanical and bromatological specimens were collected. Anthropological investigations were also carried out. Consumption of individual items was calculated by a computer program. Although cassava has been reported as the most important root crop in the Pacific lowlands (found on 40% of the farms), analysis indicated that it contributed only about 2 g|day to the adult diet. Tables are presented on the chemical food composition of several crops including cassava. Most of the data refer to crops other than cassava. *(Summary by H.J.S.)* Z00

1956-2467 DOKU, E. V. **Root crops in Ghana.** Ghana Journal of Science 6(1-2):15-36. 1966. Engl., Sum. Engl., 45 Refs.

Cassava. Cultivation. Plant breeding. Hybrids. Selection. Clones. Productivity. Resistance. Mechanization. Planting. *Manihot esculenta.* **Ghana.**

The importance of the following root crops in Ghanaian agriculture and research is discussed: cassava *(Manihot utilissima)*, yams (**Dioscorea** spp.), cocoyams *(Colocasia antiquorum* and *Xanthosoma sagittifolium)*, sweet potatoes *(Ipomoea batatas)* and Irish potatoes *(Solanum tuberosum)*. With the exception of yams and cassava, on which considerable work has been done, the other tropical roots crops are not receiving the attention they deserve. On the other hand, during the war years, a great deal of agronomic research was done on the Irish potato with seed imported from Europe, primarily to augment wartime shortages of the imported crop and secondly, if successful, to replace tropical root crops because of the false idea still held by some that the Irish potato is superior nutritionally, especially in protein content. Though many people will not readily admit the unsuitability of *S. tuberosum* to our conditions, analyses of the results of experiments in Ghana and elsewhere demonstrate clearly that it cannot be a paying crop when grown in the tropical lowlands. The nutritional composition of the tropical foot crops are compared to *S. tuberosum* and it is concluded that the latter is not as superior as was believed, they are all primarily a source of carbohydrates and must be adequately balanced with proteins. Suggestions are given on how some of the tropical roots could be improved. An appeal is made to find suitable **Solanum** spp. that would serve as breeding material from which suitable varieties for tropical lowlands could be developed if so desired. *(Author's summary)* Z00.

1957-0442 EKANDEM, M. J. **Cassava in Nigeria. I. Eastern Nigeria.** Nigeria, Federal Department of Agricultural Research. Memorandum no. 42. 1962. 21p. Engl., 9 Refs.

Cassava. Planting. Harvesting. Food products. Gari. Cultivation. Cultivation systems. Soil fertility. Rotational crops. Cultivars. Identification. Yams. Maize. Vegetable crops. Timing. Pests. Diseases and pathogens. Mycoses. *Cercospora henningsii. Sclerotium rolfsii.* **Cassava mosaic virus. Viroses. Cassava products. Uses. Productivity. Nigeria.**

A description is given of the varieties, cultural practices and production of cassava in eastern Nigeria. *(Summary by Tropical Abstracts)* Z00

1958-0383 MOSCRIP, J. **Possibilities for cassava growing in Florida.** Florida. Department of Agriculture. Bulletin no. 104. 1940. 22p. Engl., Illus.

Cassava. Animal nutrition. Cassava flour. Cassava starch. Consumption. Processing. Cultivation. *Manihot esculenta.* **Cuttings. Uses. Swine. Cattle. USA.**

This bulletin is a general review on cassava (*Manihot utilissima* Pohl) and the possibilities for its cultivation in the state of Florida. Topics include consumption of tapioca starch in the United States; grading and packing; plant varieties; leaves, flowers, and roots; chemical analysis; composition of cassava root and cassava flour; culture; planting, cuttings used as seed; cultivation; and harvesting. Uses for cassava in tropical regions are presented. Also discussed is the feeding value of cassava and its use in feeding cattle (effect on milk, butter increase, methods of feeding and value in fattening cattle) and swine. *(Summary by P.A.C.)* Z00

1959-0794 BELIEN, J. L. **L'agriculture au Nord du Territoire de Lubutu en District du Maniema; reflexions sur son development.** *(Agriculture in the northern Lubutu Territory, District of Maniema).* Bulletin Agricole du Congo Belge 50(6):1457-1471. 1959. Fr., Sum. Fr., Illus.

Cassava. Groundnut. Rice. Cultivation. Human nutrition. Cattle. Economics. Secondary crops. Development. Climatic requirements. Cultivation systems. Zaire.

The author describes the geographical conditions of the region and gives the present status of local agricultural resources. Groundnut, bananas and cassava are permanent crops, but rice is becoming very important. A program has been developed to establish palms, coffee and cacao as permanent crops. Cattle have been introduced, but wild game is still the main protein source. *(Author's summary)* Z00

1960-2253 DULONG, R. **Le manioc.** *(Cassava). In*________. Note sur l'Agriculture de la Region de la Taheza, Bassin de L'Onilahy, Province de Tulear. Tananarive, Institut de Recherches Agronomiques de Madagascar, 1969. pp.23-26. Fr., 13 Refs.

Cassava. Fertilizers. Cultivation. Viroses. Bemisia. Mycoses. Injurious insects. Cultivars. Diseases and pathogens. Pests. *Cercospora caribaea.* **Noxious animals. Productivity.** *Aonidomytilus albus. Gloeosporium manihotis.* **Mosaic diseases. Malagasy Republic.**

Recommendations are made on the best cassava varieties, manure and fertilizers, as well as a discussion of the cultural practices, planting and harvesting methods. Short descriptions of the effects of the attacks of some important pathogens are presented, and general suggestions for diminishing disease damage are given. *(Summary by H.J.S.)* Z00

1961-2252 DULONG, R. **Le manioc dans la Province de Tuléar.** *(Cassava in the Province of Tuléar).* Tananarive, Madagascar, IRAT, 1969. 20p. Fr.

Cassava. Cultivation. Cultivars. Selection. Plant breeding. Hybrids. Genetics. Productivity. Plant anatomy. Fertilizers. Soil fertility. Cultivation systems. Pests. Diseases and pathogens. Cassava mosaic virus. Viroses. *Cercospora caribaea.* **Mycoses.** *Aonidomytilus albus.* **Injurious insects. Entomology. Trade. Malagasy Republic.**

Information is given on research on cassava in the province of Tuléar, including the results of variety trials under different edaphological and climatic conditions. After 6 years of continuous experimentation, the following varieties were selected on the basis of yield per hectare: H.53, H.54, H.41, H.35, H.43. A botanical description of these and other varieties is included. Cassava mosaic was recorded, as well as anthracnose *(Cloesporium manihotis),* cercosporiosis *(Cercospora caribea),* and coccids (*Aonidomytilus albus* Ckll.). Production and export figures up to 1966, as well as the cost of producing 1 ha of cassava under the traditional system, are also included. *(Summary by J.L.S.)* Z00

1962-0602 CORREA, H. **Mandioca do indigena a mecanização.** *(Cassava from native methods to mechanization).* Brasil. Instituto de Pesquisas e Experimentação Agropecuárias do Centro-Oeste. Circular no. 10. 1970. 38p. Port., Illus.

Cassava. Cultivation. Mechanization. Bacterioses. Mycoses. Injurious insects. *Cercospora henningsii.* **Diseases and pathogens. Pests. Noxious animals. Insect control. Disease control.** *Xanthomonas manihotis. Erinnyis ello. Coelosternus granicollis. Silba pendula.* **Planting. Uses. Cultivars. Cuttings. Propagation materials. Nutritional requeriments. Fertilizers. Spacing. Timing. Harvesting.**

This bulletin prepared for Brazilian farmers presents a general background on cassava, economical aspects, potential uses,a description of poisonous and nonpoisonous varieties, propagation methods, fertilizing and harvesting. Land preparation should be mechanized to improve the quality of tillage. Results of experiments carried out by IPEACO, Brazil are included. Damage to the crop is caused by bacterioses (*Xanthomonas manihot* (Arthaud-Berthet) Burk), viroses, fungi *(Cercospora henningsii),* and pests sach as leaf-cutting ants (Atta spp.), stemborers (Coelosternus spp.), bud maggots (*Lonchaea pendula* Bezzi), hornworms (*Erinnyis ello* L.) and scales (Pseudococcus spp). *(Summary by J.L.S.)* Z00

1963-2388 COVICH, A. P. and NICKERSON, N. H. **Studies of cultivated plants in Chocó dwelling clearings, Darién, Panamá.** Economic Botany 20:285-301. 1966. Engl., Sum. Engl., 48 Refs., Illus.

Cassava. Human nutrition. Cultivation. Panama.

Useful plants and techniques of their cultivation were studied in and around clearings of Chocó Indian dwellings in the tropical rain forest of Darien (Panama). A decrease in both numbers and variety of native plants occurred as commercially important plants were established on a larger scale. Creation of open niches by means of trash heaps became more definite as distance from the riverbank increased; edible plants were often growing in such locations. Present-day agricultural techniques among the Chocó may illustrate their agricultural history. A comparison is made to several extant theories of early agriculture. Small-scale, more intensive gardening was noted in village clearings; groups of dwellings may thus have been a cause rather than a result of field agriculture. Cassava and other root crops are mentioned. *(Author's summary)* Z00

1964-0825 GREENWOOD-BARTON, L. H. *et al.* **The importance of the amino acid content of feeding-stuffs in East Africa. I. The amino acid content of eleven East African feeding-stuffs.** East African Agricultural and Forestry Journal 29(3):237-242. 1964. Engl., Sum. Engl., 31 Refs.

Cassava. Feeds and feeding. Proteins. Amino acids. Swine. Cassava meal. Analysis. Meals. Cottonseed cake. Maize meal. Wheat bran. Feed constituents. Composition. Groundnut cake. Kenya.

The methods used by the Tropical Products Institute to sample and analyze the amino acid content of East African feedstuffs are described. Results of these analyses are presented and suggest that the amino acid composition of East African feedstuffs is not significantly different from that of similar feeds in other parts of the world. It is suggested, therefore, that nutrition workers in East Africa may use overseas tables of the amino acid content of feeds with some degree of confidence. *(Author's summary)* Z00

1965-0591 TEMPANY, H. A. **Expériences sur les variétés de plantes vivrières.** *(Experiments with food plants).* Ile Maurice. Department de l'Agriculture. Bulletin no 19. 1920. 8p. Fr.

Cassava. *Manihot esculenta.* **Cultivars. HCN content. Composition. Productivity. Noxious animals. Injurious insects. Entomology. Diseases and pathogens. Pests. Mycoses.**

A summary is given of the work carried out at different experimental stations with the following crops: potatoes, cassava, yams, pistachios and upland rice. Cassava is widely grown on the island, and 51 varieties were submitted for yield trials. The HCN content of introduced varieties was determined. Three insect pests were found to attack cassava: *Phytalus smithi, Saissetia hemispherica* and Chionaspis sp. A fungal disease, *Gloeosporium manihotis* was also recorded. *(Summary by J.L.S.)* Z00

1966-0776 COURSEY, D.G. and HAYNES, P.H. **Root crops and their potential as food in the tropics.** World Crops 22(5):261-265. 1970. Engl., Sum. Engl., Fr., Span. 38 Refs. Illus.

Cassava. Development. Human nutrition. Yams. Sweet-potatoes. Production. Nutritive value. Productivity. Economics.

Carbohydrates play a central role in human nutrition, usually providing the largest single component of man's diet and the main source of energy. Adequate supplies are essential for efficient utilization of protein. While both cereals and root crops are major sources of carbohydrates in diets, root crops have traditionally been regarded as inferior foods. This attitude is regarded as untenable by the authors, and information is presented here from which the value of these crops may be reappraised. *(Author's summary)* Z00

1967-0689 KUNDU, B. C. **Some edible rhizomatous and tuberous crops of India.** *In* International Symposium on Tropical Root Crops, 1st., St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 1, pp.124-130. Engl.

Cassava. Feeds and feeding. Animal nutrition. India.

The following plants are briefly described in general terms: species of **Alocasia,** *Amorphohallus campanulatus, Canna edulis,* cassava, *Coleus parviflorus, Colocasia esculenta, Curcuma angustifolia* and *C. zeodaria;* species of **Dioscorea,** *Eleocharis edulis, Helianthus tuberosus, Ipomoea batatas, Maranta arundinacea, Pachyrrhizus erosus;* a species of **Scirpus** and *Xanthosoma maximilani. (Author's summary)* Z00.

1968-0797 MONTALDO, A., comp. **La yuca; trabajo sobre este cultivo, con especial referencia a Venezuela.** *(Cassava; a paper on this crop with special reference to Venezuela).* Maracay, Venezuela, Ministerio de Agricultura y Cria, Oficina de Comunicaciones Agrícolas, 1972. 113 p. Span., 98 Refs.

Cassava. Taxonomy. Cultivation. Genetics. Plant breeding. Storage. Uses. Soil fertility. Economics. Climatic requirements. Fertilizers. Pests. Diseases and pathogens. Composition. Injurious insects. Noxious animals. Productivity. Entomology. Venezuela.

The information on cassava which is presented is based on a literature review. Data given concern its origin, botanical characteristics, climate, soils and fertilizers, cultivation, genetics and plant breeding, diseases and pests, storage, chemical analysis, uses and economic aspects. *(Summary by H.J.S.)* Z00

1969-0624 ALBUQUERQUE, M. DE. **Estado atual das pesquisas com mandioca no IPEAN.** *(Present status of cassava research at IPEAN).* *In* Reunião da Comissão Nacional da Mandioca, 5a., Sete Lagoas, Minas Gerais, 1971. Anais. Sete Lagoas, Minas Gerais, Instituto de Pesquisa Agropecuária do Centro-Oeste, 1971. pp. 12-17, Port.

Cassava. Cultivation. Productivity. HCN. Cattle. Tubers. Cassava programs. Research. Inter-cropping. Cultivation systems. Cultivars. Plant development. Composition. Brazil.

Brief notes are given on the following: cultivation processes, toxicity, application of organic matter to the soils, intercropping, diseases and pests, cattle feeding, and yields gathered from 13 varieties. *(Summary by H.J.S.)* Z00

1970-0355 ROGERS, D. J. and APPAN, S. G. **What's so great about cassava?** World Farming 13(6):14,16,22. 1971. Engl., Illus.

Cassava. Uses. Fermentation. *Manihot esculenta.* **Protein content. Carbohydrate content. Amino acids. Composition. Cultivation. Human nutrition. Food enrichment.**

Cassava *(Manihot esculenta = Manihot utilissima)* ranks 6th among the world's crops in volume of food produced. No other crop can match its carbohydrate production (250,000 calories| ha| day) and few have its range of tolerance for poor soils and low rainfall (some varieties can grow with 510 mm of annual rainfall). In most of the tropics, it can be planted any time of the year. The roots can either be consumed as food after detoxication or be used as a livestock feed, while the flour can be processed into food products. The low protein content can be improved by prolonged fermentation (microbial synthesis of protein). Prospects of cassava are mentioned. *(Summary by Tropical Abstracts)* Z00

1971-0790 CORRIOLS. **les cultures vivrières dans les térritoires relevant du secteur soudanais de recherches agronomiques: leurs améliorations.** *(Food crops in territories pertaining to the Sudanese sector of agricultural research. Crop improvement).* Agronomie Tropicale 6(7-8):412-519. 1951. Fr., Sum. Fr.

Cassava. Sorghums. Maize. Yams. Rice. Plant breeding. Human nutrition. Resistance. Development. Sudan.

Brief notes are given on several food crops; most data refer to crops other than cassava. For cassava, general information is presented dealing with areas under cultivation, uses, yields, diseases and pests. Some geographical data (hydrography, orography, climatology and population) are given of the countries pertaining to the Sudanese sector of agricultural research. Information is given on the present and future possibilities of improving each crop. *(Summary by H.J.S.)* Z00

1972-1684 NESTEL, B. **Current trends in cassava research.** Ottawa, Canada, International Development Research Centre, 1974. 32p. Engl., Sum. Engl., Span., Fr., 90 Refs., Illus.

Cassava. Food products. Human nutrition. Food enrichment. Animal nutrition. Toxicity. Uses. Costs. Industrialization. Production. Economics. Genetics. Pests. Diseases and pathogens. Developmental research. Research.

Cassava, for long a crop neglected by research workers, is now receiving attention at both national and international research centers with the largest research program ever provided for this commodity being undertaken by the Centro Internacional de Agricultura Tropical, CIAT in Colombia. The significance of the crop in tropical agriculture and its growth potential, especially as an animal feed, have recently been recognized widely. Recent literature and a substantial volume of unpublished, ongoing work are reviewed under the headings of cassava as human and animal food, enrichment and fortification, toxicity, industrial use, economics of production, genetic improvement, diseases and pests, factors affecting yield and improved information systems. A multidisciplinary approach to cassava research and a greater research input are recommended. *(Author's summary)* Z00

1973-2056 DUFOURNET, R. and GOARIN, P. **Note sur la culture du manioc à Madagascar.** *(Notes on cassava cultivation in Madagascar).* Riz et Riziculture 3(1):15-38. 1957. Fr., Sum. Fr., Engl., Span., 17 Refs., Illus.

Cassava. Cultivation. Climatic requirements. Soil analysis. Manures. Green manures. Fertilizers. N. P. K. Nutritional requirements. Cultivation systems. Rotational crops. Cultivars. Composition. HCN content. Plant breeding. Human nutrition. Animal nutrition. Identification. Weeds. Pests. Diseases and pathogens. Injurious insects. Noxious animals. Viroses. Mycoses. Economics. Soil fertility. Malagasy Republic.

In Madagascar, cassava-planting areas extend almost to 30° S in latitude and up to 1,000 m above sea level. Because of recent river deposits, tuber and starch yields have increased as compared to those obtained on lateritic clays and laterites rich in phosphate but lacking in potash. Fertilization using green manure, farmyard manure, chemical and mixed manures is studied. Phellodermic diagnosis, although still unperfected, confirms the importance of potash. When soils have less than 0.060% exchangeable potash, 90-100 kg| ha must be applied. From a large collection of local varieties and varieties introduced mainly from

Java, a series of clones, adapted to the different soil and climatic requirements, were developed. The characteristics of the main clones are given, as well as the pattern of varietal improvement obtained by crossbreeding and 10-year selection. The percentage of HCN changes according to variety, environment, plant age, season and period of time between harvesting and utilization. The under part of the rind has a higher HCN content than the central section of the root. Under traditional farming systems, cassava yields vary from 3-15 tons| ha. For industrial purposes, cassava is either grown on large estates equipped with a starch-extracting unit or grown with other crops on a medium scale. Plowing methods and special attachments for plowing green manure into the soil are discussed. In the high plains, planting takes place from March to July; in Mahajamba, in November and December. Mechanical harvesting (using a brush breaker plow) is cheaper than pulling roots out manually. Crop enemies are reviewed: volunteer weeds, plant-destructive animals, insects and acarids *(Heteronychus plebejus* klg, is the most serious pest), diseases (mosaic, physiological), and rot caused by fungi.*(Author's summary)* Z00

1974-0326 AGBOOLA, S. A. **Patterns of food crop production in South-Western Nigeria.** Nigerian Geographical Journal 11(2):135-152. 1968. Engl., 31 Refs., Illus.

Cassava. Ecology. Economics. Cultivation. Soil fertility. Climatic requirements. Development. Savannas. Nigeria.

The broad patterns of food crop production in southwestern Nigeria are as follows: (a) yam, maize and Guinea corn, together with associated minor crops, predominate in much of the savanna area to the north; (b) maize, cocoyam and cassava are more significant in the cocoa zone as a result of labor shortage and lack of suitable soils for other crops; and (c) cassava and, to a lesser degree, maize and rice have a consolidated positive south of the main cocoa zone. Increased food crop output for the future will have to take into account the economic yields of crops and the potential areas where expansion can take place. The food crops likely to develop the most rapidly are cassava, maize and rice. It may be objected that since cassava has a low nutritive value, it is not advisable to increase its output; however, if present efforts to mechanize its processing and strengthen its food content by adding protein concentrates succeed, expanded production will be most desirable. The areas which are likely to give the best results in terms of yield and areal extension are the newer cassava areas in the easter part of the Ondo Province. A recent survey has found that fallow periods are still long enough, and the amount of good-quality soils on which tree crops are not yet grown are of sufficient areal extent to make expansion of food crop production profitable. *(Summary by H.J.S.)* Z00

1975-0634 HARRIS, D. R. **The origins of agriculture in the tropics; ecological analysis affords new insights into agricultural origins and suggests a fresh evaluation of the limited archaeological evidence.** American Scientist 60:180-193. 1972. Engl., 66 Refs., Illus.

Cassava. Sweet-potatoes. Colocasia. Yams. Ecology. Plant geography.

This is an archaelogical study of the origins of agriculture in the tropics. The following aspects are dealt with: complex and simple ecosystems, ecological manipulation and transformation, progenitors of plant domestication and cultivation, tropical vegeculture (cassava, sweet potatoes, taro and yams) and seed-culture (cereal grains and beans). In conclusion, the author states that a pantropical model of agricultural origins may be suggested that shows vegeculture anciently established in parts of all 3 continental tropical lowlands, but as an ecologically stable, localized and nutritionally unbalanced system of food production unsuited to territorial expansion; whereas seed-cultural systems, which appear to have ancient origins in drier tropical and warm temperate lands, are seen as inherently unstable and expansive complexes progressively intruding into the homelands of vegeculture. *(Summary by T.M.)* Z00

1976-0783 DUARTE, E. F. **A mandioca e a sua cultura.** *(Cassava and its cultivation).* Agronomia (Brazil) 15(3):155-180. 1956. Port., 13 Refs., Illus.

Cassava. Economics. Production. Productivity. Animal nutrition. Alfalfa. Cultivation. *Erinnyis ello. Scirtothrips manihoti.* **Bacterioses.** *Xanthomonas manihotis.* **Injurious insects. Cultivars.** *Manihot* *esculenta*. **Soil fertility. Pests. Diseases and pathogens. Noxious animals. Mycoses. Entomology. Insect control.** ***Coelosternus granicollis*****. Pest control.** ***Uromyces manihotis*****. Etiology. Brazil.**

The economic importance of cassava in Brazil is discussed.The large cassava-producing states are Bahia, Santa Catarina, Rio Grande do Sul, Minas Gerais and Pernambuco. In 1954 the area planted to cassava was 1,088,890 ha, yielding 13,050 kg|ha. The Instituto do Zootecnia (São Paulo) has undertaken some experiments for the utilization of cassava stalks and leaves as a substitute for alfalfa. Topics discussed are botanical description, varieties, climate, soils, fertilizing, spacing, planting, cultural practices, harvesting, storage and yields. The following pests were the most important: *Erinnyis ello* L., *Coelosternus rugicolis* Boh, *Coelosternus granicolis* Pierce, *Setomorpha insectella* Fabr., and *Scirtothrips manihoti*, Bondar. Description and control measures of the above pests are given. The main diseases are bacterial leaf spot caused by *Xanthomonas manihotis*; ferrugen, a leaf disease caused by the fungus *Uromyces manihotis* P. Henn, root rot caused by the fungus *Diplodia theobroma* Pat, root soft rot caused by the fungus *Rhizopus nigricans* Ehreub. *(Summary by J.L.S.)* Z00

1977-1611 COWGILL, U. M. **Some comments on Manihot subsistence and the ancient Maya.** Southwestern Journal of Anthropology 27(1):51-63. 1971. Engl., Sum. Engl., 28 Refs.

Cassava. ***Manihot esculenta*****. History. Cultivation. Cultivation systems. Food energy. Production. Productivity. Nutritive value. Composition. Water content. Protein content. Fat content. Ash content. Ca. Mineral content. P. Iron. Vitamin content. Central America.**

An anthropological study is made of the possible role played by cassava or any of the other root crops indigenous to the New World in the subsistence of the ancient Maya in the Petén. Based on studies of pollen and ecological factors, the author concludes that root crops were not important. They were more susceptible to disease and animal attack than maize, and the growing season of cassava is quite long. Even today cassava is not widely grow in the Petén because of poor land drainage, inadequate soil profiles and the peculiar distribution of rainfall during its long growing season. Nutritionally, maize is a more valuable staple than cassava. Although it is not clear what portion of the cassava plant was consumed by the ancient Maya, the flour is more nutritious than the tuber. Today, one small-scale farmer can feed 12.6 people with maize, 16 with the cassava tuber and 7.75 with the flour. *(Summary by T.M.)* Z00

1978-2447 TARDIEU, M. **Les cultures d'appoint dans la zone d'action du C.R.A. Bambey.** *(Complementary crops in the zone of the CRA Bambey). In* Annales du Centre de Recherches Agronomiques de Bambey au Sénegal. 1957. I France. Ministere de la France d'Outre Mer. Office de la Recherche Scientifique et Technique d'Outre Mer. Bulletin Economique no. 17:5-54. 1958. Fr., 37 Refs., Illus.

Cassava. Plant geography. Production. Productivity. Nutritive value. Cultivation. Storage. Silage. Plant breeding. Selection. Tubers. Flowering. Clones. Senegal.

This describes plant species that up to now have occupied a secondary place in French Africa and whose cultivation should be encouraged to improve human and animal nutrition. The species studied belong to the families Euphorbiaeae, Leguminosae, Cucurbitaceae and Malvaceae. Cassava (*Manihot utilissima* Pohl) growing, distribution, feeding value, storage and fertilization are dealt with briefly. *(Summary by S.S. de S.)* Z00

1979-3243 MINNEMAN, P. G. **Yuca** *(Cassava). In* _____. **The agriculture of Cuba, Foreign Agriculture** Bulletin no. 2:104-106. 1942. Engl.

Cassava. Productivity. Cultivation. Cuba.

Brief notes are given on cassava in Cuba, as regards its uses, area planted, starch industries, starch manufacturing, prices and international trade. *(Summary by H.J.S.)* Z00

1980-3424 PURSEGLOVE, J. W. **Manihot.** *In*______.Tropical crops; Dicotyledons. New York, Wiley, 1968. v. 1, pp. 171-180. Engl., 5 Refs.

Cassava. Cultivation. Taxonomy. Diseases and pathogens. Plant anatomy. Pests. Plant breeding. Composition.

Depending on the definition the genus **Manihot** Mill has 100-200 species, which are confused in both Americas. They are mainly shrubs and subshrubs, but trees occur. The following aspects are discussed briefly: uses systematics, origin, distribution, ecology, morphology, pollination, gemination, chemical composition, propagation, husbandry, major diseases and pests, breeding, and production data. *(Summary by H.J.S.)* Z00

1981-0437 RAMOS, N., G. **La yuca, conferencias.** *(Lectures on cassava).* Palmira, Colombia, Facultad de Agronomía, 1962. 16p. Span.

Cassava. ***Manihot esculenta.*** **Composition. Nutritive value. Cultivars. Soil fertility. Cultivation. Fertilizers. Costs. Productivity. Pests. Cassava starch. N. P. K. Animal nutrition. Diseases and pathogens. History. Industrialization. Leaves. Feeds and feeding. Swine. Taxonomy. Storage. Entomology. Production. Colombia.**

A summary is given of information on cassava (*Manihot esculenta* Crantz) in Colombia. Included are the history of cassava and world areas of cultivation, production (by "departamentos") in Colombia in 1960, chemical analysis and food value of 2 common Colombian varieties, possible industrial products (although in Colombia cassava is used mostly for human consumption), chemical analysis of foliage as food for beef and swine, botanical classification, best soil and climatic conditions for cultivation, preparation of soil for planting, planting methods and systems, cultural practices, pruning, harvesting, storage, fertilization, yields, production and marketing costs, varieties used in Colombia, and pests and diseases. Also included in this document are summaries of 3 experiments: "Leaves and stalks of cassava as a forage" by L. Juárez and two experiments by A. Machado, one on differences in yield, product quality and starch content with different systems of cultivation and the other comparing cassava production of plants from large cuttings to that of plants from small cuttings. *(Summary by P.A.C.)* Z00

1982-2420 WOILLET, J. C. **(Essai de micro-regionalisation de la prefecture du Vakinankaratra.** *(Essay on the regionalization of the Vakinankaratra prefecture).* Revue de Geographie (Madagascar) no. 3:45-111. 1963. Fr., Illus.

Cassava. Maps. Production. Malagasy Republic.

The Vakinankaratra prefecture of Madagascar is about 16,000 km^2. Altitudes range from 800 to 2,000 m above sea level; in 1960, there were 366,428 inhabitants. Seventeen maps are presented showing political divisions, natural regions, hydrology, climate, population density, cultivated areas of different crops including cassava, agricultural production, industrial units, transport, markets, soil erosion and human migration. Most data refer to items other than cassava. *(Summary by H.J.S.)* Z00

1983-3095 PYNAERT, L. **Le manioc.** *(Cassava).* 2 ed. Bruxelles, Ministere des Colonies, Direction d'Agriculture, 1951. 166p. Fr., 35 Refs., Illus.

Cassava. Taxonomy. Cultivation. Diseases and pathogens. Pests. Feeds and feeding. Plant breeding. Uses. Industrialization. Human nutrition. Animal nutrition. Toxicity. HCN. Africa. Asia.

This book includes brief information on the use of cassava *(Manihot utilissima)* roots for feeding animals, especially as regards their chemical composition and HCN content. A great part of the cassava grown in the USA, where only sweet varieties are employed, is fed to horses, cattle, pigs and poultry. When fed to dairy cows, it does not affect the flavor of the milk. *(Summary by Herbage Abstracts)* Z00

1984-4862 WILLIAMS, W. A., LOOMIS, R. S. and ALVIM, P. de T. **Environments of evergreen rain forests on the lower Rio Negro, Brazil.** Tropical Ecology 13(1):65-78. 1972. Engl., Sum. Engl., 27 Refs., Illus.

Cassava. Rainfall data. Soil analysis. Photoperiod. Forestry. Soil fertility. Leaf area. Ecology. Brazil.

The light, soil, and water environments of vegetation were studied in the evergreen forests of the lower Rio Negro in the Amazon Valley. Illumination penetrating to the ground amounted to 1-5% of total daylight on the undisturbed sites and 54% on the disturbed site, as measured by Ozalid-paper light integrators. The leaf area index for the undisturbed forests was estimated to range from 4.7-6.9 m^2| m^2. The spectral distribution (380-1060 nm) of the light penetrating to the floor of the forests was similar to those reported elsewhere for agricultural communities of maize and soybeans. Since reported photosynthetic rates of tropical rain forest species are quite low, the angles of presentation of leaves to the sun may be particularly important to the efficiency of solar energy conversion by these species because a benefit results from the sunlight being spread over a large leaf surface at small angles of incidence where maximum photosynthesis occurs in low levels of light. The soils studied were extremely acid (pH 3.8), had kaolinite as the dominant clay mineral, and were impoverished in plant nutrients with the possible exception of N, which was present in modest amounts. The biomass of forest species supported was more robust than might be expected in such inhospitable soil environments. The forest flooded seasonally by black water was shorter in stature and different in species composition from forest flooded by white water of the Rio Branco. Leaf area index in the two forests was estimated to be 4.7 and 5.4 m^2| m^2, respectively. The black water (pH 4.9) was higher in sulfate and lower in bicarbonate than the white water (pH 6.2), but the concentrations of cations and other anions did not differ appreciably. *(Author's summary)* Z00

1985-3299 MAGOON, M. L. and APPAN, S. G. **Cassava a food for the millions.** Indian Farming 16(1):12-13. 1966. Engl., Illus.

Cassava. Cultivation. Climatic requirements. Rainfall data. Human nutrition. Uses. Composition. India.

Brief notes are given on the reasons why cassava is becoming a crop of importance in India. Mention is made of its high caloric content, use of the leaves as a vegetable, animal feedstuffs using cassava and industrial uses of starch. *(Summary by T.M.)* Z00

1986-3255 ALBUQUERQUE, M. DE **Aspectos de tecnologia da mandioca na Amazonia Oriental.** *(Some aspects of cassava technology in the Eastern Amazon Region).* Belem, Brasil. Instituto de Pesquisa Agropecuaria do Norte. 1973. 32p. Port.

Cassava. Ecology. Injurious insects. Processing. Productivity. Diseases and pathogens. Pests. Noxious animals. Cassava products. Cultivars. Cultivation. Research. Brazil.

This paper presents a general overview of the present status of cassava in the state of Pará (Brazil). Emphasis is placed on the ecological conditions for cassava. This region presents the most sanitary conditions since diseases and pests are not of economic importance. Only the leaf-cutting ant (Atta sp.) is commonly found to attack this crop. The following topics are also discussed: uses, socioeconomic factors, cultural patterns, varietal trials, technology and processing of cassava food products. *(Summary by J.L.S.)* Z00

1987-3422 CAIRE, P. A. **Cultura da mandioca.** *(Cassava cultivation).* 3 ed. Rio de Janeiro, Brasil, Ministerio da Agricultura, Industria e Comercio, 1919. 29p. Port .

Cassava. Harvesting. Productivity. Nutritive value. Human nutrition. Soil requirements. Cultivars. Feeds and feeding. Cultivation. Uses. Processing. Productivity. Cassava products. Brazil.

General information is given on plant morphology, varieties, cultivation, soil requirements, harvesting, yields, nutritive value, uses (mainly products for human consumption in Brazil).*(Summary by H.J.S.)* Z00

1988-3112 GREENSTREET, V. R. and LAMBOURNE, J. **Tapioca in Malaya.** Malaya. Department of Agriculture. General Series no. 13. 1933. 76p. Engl., 43 Refs., Illus.

Cassava. *Manihot esculenta*. Cultivars. Identification. Selection. HCN content. Toxicity. Composition. Cultivation. Fertilizers. Soil impoverishment. Spacing. Planting. Harvesting. Starch content. Timing. Productivity. Tuber productivity. Manures. Nutritional requirements. N. P. K. Diseases and pathogens. Pests. Entomology. Injurious insects. Pest control. Processing. Cassava starch. Tapiocas. Washing. Rasping. Silting. Screening. Drying. Industrialization. Factories. Costs. Prices. Economics. Cassava products. Processed products. Uses. Wastes. Trade. Marketing. Malaysia.

This monograph presents the results obtained from research on the agronomic and fertilizer requirements of cassava in Malaya. The main topics discussed are history, legal restrictions, varieties under cultivation (including keys for their classification according to the color of the inner bark or cortex of the stem and of the root), toxicity, cultivation, yields, soil impoverishment and fertilizer trials, cassava products and their manufacture, and production costs. *(Summary by J.L.S.)* Z00

1989-3278 HUBERT, P. and DRUPRE, E. **Le manioc.** *(Cassava).* Paris, H. Dunod et E. Pinat, 1910. 368p. Fr., Illus.

Cassava. Cultivars. Plant geography. History. Sweet cassava. Bitter cassava. Cultivation. Trade. Marketing. Human nutrition. Prices. Economics. Planting. Cuttings. Spacing. Fertilizers. Harvesting. Productivity. Agricultural equipment. Pests. Noxious animals. Injurious insects. Industrialization. Factories. Processing. Industrial machinery. Development. Industrial starches. Glucose industry. Cassava starch. Tapiocas. Cassava flour. Uses. Cassava products. Ethanol. Fermentation.

This book includes chapters on the following subjects: plant geography (dispersion of varieties, synonymy); methods of cultivation; industrialization including the processing of alcohol; fresh cassava as a foodstuff; commerce; local industries; and literature on cassava. *(Summary by H.J.S.)* Z00

1990-0680 MORGAN-REES, A. M. **Some economic aspects of root crop production; with particular reference to the economics of producing carbohydrates from roots as compared with other sources in private, developing and advanced economies.**
1st, St. Augustine, Trinidad, 1967. Proceedings. St. Augustine, University of West Indies, 1969. v. 2. pp.18-33. Engl., Sum. Engl., 12 Refs.

Cassava. Root crops. Yams. Cereals. Costs. Productivity. Soluble carbohydrates. Food energy. Human nutrition. Trinidad and Tobago.

The data presented in this paper, although not conclusive and very patchy, suggest that root crops as a source of carbohydrates compare favorably with other sources. The exact relationships in terms of economics will vary with the environment and with local conditions; but irrespective of the level of economic development, the root crops appear to play an important role in terms of both food and monetary values. As development takes place, the importance of starchy roots in diets may well decline; but with the aid of modern technology to raise the level of yields and the application of mechanization to offset the inherently high costs of production per acre, there is little reason to assume that the returns from growing these crops will not remain at a satisfactory level. One of the key factors contributing towards success is the achievement of high levels of yield over which to spread the high levels of input costs. This requirement is likely to call for an increasing degree of specialization in production as development takes place. In the West Indies this might well result in the production of increasing quantities of ground provisions (apart from Irish potatoes) in the plains where conditions would allow for mechanization as a means of increasing the productivity of labor. Traditional methods of production are likely to become less remunerative as time goes on because of their heavy labor demands and relatively low yields; and the root crops, like any other form of agricultural production, will have to adapt to changing circumstances. If adjustments in outlook, methods and location of production occur, then the starchy roots can make a very valuable contribution to the economy of the West Indies, where land is limited in supply and a high man|land ratio exists. *(Author's summary)* Z00

1991-4948 YEOH, H.H. and CHEW, M.Y. **Research in tapioca; a brief review.** Malaysian Agricultural Journal 49(3):332-343. 1974. Engl., 56 Refs., Illus.

Cassava. *Manihot esculenta.* **Productivity. Uses. Composition. Amino acids. HCN. Toxicity. Cyanogenesis. Malaysia.**

A brief analysis is made of current research in cassava. The economic importance of cassava is discussed. Total world acreage planted to this crop is 9.8 million ha, more than half of which is concentrated in tropical Africa. Cassava ranks 6th among crops in volume and food produced and is one of the 12 to 15 most important food crops in the world. More than 90 million tons are harvested annually. Major exporters are Thailand, Brazil, Indonesia, Madagascar, Togo and Malaysia. Europe imports over 600,000 metric tons a year of cassava chips and pellets for animal feed. Industrial uses include production of glucose, dextrin, acetone, butyl alcohol, ethyl alcohol, beer, alumina, and textile sizing, etc. The chemical composition of cassava is briefly analyzed. Cyanogenic glucosides are distributed throughout the plant; quantities vary greatly among cultivars. The normal range of cyanogens is between 15-400 ppm, calculated as mg HCN|kg fresh weight. Linamarin (93%) and lotaustralin (7%) account for the total cyanogenic glucoside in cassava. Both CIAT and IITA have been searching for low or zero cyanide or cyanogenic glucoside varietal plants to be used in breeding programs to eliminate the problem of chronic cyanide toxicity. The true digestibility of cassava leaves used in feeding experiments with animals was found to vary from 70-80%, whereas the biological value ranged from 44-57%, depending upon methionine content. The ample scope for fundamental and applied aspects of cassava research is outlined briefly. *(Summary by L.C. Trans. by T.M.)* Z00

1992-3238 **THE CULTIVATION and the uses of cassava.** Farming in South Africa 14:404-405. 1939. Engl., Illus.

Cassava. Cultivation. Uses. Human nutrition. Processing. Cultivars. Analysis.

The status of cassava in various regions of South Africa is given, including some remarks on local cultural practices and preparation and uses of cassava roots. Young leaves are eaten as a vegetable. *(Summary by J.L.S.)* Z00

1993-0815 FONSECA, N. G. DA. **Mandioca, uma fabulosa cultura.** *(Cassava, a wonder crop).* Sitios e Fazendas 32(6):17-18. 1966. Port. Illus.

Cassava. Cultivation. Uses.

A brief description is given of cultivation, diseases and uses of cassava. *(Summary by H.J.S.)* Z00

1994-3207 BRASIL. UNIVERSIDADE FEDERAL DA BAHIA. ESCOLA DE AGRONOMIA. **Projecto mandioca.** *(Cassava project).* Cruz das Almas, Bahia, Brasil, 1973. 115p. Port., Illus.

Cassava. *Manihot esculenta.* **Plant breeding. Crossbreeding. Flowering. Developmental Stages. Propagation. Clones. Pests. Injurious insects. Noxious animals.** *Teleocome crassipes. Anastrepha pickeli. Silba pendula.* **Injurious mites. Insect control. Pest control.** *Erinnyis ello. Erinnyis alope.* **Mycoses. Cultivation. Fertilizers. Nutritional requirements. N. P. K. Spacing. Cuttings. Processing. Food enrichment. Storage. Cassava products. Toxicity. Animal nutrition. Swine. Poultry. Domestic animals. Leaves. Feeds and feeding. Marketing. Economics. Cassava programs. Development. Brazil.**

This is a technical report on cassava (*Manihot esculenta* Crantz) research carried out at the Escola de Agronomia da Universidade Federal da Bahia, Cruz das Almas, (Brazil) from July to December, 1973. Research, experimentation and results are reported and discussed. The project studies plant breeding, pests, diseases, irrigation, climate, cultural practices, soils and fertilizers, processing and storage toxicity, animal nutrition, and socioeconomic factors. *(Summary by J.L.S.)* Z00

1995-0712 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. Cassava production systems. *In* ________. Annual report 1971. Cali, Colombia, 1972. pp. 25-34, 37. Engl., 1 Ref., Illus.

Cassava. Germplasm. Entomology. Diseases and pathogens. Pests. Cultivation. Cultivars. Development. Swine. Animal nutrition. Processing. Colombia.

The cassava program at CIAT aims at selecting varieties resistant to diseases and insects and having desirable agronomic characteristics. Studies in plant pathology and entomology are in progress. The germplasm collection of approximately 2,800 cultivars is being catalogued. The agricultural engineering program has designed a low-cost cassava chipper, similar to type used in Thailand. *(Summary by J.L.S.)* Z00

1996-2038 **BAIXA TECNICA contribui para as crises da produção da mandioca.** *(Poor techniques contribute to the cassava production crisis).* Correio Agro-pecuário 1969:16-17. Setembro 1969. Port.

Cassava. Productivity. Industrialization. Cassava flour. Cassava starch. Brazil.

Factors related to cassava cultivation in São Paulo are discussed. Data refer to recent low yields, the improvement of industrial utilization and quality control of cassava products for exportation. *(Summary by H.J.S.)* Z00

1997-2122 **PLANTER. Manioc.** *(Cassava).* Rhodesian Agricultural Journal 2:25-27. 1904. Engl.

Cassava. Cultivars. Cultivation. Uses. Cassareep. Cassava products. Brazil.

Brief notes are given on cassava varieties, cultivation and preparation of products. *(Summary by H.J.S.)* Z00.

1998-3292 PECKOLT, T. **Mandioca.** *(Cassava). In* ________. Historia das plantas alimentares e de gozo do Brasil. Rio de Janeiro, Eduardo & Henrique Laemmert, 1878. pp.79-175. Port.

Cassava. History. Cultivation. Cultivars. Composition. Taxonomy. Uses. Brazil.

Data in this study refer to origin, plant morphology, taxonomy (44 species and 15 varieties of sweet cassava and 55 species and 21 varieties of bitter cassava), cultivation, chemical analyses and uses. Results of chemical analysis (mainly of the roots) and glossary of Amerindian cassava terms are presented in 14 tables. *(Summary by H.J.S.)* Z00

1999-3291 **QUATRE IMPORTANTES cultures vivrières: le mil, le riz, le manioc et le mais.** *(Four important food crops: millet, rice, cassava and maize). In* Le Marché Sénégalais. Marchés Tropicaux et Mediterranéens 1283:1851-1852. 1970. Fr.

Cassava. Millets. Rice. Maize. Production. Cereals. Senegal.

Information is given on the production of principal foodstuffs (millet, rice,cassava and maize) in Senegal. Cassava is largely grown in the regions of Casamance, Diourbel, Thies and Sine-Saloum. *(Summary by J.L.S.)* Z00

2000-4345 WILL PERERA, J. A. **Cassava in Ceylon.** Tropical Agriculturist 94(1):24-26. 1940. Engl.

Cassava. History. Processing. Cassava products. Sri Lanka.

A brief history is given of the introduction of cassava to Ceylon. Native (West Indian) methods of preparing cassava bread, casleep sauce and tapioca are described. *(Summary by L.C. Trans. by T.M.)* Z00

AUTHOR INDEX

Abraham, A. 0925 0928 0945 0976
Abramides, E. 0772 0699
Accra, Ghana Academy of Science 0980
Acena, B. 1570 1598 1633 1838
Acosta J., R. 0408
Adams, C.W.M. 1354
Adams, J.H. 1186
Addoh, P. G. 0973
Adeyinka, D. 1492 1532
Adriaens, E. L. 0022 1078 1111 1391
Adrian, J. 1124 1136
Adriano, F. T. 0154 1043 1663
Affran, D. K. 1880
Afonja, B. 0311
Agarwal, P. N. 1144
Agboola, S. A. 0011 1974
Agrawal, M. 0167
Agudu, E. W. 1266
Ahmad, M. I. 0556
Aina, J. A. 1250
Aiyer, R. S. 0158
Akinrele, I. A. 1083 1527 1620 1632 1662 1684 1710 1788 1791
Alagianagalingam, M. N. 0747
Alba, J. de 1202
Alba, M. G. 1298
Alberto, J. 0326 0587 1041 1098
Alburquerque, M. de 0349 0401 0540 1018 1464 1740 1969
Alcacid, E. 1210
Alexander, M. N. 1849
Almeida, F. C. G. de 0402
Alquier, J. 1239
Alvarez G., R. 1254
Alvarez-Luna, E. 0983
Amaral, J. F. do 0579 0616 0628 0631 0774
A[illegible]ann, P. 0213
A[illegible] B.O. E. 0277
A[illegible]rayanan, K. P. 0793
Anas[illegible]zo, S. A. 1141
Ancelot, H. 1080
Andersen, P. P. 1805
Angladette, A. 0382 1894
Ankrah, E. K. 1079
Appan, S. G. 0026 0895 0972
Aragao, H. de B. 0621
Araque, R. 0262 0282
Arboleda, D. M. 1585
Ardary, Z. L. 1426
Arismendi, L. G. 0492 0571
Arman, P. 1360
Armitage, F. D. 1474
Arnal - Peyrot, F. 1030
Arnould, J. P. 1862 1896
Arraudeau, M. 0052 0933 0966 0984
Asico, P. M. 1346
Assis, F. de P. 1211
Aulsebrook, J. B. 15[illegible]2
Aumaitre, A. 1214
Averre, C. W. 1617
Aw-yong, K. K. 0348
Ayanru, J. O. 1168
Aykroyd, W. R. 1118
Ayres, J. C. 1643

Bacon, R. F. 1713[illegible]
Bahia, Secretaría de Agricultura 0830
Bai, K. V. 0892
Bailey, K. V. 1169 1178 1199
Baillaud. M. E. 1864
Bains, G. S. 1065 1138 1525
Baker, C. F. 0653
Balakrishnan, R. 0461
Baldwin, R. R. 1483
Balencie, H. 1564
Ballou, H. A. 0785
Baudon, A. 0010
Bangham, W. N. 1019
banks, L. 1626
Banks, W. 1479
Banzon, J. 1423 1683
Banzon, J. R. 1724
Barat, H. 0603
Barrau, J. 0258
Barrios, E. A. 0144
Barrios, J. R. 0457 0871
Barros, M. de S. 1796 1836
Barrosa, A. S. 1207
Bassett, I. G. 1918
Bassler, R. 0179 1619
Bastos, J. A. M. 1470
Batavia. Division of Commerce 1567
Bates, F. L. 1453
Bates, W. N. 0516
Batista, A. M. 0905
Baumer, G. W. 1618
Baybay, D. S. 1513
Bayma, A. C. 1536
Bayma, C. 0062
Beck, B. 1374
Beck, B. D. A. 0767 0909
Beeny, J. M. 0449

Belien, J. L. 1959
Bell, J. M. K. 1011
Bennett, F. D. 0879
Bergamin, F. 1521
Berger-Ardouin, G. 1809
Berson, P. 0364
Berthet, J. J. A. 0588
Bertoni, M. S. 0489
Bethlem, M. L. B. 1395
Bezzi, M. 0794
Bhadra, R. 1434
Bhatia, D. S. 1077 1615
Bigwood, E. J. 1569
Birkinshaw, F. 0325
Bisset, F. H. 0125
Bitancourt, A. A. 0634 0675
Blanche, D. 0837
Blin, H. 0365
Bloch, T. 1942
Bodkin, G. E. 0864
Boiteau, P. 0989
Bolhuis, G. G. 0103 0146 0482 0512 0715 0908 0929 0940 0979 1375
Bolian, C. E. 0521
Boname, P. 1811
Bondar, G. 0624 0732 0791 0810
Bonnefoy, J. V. 0301 0372 1681
Booth, R. H. 1494 1572 1592 1853
Borasio, L. 1055
Bordas, M. 1584
Borget, M. 1362
Bouillon, J. 1675
Bourdet. 1877
Bouriquet, G. 0578 0659 0775
Boxser, D. 1833
Bradbury, J. F. 0638
Bradley, W. G. 0843
Brand, D. D. 0249
Brandao, S. S. 0486
Brasil. Centro de Tecnología Agrícola e Alimentar 1033
Brasil. Universidade da Bahia. Escola de Agronomía 1994
Bravo, A. F. 0265
Briant, A. K. 0726
Briceño P., R. H. 0426
Broadbent, J. A. 1778
Brook, E. J. 1787
Bruel, G. 1846
Bruijn, G. H. de 0114 0127 0529
Buchanda, V. 0576
Bulow, J. F. W. von. 0554
Burkholder, W. H. 0630
Burton, C. L. 0599
Burton, L. V. 1541
Busson, F. 0149
Bussy, M. 1102
Butler, E. J. 1904
Butler, G. W. 0117 0119
Buyckx, E.J.E. 0589
Byers, M. 0188
Caesar, G. V. 1488
Caire, P. A. 1987
Cali, Universidad del Valle. Centro de Formación Profesional e Investigación Agrícola. 0273
Callan, E. McC. 0840 0853 0857
Calvo A., A. 1899
Campbell, H. A. 1421
Campos, F. A. de M. 0141
Campos, H. dos R. 0077
Canella, C. F. C. 1403
Capinpin, J. M. 0040
Carden, P. 0812
Cardenas, R. 0849
Cardenas D., L. 0801
Cardoso, R. M. 1305
Carmo, G. F. do 0377
Carr, A. B. 0447
Carvalho, J. P. de 1311
Castagnino, G. A. 1750
Casseres, E. 1950
Castaño A., J. J. 0626 0637 0674 0697
Castellar M., J. A. 0424
Castillo, L. S. 1270 1281 1588
Castro, C. 0341
Catambay, A. B. 1855 1856
Cavle, M. G. 1810
Celís, E. 0524
Cedillo, V. G. 1114
Cenoz, H. M. 0067 0074
Centro Internacional de Agricultura Tropical 0221 0256 0805 0910 1890 1995
Chacón, S. O. 0287
Chadha, T. R. 0378
Chadha, Y. R. 1429
Chamberlin, J. C. 1061
Chan, S. K. 0269 0391
Chandra, S. 1931
Chandraratna, M. F. 0014 0016 0952
Chant, S. R. 0480 0733 0741 0742 0748 0750 0771
Charavanapayan, C. 1387
Checchi and Company, Washington 1505
Chevageon, J. 0684
Chevalier, A. 0303
Chew, M. Y. 0143 0191 0199
Chew, W. Y. 0405 0407
Chicco, C. F. 1274 1335
Childs, A. H. B. 0701
China, W. E. 0792
Chirife, J. 1415 1531
Chitharanjan Nair, N. 0070 0166
Chou, K. C. 1233 1282
Cicogna 1263
Ciferri, R. 0008 0082 0356 0646 0683
Clapp, R. C. 0116
Clark, A. 1390 1396 1398
Clement, R. 1800
Clendenning, K. A. 1761
Clerk, G. C. 0647
Clerk, J. de 1542
Close, J. 1095

Cock, J. H. 0254 1832
Codner, R. 1789
Coelho, C. 0484
Coelho, J. P. 0441 0445
Cohenca, J. M. 1495
Collard, P. 1776 1784
Collens, A. E. 0193 1665 1674
Collins, G. N. 1699
Colom, J. L. 0284
Colombia. Instituto de Investigaciones Tecnológicas. 1661
Colombia. Ministerio de Agricultura. 0557 1851
Colombia. Ministerio de Agricultura. Oficina de Planeamiento del Sector Agropecuario. 1892 1893
Colson, L. 0240
Comhaire-Sylvain S. 1028
Commonwealth Institute of Entomology. 0819
Commonwealth Mycological Institute. 0729 1784
Conceicao, A. J. 0462 0968
Conceicao, A. J. da. 0101 0369 0375 0450 0467 0471 0592 0947
Concepcion, I. 1059
Conde T., M. L. 0495
Congo Belge. Institut National Pour L'etude Agronomique du Congo. 0548 0549
Conn, E. E. 0115 0120
Conner, C. M. 1304 1314
Contreras G., J. 0046
Cooper, P. S. 0085
Copeland, E. B. 1563
Correa, H. 0473 0503 0573 1913 1962
Correa de M., B. C. Correa de R., M. 0590
Correia, F. A. 0184
Corriols 1971
Corseuil, E. 0831 0834
Cosenza, G. W. 0874
Costa, A. S. 0615 0744 0752
Costa, F. 0636
Costa, J. M. da. 0855
Costa, R. G. 0872
Cours, G. 0147 0155 0237 0431 0917 0919 1565 1946
Cours-Darne, G. J. M. 0958
Coursey, D. G. 1121 1260 1379 1966
Cousins, H. H. 0537 0565 1110 1372 1435
Coutinho, L. P. 1116
Covich, A. P. 1963
Cowgill, U. M. 1977
Cox, M. J. 1486
Crandall, B. S. 0581
Crawford, J. 0304
Crawford, M. A. 1200
Croizat, L. 0002 0032
Crossland, L. B. 1476
Cruz, N. D. 0064
Cruz, N. D. da 0019 0996
Cruz, S. R. 1743
Cruz M., H. G. 0150
Cruz R., L. C. 0222
Cuadrado, G. A. 1067
Czyhrinciw, N. 1638 1641

Dadwood, M. Y. 1167
Dame, C. 1064
Das, N. M. 0882
Das Gupta, H. P. 1456
Dauvrin, A. 1806
Davesne, A. 0219
Dechambre, M. 1341
Decker, J. S. 0060
De Cock, R. 0545
Defontaine 0878
De Geus, J. G. 0352
Deighton, F. C. 0706
Delange, F. 1172 1192 1195 1197 1198
Delcasso, M. 1803
Delgado, R. E. 0289
Delgado, T. E. 0977
Dendy, D. A. V. 1161 1581
Dentan, R. K. 0476
Deslandes, J. A. 0594
Desvergnes, L. 1115
Devendra, C. 1293
Devez, G. 0868
Dias, C. A. C. 0815
Dias, C. A. de C. 0384
Dias, M. 1104
Diaz, R. O. 0575 1517 1870 1901
Dimacali, A. 0496
Dina, J. A. 1886
Dinther, J. B. M. van. 0880
Doku, E. V. 0054 0906 1536 1956
Dole, G. E. 1551
Doa, J. D. 0474
Dommergues, Y. 0360
Doop, J. E. A. den 0353
Doughty, L. R. 0926 0935 0948
Dovlof, E. 1023
Drummond, O. A. 0623
Drummond, O. de A. 0586 0709
Drummond-Goncalves, R. 0580 0595 0611 0642 0657 0660 0708 0717
Duarte, A. C. 0155 1554
Duarte, E. F. 1976
Dubern, J. 0769
Dufournet, R. 1973
Dufrenoy, J. 0712
Dulong, R. 0296 1960 1961
Dumas, 0260
Dumont, J. E. 1193
Duncan, E. J. 0073
Dussel, L. 1859

Echandi, M. O. 1209
Edwards, D. 1496
Edwards, D. T. 1837
Eerley, R. W. 1235

Egels, W. 1723
Eggum, B. O. 0124
Eisenloeffel, A. 1672
Ekandem, M. J. 0328 0725 0740 1560 1957
Ekpechi, O. L. 1163 1190 1201
Ekundayo, J. A. 0681
Elías, L. G. 1152
Elskens, O. 0333
Emmons, D. B. 1448
Enriquez, F. Q. 1320 1356
Enyi, B. A. C. 0080 0106 0108 0488 0498 0542 0567
Ermans, A. M. 1171 1185 1191
Eskes, A. B. 0078
Espino, R. B. 0487
Esquivel, T. F. 0189
Estevao, E. de M. 0562
Estima, A. L. 1295
Estrada R., N. 0217 0291 0293 0295 0321 0342 1813
Etchegoyen, F. 1326
Etorma, S. B. 1430
Ettori, O. J. T. 1852
Everington, E. 1413

Falanghe, O. 1348
Fangauf, R. 1299
Farias, I. 1302
Fassi, B. 0671 0783
Fauchere, A. 0233 0438 0455
Favier, J. C. 0208 208 1419 1512
Fernandes, N. S. 1389
Fernandes, S. 1608
Fernandez, O. 1481
Fernandez Y., F. 0797
Fernando, M. 0470
Fernier, H. 0662
Ferrao, J. F. M. 1820
Ferreira, J. J. 1272
Ferrer, A. 1285
Fierens, P. 1586
Figueiredo, A. de A. 0168
Figueiredo, M. B. 0672
Figueiredo, M. M. 0676
Filho, J. C. 0133 1596
Filho, J. R. 0434
Flaws, L. J. 1709
Fleming, H. S. 0023 0923
Floch, H. 0161
Fonseca, J. P. da 0817 0828 0859 0863
Fonseca, N. G. da. 1993
Foo, L. C. 0183
Food and Agriculture Organization of the United Nations. 0531 1814 1867 1879
Food and Agricultural Organization of the United Nations. Food Research and Development Unit, Accra, Ghana. 1764
Food and Agricultural Organization of the United Nations. Industry Cooperative Programme. 1817
Forno, D. A. 0363
Forsteneichner, 0749
Foster, J. F. 1472 1477
Foster, L. J. 1769
Fox, R. H. 0409
Franchini, G. 0609
Francois, E. 0731 1589 1952
Franke, G. 0288
Frappa, C. 0829 0842 0850 0870
Fraser, D. M. K. 1234
Freire, J. R. J. 0614
Freise, F. W. 1760
Fricout, M. R. 0453
Fritz, A. 0283
Fritz, J. 0259 0452
Fuller, A. B. 1120
Fullerton, J. 1291
Fullgrabe, A. 1526 1629
Furlong, J. R. 1441

Gadelha, J. A. 1343
Gaide, M. 0267
Galang, F. G. 0268
Gall, F. 0601
Gallardo, A. L. 0532
Gallo, D. 0803
Galloc, A. 1884
Ganguly, B. 0763
García B., J. 0386
Gecan, J. S. 1746
Georgi, C. D. V. 1500
Ghana. Academy of Sciencies. 0903 1614
Ghesquiere, J. 0481
Ghosh, B. N. 1546 1602 1763
Gill, K. S. 1582
Glicksman, M. 1424
Godfrey-Sam-Aggrey, S. 0359
Godfrey-Sam-Aggrey, W. 1921
Godoy, J. M. de 1599
Gohier, M. 0312
Golato, C. 0600 0608 0668 0680
Goldfiem, J. de 1325
Golding, F. D. 0753 0822
Gonzalez J., J.O. 0899
Gonsalves, P.E. 1404
Gontijo, R.M. 1315
Gonzalez-Valdes, A. 1953
Go y, T. 0784
Gopalakrishna Rao, N. 1538
Gouin, A. 1240 1284
Govea, V. de S. 1508
Gramacho, D. 0207
Gramacho, D. D. 1232
Graner, E. A. 0069 0110 0381 0890 0893 0901 0988 0990 0991 0999
Grant, W. F. 0985
Gray, . D. 1777
Greenstreet, V. R. 0195 1988
Greenwood-Barton, L. H. 1964
Grillo, H. Y. S. 0691
Grimme, C. 1134

Gropp, J. 1231
Groskreutz, X. A. 1334
Groult, P. B. 1821
Guagliumi, P. 0844
Guernelli, O. 1127
Guilbot, A. 1445
Guillen, R. D. 0413 1869
Guilloteau, S. 0723 0962
Guimaraes, M. L. 1160
Gulliver, T. A. 0308
Gurnah, A. A. 0324
Gutheil, N. C. 1717

Hachero, L. 1649
Hahn, S. K. 0957
Halewijn, E.K.E. 1739 1745
Hall, C. J. J. van 0816 0881
Holliday, D. 1650
Hambleton, E. J. 0799
Hamid, K. 1318
Hansford, C. G. 0572
Hanson, A. P. 0250
Hansson, N. 1149 1154
Hao, P. L. C. 1790
Hargreaves, E. 0807
Harper, R. S. 0331 0422
Harris, D. R. 1929 1975
Harris, R. V. 1792
Hassain, Z. 0314
Hassania, Y. O. K. 0266
Haut de Sigy, G. de 0253
Hedin, L. 0251 0724
Heim, F. 1261
Heim, R. 0665
Hein, E. A. 1621
Hein, R. 1700 1753
Heiser Junior, C. B. 0035
Hellman, N. N. 1406 1451 1692
Henain, A. E. 0009
Hendriks, J. A. H. 0559
Henke, L. A. 1351
Henningsen, H. F. 1881
Henry, C. 0164
Henry, Y. 0247
Hernaez, A. 0425
Hernandez X., E. 0970
Hew, V. F. 1345
Higginbotham, R. S. 1431 1452 1489
Hill, D. C. 1380
Hixon, R. M. 1459
Hodge, J. E. 1433
Hofman, P. 1310
Hogger, C. 0778 0779
Holleman, L. W. J. 1530 1742 1895
Holleman, S. W. J. 1522
Hongsapan, S. 0390
Honsch, W. M. 1465
Hood, L. F. 1442 1625
Horii, S. 1383
Hossne G., A. J. 0485
Howell, D. D. 0197
Howie, G. W. 1342
Hrishi, H. 0916
Hrishi, N. 1822
Hsieh, P. T. 1443 1759
Hubert, P. 1989
Huchette, M. 1730
Hudson, B. J. F. 0153
Huertas, A. S. 0546
Hutagalung, R. I. 1269 1338 1363
Hutchinson, R. C. 1676

Ibn-Mohamed Tamin, M. S. 0107
Igbozurike, M. U. 1922
Indira, P. 0041 0100 0113
Ingleton, J. F. 1708
Ingram, J. S. 1498 1577 1645
Institut de recherches Agronomiques Tropicales et des Cultures Vivrieres 0313 0946 1943
Instituto Colombiano Agropecuario 0376
Instituto Colombiano Agropecuario. Manizales 0346
Instituto Nacional de Nutricion (Colombia) 1146
International Institute of Tropical Agriculture 1868
International Trade Centre UNCTAD—GATT 1871
Iousogie, E. O. 0572
Irvine, F. R. 0981
Irving, H. 0419
Ito, K. 1466
Iyer, A. P. 0238

Jacob, A. 0362
Jacoby, T. 0387
Jacquat, R. 1002
Jadot, J. 1132
Jalaludin, S. 1376
Jameson, J. D. 0454 0754
Janlekha, K. 1915
Janssens, P. 1917
Jansz, E. R. 0134 0215
Jaramillo M., G. 1410
Jarmai, S. 1628
Java. Department of Agriculture, Industry and Commerce 1555
Jeffers, H. E. K. 1089
Jennings, D. L. 0225 0719 0751 0886 0924 0971 0982 1941
Jeyaseelan, K. N. 0547
Joachim, A. W. R. 0145 1046
Johnson, I. M. 1727
Johnson, M. O. 1501
Johnson, P. T. C. 1328
Johnson, R. N. 0148
Johnston, A. 0597
Joia, J. 0172
Joly, R. L. 0770
Jones, W. O. 0001 0013
Jos, J. S. 0896 0998
Joseph, A. 0176
Joseph, K. 1049

Joseph, R. 1785
Jowett, D. 1052
Juarez G., L. 1313
Junqueira, A. A. B. 1799

Kaiser Bauxite Company 0309
Kamala, B. 1156
Kanapathy, K. 0404
Kannegieter, A. 0967
Kapil, R. P. 0802
Kartha, K. K. 0109
Karve, C. N. 1278
Kasasian, L. 0444 0446
Katiyar, K. P. 1741
Kaufman, C. W. 1698
Kaufmann, T. 0858
Kay, D. E. 1937
Kensinger, K. M. 0264
Kenya. Department of Agriculture 0528 0700 0702 0728 0904
Kerr, A. J. 1728
Kerr, R. W. 1460 1473
Kervegant, D. 0299
Ketiku, A. O. 0192 0209
Kiger, J. 1047 1765
Kitajima. E. W. 0736 0757 0759 0765 0777
Klein, W. 1241
Kloppenburg, T. G. A. 0458
Knight, J. W. 1446
Knudsen, F. E. 1755
Koch, L. 0248 0494 0959 0961 1147
Kohlmann, R. F. 1158 1804
Kok, E. A. 1265 1347
Kook Choo, T. L. 1223 1273
Koritowski C. A. 0798
Korula, S. 1068
Korytkowski, G., A. 0852
Koshy, T. K. 0281
Krauss, F. G. 1352
Krishnamurti, B. G. 1685
Krishnan, R. 0888
Krochmal, A. 0350 0389 0430 0479 0845 1533 1613
Krufferath, H. 0761
Kruijff E. de. 0607 1515
Kruyff, M. E. de 1559
Kumar, B. M. 0393
Kumar, H. 0483
Kundu, B. C. 1967
Kuppuswami, B. S. 0243
Kuppuswamy, S. 1514
Kurien, P. P. 1048
Kwee, W. H. 1137

Lagos U., J. A. 0226 1604
Lal, B. 0606 0648
Lambourne, J. 0357 0460 0555
Lan, M. J. 0502
Langlands, B. W. 0018
Lansky, S. 1487
Lartey. B. L. 1772
Lavigne, R. 1657 1680
Lavollay, J. 0196
Leather, R. I. 0655
Lebedef, S. 1549
Le Berre, S. 0203
Lecointe, P. 0220
Le Dividich, J. 1244
Lee, S. Y. 1839
Leefmans, S. 0796 0827 0862
Lefebre, P. 0738
Lefebre, P. C. 0825
Lehman, P. S. 0589
Lehmann, G. 1112
Leitao, A. B. 1897
Leitao, M. A. 1086
Leite, A. C. 1350
Leloussey, J. 1660
Leon, D. G. R. 0463
Leon, J. 0020 0938
Leonard, M. D. 0786
Lepage, H. S. 0824 0839
Leroy, A. M. 1246
Lertora C., J. 0523
Leslie, K. A. 1827
Leu, L. S. 0617
Levi, S. S. 1524
Lewis, Y. S. 1652
Lim, C. K. 0420
Lima, A. O. F. 0619
Lima, H. G. de. 1907
Lima, U. de A. 1504 1693
Lin Khor, G. 1780
Linares, F. A. 1004
Lira, M. B. 1031
Lister, R. M. 0710
Longman, K. A. 0086
Longuet, P. 1801
Lopez, H. 1122
Lopez de A., J. M. 1139
Lopez H., J. 0526
Lopez J., L. 0004
Lopez Z., M. 0418
Loria M., W. 0380 0450 0533
Lozano, J. C. 0497 0593 0612 0622 0627 0632 0639 0640
Luc, M. 0239 0781
Lugtmeijer, H. I. 0468
Lulofs, R. B. 0274
Luyken, R. 1027
Lyon, W. F. 0814 0836

McIntyre, K. H. 1264
McKinney, H. H. 0722
McMillan, A. M. 1349
Machado, A. 0506
Machado, E. L. 0541
Machado, F. de C. 1705
Machado S., A. 0501 0507
Madhava Rao, V. N. 0918
Magoon, M. L. 0102 0891 0900 0912 0932 0943 0953 0987 0992 0993 0994 0995 1985

Mahendranathan, T. 1259 1268
Main, F. M. 0538
Majumber, S. K. 1654
Makanjoula, G. A. 0442
Makene, W. J. 1184
Malavolta, E. 0370
Mallamaire, A. 0832
Mallevre, M. 1309
Mandal, R. C. 0355 0414
Maner, J. H. 1289 1297 1355 1400
Manjarrez M., B. 1361
Mansfield-Aders, W. 0841
Mantel, K. 1230
Manurung, F. 1595
Maraite, H. 0641
Marassi, A. 0332
Maravalhas, N. 1015 1039 1105 1411
Marcano L., J. 0185
Marcus, A. 0344
Marinet, J. 0320
Marriot, J. 1594
Marsh, T. D. 1229
Marshall, G. A. K. 0790
Martiis, P. de 1060
Martin, F. 0228 0323 1566
Martin, F. W. 0907
Martinez-Crovetto, R. 0012
Martino, G. 0129 1107
Marvalhas, N. 0186
Marwaha, P. S. 0306
Mason, R. R. 0005
Mason, T. G. 0087
Massal, E. 1082
Mathieu, E. 1926
Mathot, P. J. 1823
Mathur, M. L. 1220
Matos, P.L.P. de. 0568
Mattos, P. L. P. de. 0561
Maust, L. E. 1226 1276
May, L. C. 1923
Medard, R. 0068
Meeting on Fortification of Mandioca Products 1087
Meikler, R. A. 1478
Mejia C., T. R. 1247
Mejia F., R. 0329 0433
Melo, M. S. 1096
Melotii, L. 1148
Mendes, C. T. 0245 1507
Mendes, M. A. 1306
Mendiola, N. B. 0229
Menezes, D. M. de. 0499
Menon, M. K. 1932
Menon, M. R. 0746
Mercado, T. 0889
Merlini, A. 1408
Merny, G. 0782
Meyer, K. H. 1405 1468
Michaud, M. R. 1439
Miege, J. 0050 0057 0075 0884
Mier, J. M. 0335
Milanez, F. R. 0043
Minneman, P. G. 1979
Miranda, R. M. 1262
Mirrado, J. H. M. 0263
Modebe, A. N. A. 1312
Modrin, G. 1947
Mogilner, I. 0076 0093 0128 0508
Moh, C. C. 0081 0202
Mohme, H. 1228
Molestina O., E. 0230
Molinary-Sales, E. 0278
Molinyawe, C. D. 0270 0334 1006
Mondoñedo, M. 1212 1290
Moneskoso, G. L. 1164
Monge, F. 1935
Montaldo, A. 0140 0316 0379 0437 0598 0914 0949 1747 1748 1854 1968
Monte, O. 0820 0833 0873
Monteiro, F. P. 0509
Montgomery, R. D. 1386
Montilla, J. J. 1370
Montilla S., J. de J. 1288 1368
Montoya, L. A. 0042 0936
Moody, K. 0428
Moorjani, M. N. 1758
Morales, F. J. 0730
Moran, E. F. 0091
Moreira, N. 1499
Morgan-Rees, A. M. 1990
Morimoto, H. 1238
Morin, R. L. M. 1642
Morton, J. F. 1130
Moscrip, J. 1958
Mosha, A. C. 1045
Mosqueda V., R. 0234
Mota, T. P. 0177
Mouton, J. 0716
Mukherjee, S. 1020
Mullen, H. J. W. 1484
Muller, A. 0656
Muller, A. S. 0582 0652
Muller, H. R. A. 0720
Muñoz, G. A. 0142
Murthy, H. B. N. 0084 1101
Murty, K. S. 0079
Muthuskrishnan, C. R. 0396
Muthusaamy, P. 0130 0131 0138
Myers, I. H. 0788
Mysore. Central Food Technological Research Institute 1696

Nagaraja, V. 0693
Naismith, D. J. 1170
Nakano, O. 0818
Nara, S. 1482
Narayana Rao, M. 1040 1519
Nartey, F. 0094 0118 0121 0122 0156 0173
Nausbaum, S. J. 1577
Negrete L., F. M. 0838
Nestel, B. 1847 1972
Neto, J. S. A. 1024

Neumayer, P. 1624
Neuville, H. 1558
Neves, J. D. 1317 1359
Nguyen Cong Thanh 1597
Nichols, R. F. W. 0718 0755 0939 0978
Nickell, L. G. 0887
Nielsen, H. E. 1235
Nigeria. Department of Agricultural Research. 0171 0551 0711 0911
Nigeria. Department of Commerce and Industries 1072
Nigeria. Federal Institute of Industrial Research 1658 1664 1707
Nijveldt, W. 0806
Ninan, C. A. 0059
Nobre, A. 0055 0169 0232 1081 1550 1627 1648
Norman, J. C. 1008
Normanha, E. S. 0104 0244 0280 0322 0368 0371 0392 0435 0475 0522 0650 0686 0739 0789 0813 1007 1237 1253 1323 1377 1388 1506 1938 1940
Nunes, W. de O. 0261
Nusbaum, S. J. 1911
Nwokolo, C. 1175
Nwosu, N. A. 1919
Nyiira, Z. M. 0876

Obigbesan, G. O. 0543
Obihara, C. H. 0472
Obregon B., R. 0201 0290
Oei - Oharma, H. P. 0835
Oelsligle, D. D. 0214
Ofori, C. S. 0071 0358 0552
Ogihara, T. 1183
Oh Saw Yin 1249
Oke, O. L. 0206 1035 1056 1108 1131 1381 1385 1573
Okigbo, B. N. 0464 0518
Okusanya, B. A. O. 0736
Olaloku, E. A. 1316
Oliveira, J. E. D. de. 1074 1119
Oliveros, B. 0644
Olson, D. W. 1333
Onochie, B. E. 0439 0510
Oomen, H. A. P. C. 1063
Opfermann, E. 1767
Opsomer, J. E. 0773 0963
Oputa, C. O. 0534 0564
Ordoñez A., J. A. 1634
Orioli, G. A. 0152
Orshan, J. 1883
Ort, J. K. 0517
Ortiz, M. A. 0337
Osores, A. 0942
Osuntokun, B. O. 1165 1166 1173 1174 1179 1180 1181 1182 1188 1189 1196
Otoya A., F. J. 0809
Overeem, C. van 0694
Oyenuga, V.A. 0165 0175 1050 1287 1294

Pacca, D. W. 0625 0687
Pacheco, C. 0469
Pacheco, J. A. de C. 0181 1509 1623 1666 1757
Pages, A. 1093
Pakistan Council of Scientific and Industrial Research 1528
Palad, J. G. 1085
Paliwal, G. S. 0047
Pandeya, R. S. 0944 1392
Papadakis, J. 0319
Pape, G. 1070 1655 1734
Paprzycki, P. 0883
Park, Y. K. 1447 1682 1737
Parkinson, S. 1084
Parpia, H. A. B. 1012
Pascalet, M. 0745 0768
Patel, B. M. 1251 1322
Patiño, V. M. 1013
Paula, R. D. de G. 1636
Pechnik, E. 1109 1125 1129 1135
Peckolt, T. 1998
Peiris, E. A. 1562
Peixoto, R. 1267
Peixoto, R. R. 1187 1308 1353 1367
Pele, J. 1123
Penuliar, S. P. 1303
Peracchi, A. L. 0804
Percy, M. J. 1635
Perera, J. A. W. 1100
Perez, O. 0294
Pereira, A. L. G. 0610
Pereira, A. S. 0139 0210 1321 1393
Pereira C., O. 1021 1117
Perisse, J. 0198 1066 1091
Pernot, S. 1340
Peyrot, F. 1058
Pham, H. D. 1401
Phillips, P. G. 1094
Phillips, T. P. 1818 1872 1887
Phuah, C. H. 1357
Pickles, A. 0330
Piedrahita, W. 0440 0515
Pieris, N. 1399
Pierson, G. G. 1457
Pigatti, A. 0856
Pilac, L. M. 0211
Pillai, S. C. 1337
Pineda M., J. 1280
Pingale, S. V. 0826
Pittier, H. 0031
Polanco, I. de 0292
Pollock, . A. R. 1948
Pope, F. T. 1829
Portuguez A., J. D. 0092
Potter, A. L. 1475
Powell, P. E. 0677
Prabhudesai, V. R. 0083
Pramanik, A. 1659
Prentice, N. 1749
Prevot, P. 0388
Prudhomme, E. 0159

Purcell, J. G. 1575
Purseglove, J. W. 1980
Pushparajah, E. 1920
Pynaert, L. 0951 1983

Qudrat-I-Khuda, M. 1076 1440
Queier, H. 1378

Rahm, G. 0780
Raison, J. P. 0021
Rajagopalan, K. 1691
Rajasekharan, N. 1637
Ramakrishnan, C. K. 0664 0734
Ramasubban, S. C. 1912
Ramirez, J. H. 0160
Ramos-Ledon, L. J. 0182
Ramos, N., G. 1981
Rao, B. S. 1924
Rao, G. 1548
Rao, H. A. G. 0305
Rao, K. K. P. N. 1133
Rao, N. S. 0227
Rasper, V. 1427 1438 1454 1455 1485 1751
Raux, J. 1510
Raymond, W. D. 1014
Razafimahery, R. 1373
Rea, J. 0922 0931
Reddy, S. K. 1057
Regnaudin, A. 0275
Reiniger, C. H. 0851
Reinking, O. 0602
Rendon, M. 1275
Renvoize, B. S. 0038
Resenthal, F. R. T. 1412
Reynuaan, J. 0511 0566 1029
Ribeiro, O. 1153
Rice, H. L. 1053
Richards, M. B. 0132
Rieders, F. 1394
Rio de Janeiro. Instituto Nacional de Tecnologia 1547
Rios, F. 0338
Rios R., M. 0272 1949
Roa, G. 1576
Robbs, C. F. 0875
Roberts, J. 1910
Robin, J. P. 1432
Rodrigues, A. J. 1296
Rodriguez, N. F. 0310 0493 0500
Rodriguez V., M. 1568
Rogers, D. J. 0003 0006 0017 0025 0029 0032 0037 0162 0170 0553 0894 0965 1005 1898 1970
Roig y Mesa, J. T. 0034
Rojas S., A. 0539
Rollot, C. 0241
Romero S., J. I. 0847
Ronald, K. S. 1497
Rorer, J. B. 0692
Rosas S., C. 0423 0429
Rosenthal, F. R. T. 1471 1480 1754
Ross, E. 1332
Ross, H. B. 0036
Roverso, E. A. 1339
Roxas, M. L. 1574
Ruiz, J. F. 1493

Sacea, R. A. 0695
Sadasivam, K. V. 0072 0651 0658
Sadik, S. 0200
Sadki, S. 1384
Saint-Amand, J. D. de 0204 0411
Sam Raj, J. 0776
Samson, G. D. 1420
Samuels, G. 0410
Sanchez de B., C. A. 0478
SanJoval, G. M. 1544
Santos, G. A. L. dos. 0504
Santos, R. B. 0563
Sao Paulo. Agricultural Institute of the State. 0426
Sapin, P. 0986
Sarmiento, M. E. 0056
Sathyrajan, P. K. 0663
Savithri, P. 1537
Scaife, A. 0327 0505 0727
Schaller, R. von 1414
Scharenguivel, A. G. 1914
Scherry, R. W. 1103
Schery, R. W. 0007
Schewerin, K. H. 0028
Schmiedel, W. L. von 1520
Schmidt, C. B. 0343
Schmidt, H. D. 1841
Schmidt, H. L. 1151
Schmidt, N. C. 0242
Schoonhoven, A. van 0823
Schoonneveldt, J. C. 1930
Schopmeyer, H. H. 1752
Schwarz, M. B. 0635
Sechet, M. 0670
Seck, W. 1463 1490
Seemanthani, K. B. 0535
Seidemann, J. 1425 1647
Seigler, D. S. 0151
Sena, Z. F. de 0096 0111
Sene, D. 0061
Seneratna, J. E. 0044
Serck-Hanssen, A. 1176
Sergipe. Superintendencia da Agricultura e Producao 0354 0448
Serres, H. 1329 1218
Setzer, J. 0415
Shank, R. C. 1402
Shanmugavelu, K. G. 0525
Shanmugham, A. 0097
Sheng, C. Y. 0383
Shimada, A. S. 1336
Shipman, L. 1771
Shorts, R. 1545
Shultz, E. 1283
Shultz, T. A. 1292

Silberschmidt, K. 0703, 0762
Sills, V. E. 1770
Silva, A. de F. 1722
Silva, D. M. 0758
Silva, F. 0257
Silva, J. R. da 0307 0395 0397 0400 0921 0941
Silveira, A. H. da. 1579
Silvestre, P. 0246 0345 0955 1933
Singh, A. P. 0897 1000
Singh, K. D. 0436
Singh, K. K. 1606
Singmaster, J. A. 0212
Sinha, S. K. 0112 0123
Siqueira, F. T. de 1736
Siskind, J. 1126
Sivagami, R. 0854
Sivan, P. 0045
Smart, H. P. 1580
Smith, B. G. C. 0053 0477
Smith, C. E. 0024
Smith, K. M. 0764
Smith, L. R. 0224
Soares, P. R. 1219 1271
Sobriho, V. 0039
Soehardjan, M. 1944
Sohmer, S. H. 0027 0049 1001
Soliven, F. A. 1417
Solorzano H., A. 0544
Somasundaram, S. S. 1669
Spencer, R. 0051
Spicer, A. 1782
Spickett, R. G. W. 1026
Splittstoesser, W. E. 0190
Sprung, D. W. 1773
Squibb, R. L. 1242
Sreekantiah, K. R. 1766
Sreeramamurthy, V. V. 1062
Srinivasan, K. 0105
Srivastava, H. C. 1461
Srivastava, K. C. 0643 0654
Srivastava, L. M. 0074 0137
Staner, P. 0766
Stanton, W. R. 1775 1794
Steck, K. H. 1225
Stehle, H. 0271 0347
Stephens, D. 0385
Steppler, H. A. 1802
Steyaert, R. L. 0045
Storey, H. H. 0714 0735 0760 0960
Stovall, R. P. 0302
Strauch, D. 1825
Strasser, J. 1781 1783 1795
Stuart, T. H. 0514
Subrahmanyan, V. 1009 1016 1025 1032 1037 1038 1042 1051 1071 1073 1099 1106 1113 1159 1416 1418 1732 1735
Subramanian, SA. 0216
Sundhagui, M. 1687
Sur, G. 1034
Sutherland, E. C. 1543
Sutra, R. 1444
Swaine, G. 0800
Swaminathan, M. 1703
Sykes, J. T. 0099 0491

Tabangui, M. A. 1679
Tabayoyong, T. T. 1208
Takeshita, M. 1694
Takyi, S. K. 0373
Tan, K. H. 0276
Tang, P. S. 0090
Tanganyika. Ministry of Commerce and Industry. 1903
Tapia, E. A. 0787
Tardieu, L. 1835 1858
Tardieu, M. 0417 0975 1978
Tasker, P. k. 1022 1150
Tavares, M. 1861
Taylor, J. n. 1688
Teixeira, C. 1671
Teixeira, C. G. 1467
Tejada, A. A. 1088
Tejada de H., L. 1222
Teleni, E. 1366
Tempany, H. A. 1965
Temperton, H. 1277
Templeton, J. K. 0048
Terra, G. J. A. 1092
Teulieres, R. 1797
Thailand. Ministry of Economic Affairs. 1601 1702
Thakur, M. L. 0178
Thankappan, M. 0737
Thilly, C. H. 1194
Thomas, W. G. 1866
Thompson, A. 0689 0696
Thompson, F. W. 1327
Thompson, H. J. 1716
Thompson, R. L. 0465
Thurston, H. D. 0704
Tidbury, G. F. 0721
Tillon, J. P. 1331
Tkatchenko, B. 1583 1587 1590 1591 1593 1616 1690 1744 1762
Toledo, A. P. de 0058 0066
Toledo, F. F. de 0218 1319
Toller, R. W. 0591
Tondeur, R. 1863
Torneur, M. 0300
Torres, A. de P. 1215 1248
Torres, F. S. 1529
Torres, J. R. 1365
Tosello, A. 1656
To-Tam, N. 1422
Trevelyan, W. E. 1793
Trivandrum. Central Tuber Crops Research Institute. 0898 0930 0956
Tropical Products Institute 1850
Tseng, R. H. 1640
Tsuchiya, M. 1603
Tulananda, D. 1826
Turnock, B. J. W. 0205

Ufer, M. 1017
Umanah, E. E. 0157 0969 0997
Universidad Central de Venezuela, Maracay. Facultad de Agronomia. 1908
Urich, F. W. 0795
Urueta, E. 0869
Urueta, E. J. 0867
Uzozie, L. C. 1928

Vaivanijkul, P. 0811
Valdivieso, C. A. 1206 1364
Valenzuela S., G. 1768 1832
Van Biema, G. 1639 1733
Van Veen, A. G. 1090
Van Veen, M. S. 1010
Vargas C., C. 1951
Varon R., F. H. 0596
Vasconcelos, D. de M. 0574
Vasudevan, K. N. 0885 0954
Veendam. Nivoa Bv. 1535
Vega F., E. 0519
Velden, M. van der 1397
Velikaya, E. I. 1437
Velloso, L. 1205
Velly, J. 0398
Venkat Rao, S. 1157
Venkatachallum, C. N. 1695
Venugopalan, S. 1842
Verma, U. P. 1689
Verteuil, J. de 0339 0432
Viegas, A. P. 0645 0678 0679 0682 0688 0690
Viennot-Bourgin, G. 0666
Vignoli, L. 1534
Vijayan, M. R. 0403
Virieco, S. D. 0298
Viswanathan, P. N. 0088 0089 0136 0187 1407 1436
Vitti, P. 1622 1678
Vogt, H. 1204 1257 1279
Voisin, J. C.
Vries, C. A. de. 0558

Waffelaert, T. 0399
Walker, A. 1227
Walker, H. 1882
Wang, H. F. 0530
Webb, b. H. 1686
Wegmann, K. 1651 1725
Weiss, B. E. 0366
Wernimont, K. 1845
Westeijn, G. 1450
Whitty, E. B. 0297
Wholey, D. W. 0095 0443
Wiehe, P. O. 0620
Wijeratne, W. B. 0252
Will Perera, J. A. 2000
Williams, A. E. 1731
Williams, A. O. 1177
Williams, C. N. 0098 0126 1630
Williams, L. 1925
Williams, R. J. 0613
Williams, T. L. 0913
Williams, W. A. 1984
Wilson, J. 1162
Wilson, K. I. 0649
Woillet, J. C. 1982
Wolf, F. A. 0583
Wood, T. 0163 0174 1371
Woodman, H. E. 1203 1217
Woolen, A. H. 1786
Wurzburg, O. B. 1409 1491

Yeoh, H. H. 1991
Yoshida, M. 1245

Zacher, F. 0866
Zanzibar. Department of Agriculture 0527
Zapata, A. O. 1307
Zarate, J. J. 1216
Zausch, M. 1330
Zikan, W. 0808 0821
Zimmermann, A. 0934 1807 1939
Zitnak, A. 0180
Zoby, J. L. F. 1301

SUBJECT INDEX

Absorption 0071 0214 0244 0351 0352 0359 0372 0387 0390 0393 0398 0898 1164 1197 1406

Acaricides 0869 0876 0879

Adaptation 0339 0541

Adhesives 1688 1695

Agbeli Kaklo
Analysis 1023
Processing 1023 1498

Agricultural equipment 0831
Costs 0426 0430 0439 0440 0442 0466 0485 1855 1856 1989
Land preparation 0355
Planting 0333 0430 0496 1989

Alcohol 1685 1694 1717 1831
Fermentation 1423 1467 1508 1540 1574 1599 1603 1679 1681 1683 1724 1790
Processing 0349 1423 1467 1506 1508 1540 1574 1579 1599 1674 1676 1681 1683 1724 1731 1790
Production 1507 1508 1540 1574 1599 1676 1683 1731 1790
Uses 1507 1701

Aleyrodidae 0328 0735 0742 0746 0756 0761 0769 0775 0776 0791 0822 0849 0850 0870

Aluminium sulphate 1739

Aminoacids 0190 1004 1033 1049 1083 1119 1122 1155 1181 1196 1256 1333 1381 1390 1421 1970
Analysis 0037 0072 0115 0117 0121 0737 1030 1040 1053 1062 1078 1095 1113 1129 1135 1173 1332 1573 1780 1964
Deficiencies 1136 1157 1174 1200 1332 1756
Dietary value 0124 1024 1030 1058 1113 1136 1152 1157 1158 1199 1223 1263 1269 1320 1354 1363 1400 1401 1748
Industrial microbiology 1780 1782
Leaves 0037 0072 0121 0122 0124 0148 0149 0162 0206 1027 1058 1092 1109 112, 1129 1130 1135 1136 1223 1268 1269 1332 1363 1748 1953
Storage 1401 1573 1782
Tubers 0148 0369 0647 1027 1040 1059 1062 1573 1953

Ammonium sulphate 0419

Amorphophallus 0074 0945

Amygdalin 0127
Metabolism 0114

Anaemia 1162 1178

Anastrepha pickell 0110

Insect control 1994

Animal Physiology 1022 1030 1049 1071 1120 1150 1157 1163 1182 1214 1223 1269 1316 1322 1332 1338 1354 1357 1376 1389 1390 1403
HCN Toxicity 1392

Anthers 0058 0064 0886 0897 0998

Aonidomytilus albus 1960 1961
Insect control 0225 0589 0800 0854
Insecticides 0800 0854 0898
Maps 0819
Resistance 0898 0930

Arracacia 0599 1006 1641

Arcorbic acid 0161 0164 0203 1014 1748

Ash content 0004 0037 0144 0176 0177 0182 0198 0201 0203 0370 1021 1024 1040 1043 1047 1051 1054 1056 1109 1131 1209 1210 1223 1232 1268 1369 1416 1501 1522 1526 1530 1534 1547 1698 1748 1751 1977

Aspergillus 0681 1402 1732
Aminoacid content, altered by 0647
Industrial microbiology 1737 1773 1787 1793

Ataxic neuropathy 0120 1181
Clinical manifestations 1053 1162 1166 1173 1177 1179 1180 1182 1184 1188 1189 1196 1380
Cyanides 1166 1177 1179 1180 1182 1184 1188 1189 1196 1380
Diets 1166 1174 1180 1181 1182 1188 1189 1196 1380
Etiology 1166 1174 1 11 111111111

Absorption 0071 0214 0244 0351 0352 0359 0372 0387 0390 0393 0398 0898 1164 1197 1406

Acaricides 0869 0876 0879

Adaptation 0339 0541

Adhesives 1688 1695

Agbeli Kaklo
Analysis 1023
Processing 1023 1498

Agricultural equipment 0831
Costs 0426 0430 0439 0440 0442 0466 0485 1855 1856 1989
Land preparation 0355
Planting 0333 0430 0496 1989

Alcohol 1685 1694 1717 1831
Fermentation 1423 1467 1508 1540 1574 1599 1603 1679 1681 1683 1724 1790
Processing 0349 1423 1467 1506 1508 1540 1574 1579 1599 1674 1676 1681 1683 1724 1731 1790
Production 1507 1508 1540 1574 1599 1676 1683 1731 1790
Uses 1507 1701

Aleyrodidae 0328 0735 0742 0746 0756 0761 0769 0775 0776 0791 0822 0849 0850 0870

Aluminium sulphate 1739

Aminoacids 0190 1004 1033 1049 1083 1119 1122 1155 1181 1196 1256 1333 1381 1390 1421 1970
Analysis 0037 0072 0115 0117 0121 0737 1030 1040 1053 1062 1078 1095 1113 1129 1135 1173 1332 1573 1780 1964
Deficiencies 1136 1157 1174 1200 1332 1756
Dietary value 0124 1024 1030 1058 1113 1136 1152 1157 1158 1199 1223 1263 1269 1320 1354 1363 1400 1401 1748
Industrial microbiology 1780 1782
Leaves 0037 0072 0121 0122 0124 0148 0149 0162 0206 1027 1058 1092 1109 1124 1129 1130 1135 1136 1223 1268 1269 1332 1363 1748 1953
Storage 1401 1573 1782
Tubers 0148 0369 0647 1027 1040 1059 1062 1573 1953

Ammonium sulphate 0419

Amorphophallus 0074 0945

Amygdalin 0127
Metabolism 0114

Anaemia 1162 1178

Anastrepha pickell 0110

Insect control 1994

Animal Physiology 1022 1030 1049 1071 1120 1150 1157 1163 1182 1214 1223 1269 1316 1322 1332 1338 1354 1357 1376 1389 1390 1403
HCN Toxicity 1392

Anthers 0058 0064 0886 0897 0998

Aonidomytilus albus 1960 1961
Insect control 0225 0589 0800 0854
Insecticides 0800 0854 0898
Maps 0819
Resistance 0898 0930

Arracacia 0599 1006 1641

Arcorbic acid 0161 0164 0203 1014 1748

Ash content 0004 0037 0144 0176 0177 0182 0198 0201 0203 0370 1021 1024 1040 1043 1047 1051 1054 1056 1109 1131 1209 1210 1223 1232 1268 1369 1416 1501 1522 1526 1530 1534 1547 1698 1748 1751 1977

Aspergillus 0681 1402 1732
Aminoacid content, altered by 0647
Industrial microbiology 1737 1773 1787 1793

Ataxic neuropathy 0120 1181
Clinical manifestations 1053 1162 1166 1173 1177 1179 1180 1182 1184 1188 1189 1196 1380
Cyanides 1166 1177 1179 1180 1182 1184 1188 1189 1196 1380
Diets 1166 1174 1180 1181 1182 1188 1189 1196 1380
Etiology 1166 1174 1182 1188 1189 1196

Atieke
Processing 1660

Backcrossing 0281 0527 0718 0886 0908 0932 0940 0944 0948 0964 0978 0982 0994

Bacterioses 0009 0242 0244 0296 0497 0577 0584 0585 0597 0599 0604 0607 0610 0613 0616 0620 0621 0624 0628 0630 0631 0632 0634 0635 0637 0638 0642 0658 0659 0957 1151 1464 1938 1943 1976
Disease control 0280 0294 0296 0427 0579 0589 0592 0593 0594 0595 0596 0601 0611 0612 0614 0617 0618 0619 0622 0623 0625 0626 0627 0629 0633 0636 0639 1962
Resistance 0242 0244 0349 0427 0604 0610 0633 0635 0639 0866 0957 1464

Bakery products 0271 0299 0347 1023 1044 1055 1060 1070 1100 1112 1138 1161 1495 1498 1501 1581 1584 1590 1591 1593 1616 1631 1663 1690 1753 1861

Banana-plantains 0203 1003 1011 1200 1419 1573 1928

Bananas 0558 1244 1286 1419

Bemisia 0585 0698 0787 0791 0975
Cassava mosaic virus 0328 0733 0735 0742 0746 0750 0753 0756 0763 0776 0850 0930 0969
Insect control 0280 0849 0870

Beverages 0220 0330 1510 1612
Processing 1598

Biochemistry 0074 0088 0117 0122 0136 0137 0143 0163 0166 0167 0187 0191 0215 0620 0647 0783 0957 1059 1139 1150 1157 1165 1174 1179 1184 1185 1391 1399 1407 1432 1436 1437 1447 1454 1471 1479 1480 1528 1543 1755 1766

Biological control 0329 0749 0809 0813 0817 0831 0862 0876

Bitter cassava 0038 0123 0135 0140 0142 0179 0193 0229 0250 0308 0349 0356 0369 0571 0727 0768 1045 1088 1095 1111 1321 1377 1386 1665 1729 1989
Plant anatomy 0010 0063 0333 0991 1936
Starch content 0177
Tuber productivity 0914

Boiling 1111 1631
Detoxification 0114 0145 1125
Leaves 0114 0145 1125
Tubers 0114 0145 1240 1388

Boron 0147 0155 0420
Deficiencies 0197 0350

Branching 0025 0037 0054 0056 0057 0068 0513 0938 0949

Bread improvers 1112
Calcium stearyl lactylate 1070 1734
Sodium stearyl lactylate 1734

Breads 0347 1112
Analysis 1060 1117 1138 1446
Cassava flour 1055 1064 1070 1107 1117 1138 1145 1581 1621 1663 1690 1753

Brewers grains 1715

Calcium 0124 0144 0147 0152 0158 0176 0198 0359 0363 0410 0414 0747 1017 1034 1048 1051 1056 1089 1093 1131 1220 1294 1512 1526 1883 1977
Deficiencies 0350
Tuber productivity 0106 0352 0373 0488

Calcium chloride 1739

Calcium stearyl lactylate 1070 1734

Calcium superphosphate 0368 0397

Canopy 0475

Carbohydrate content 0182 0201 0209 0898 0930 0956 1043 1046 1047 1051 1056 1111 1114 1134 1149 1170 1526 1537 1782 1795 1970
Leaves 0037 0089 0144 0175 0767 1054 1209 1232 1748
Stems 0037 1209 1232
Tubers 0175 0203 0647 1054 1062 1777

Carpels 0058 0064

Carpolonchaea chalybea 0224 0312 0789 0794 0795 0798 0935 1505 1562
Biological control 0329
Insect control 0294 0418 0483 0812 0877
Insecticides 0294 0313 0843 0867 0877

Casave 1146
Processing 0230 0532 1028 1498

Cassareep 1054
Processing 0230 0284 1100 1721
Uses 0284 1740 1997

Cassava bacterial blight
Disease control 0497 0612 0622 0627 0633 0640
Etiology 0627 0632

Cassava beer
Composition 1029 1542 1547 1598
Processing 1510 1598

Cassava bread 0230 0453 0532 1028 1067 1100 1146 1498 1558
Analysis 1117 1749
Detoxification 1029 1054
Protein content 1044 1047 1054
Soybean flour 1044

Cassava brown streak virus 0600 0700 0729 0971
Disease control 0593 0714
Etiology 0593 0736 0755
Resistance 0701 0702 0719 0914 0939 0948 0964 0978
Virus transmission 0710

Cassava cheese
Industrial microbiology 1774 1775 1779 1786 1787 1789 1792 1794
Processing 1775 1786 1787 1792
Proteins 1774 1775 1779 1786 1787 1789 1792 1794
Rhizopus stolonifer 1774 1775 1787 1794
Yeast production 1774 1789

Cassava chips 1151 1220 1311 1568 1619
Cattle 1224 1235 1243 1325 1867
Consumption 1496 1867 1875
Costs 1263 1496 1756 1875 1881 1883 1895 1901

Detoxification processes 0145 1391
Development costs 1496
Drying 0145 1548 1576 1595 1597 1607 1608 1622 1657 1680 1706
HCN content 0145 1235 1399
Industrial machinery 1496 1517 1595 1597 1622 1645 1649 1657 1816
Industrialization 0826 1496 1517 1659 1680 1756 1790 1875 1882 1883 1895
Marketing 1235 1391 1496 1597 1659 1756 1816 1826 1866 1867 1875 1881 1882 1883 1895 1901
Packaging 1816 1875
Prices 1496 1659 1826 1867 1875 1883 1901
Processing 1391 1496 1517 1548 1579 1585 1595 1597 1601 1607 1608 1622 1649 1657 1680 1723 1756 1790 1816 1875 1881 1895
Solar drying 1548 1595 1608 1680 1706
Storage 1571 1585 1595 1597 1607 1651 1706 1728 1875
Injurious insects 0826 0842
Swine 1224 1235 1365 1866 1867
Trade 1235 1496 1657 1659 1816 1826 1866 1867 1875 1881 1882 1883 1895 1901

Cassava common mosaic virus 0225 0615 0739 0744 0757 0765 0772 0774 0777 1938
Disease control 0579 0592 0593 0596 0601 0705 0708 0730
Germination, effects on 0717
Resistance 0244 0604 0709
Rooting, effects on 0717
Tuber productivity 0699
Virus transmission by grafting 0762

Cassava flour 0219 0331 0453 1048 1064 1070 1080 1096 1101 1132 1139 1144 1145 1150 1153 1155 1161 1219 1243 1340 1462 1497 1569 1581 1619 1645 1646 1690 1734 1741 1765
Composition 0145 0149 0153 0174 0176 0232 0271 0275 0290 0349 1016 1029 1031 1033 1039 1042 1044 1045 1046 1047 1051 1055 1067 1071 1073 1077 1078 1085 1095 1106 1107 1111 1113 1115 1117 1134 1146 1154 1157 1160 1276 1325 1341 1399 1401 1495 1501 1525 1430 1534 1564 1584 1598 1599 1663 1677 1698 1700 1733 1751 1792 1793
Consumption 1031 1550 1714 1850 1875 1879 1888 1958
Costs 0227 0271 1501 1599 1627 1663 1783 1875 1901
Deterioration 1071 1571 1651 1700 1725 1764
Detoxification processes 0145 1401 1551
Digestibility 1217 1226 1276 1330 1341 1401
Drying 0145 0176 0230 0275 0343 1025 1111 1138 1401 1501 1514 1530 1621 1711 1729 1742 1764
Feed mixtures 1016 1071 1077
Industrial machinery 0230 0275 1495 1544 1639 1711 1984
Industrial microbiology 1023 1599 1775 1779 1786 1787 1792 1793 1794
Industrialization 0223 0232 0271 0275 1077 1111 1147 1495 1499 1502 1530 1539 1550 1559 1578 1598 1599 1621 1639 1655 1663 1673 1677 1678 1698 1711 1714 1735 1738 1753 1764 1775 1787 1797 1831 1850 1875 1882 1888 1989 1996
Marketing 0223 0232 0456 1031 1558 1677 1714 1738 1800 1804 1812 1824 1826 1831 1834 1839 1850 1861 1863 1865 1874 1875 1879 1885 1899 1901 1909 1989
Nutritive value 0149 0290 1016 1025 1042 1045 1051 1057 1065 1071 1073 1074 1077 1081 1085 1106 1107 1113 1117 1119 1137 1154 1225 1401 1495
Organoleptic examination 1067 1081 1119 1137 1138 1698
Palatability 1025 1039 1138 1154 1158
Patents 1794
Prices 0223 0232 0271 1550 1677 1826 1850 1875 1879 1885 1888 1901 1909 1916 1989
Processing 0176 0223 0230 0231 0271 0275 0290 0305 0343 0349 1023 1025 1028 1071 1077 1104 1111 1141 1147 1395 1495 1499 1501 1503 1504 1515 1516 1525 1530 1533 1536 1544 1551 1558 1559 1564 1574 1579 1598 1599 1611 1615 1621 1645 1647 1655 1663 1673 1778 1689 1698 1711 1723 1729 1735 1738 1742 1751 1764 1775 1783 1786 1787 1792 1793 1797 1875 1958 1989
Production 0232 0271 0275 1045 1071 1099 1284 1296 1495 1501 1530 1550 1559 1574 1578 1599 1627 1663 1678 1775 1797 1834 1874 1875 1882 1916
Protein content 0232 1044 1046 1047 1051 1078 1095 1107 1111 1137 1401 1501
Storage 0176 1042 1401 1514 1525 1571 1651 1700 1725 1764 1875
Injurious insects 0587 0811
Swine 1154 1217 1225 1226 1296 1325 1330 1958
Trade 0456 1558 1578 1663 1677 1714 1800 1812 1826 1831 1834 1839 1850 1861 1863 1865 1874 1875 1882 1888 1901 1989 1996
Water content 0153 1039 1046 1047 1051 1501 1525 1530 1534 1698 1700

Cassava leaves (vegetable) 1092
Animal nutrition 0175 1019 1147 1319

Composition 0175 1019 1045 1090 1124 1319 1401
HCN content 1401
Human nutrition 0175 1019 1030 1080 1086 1090 1124 1147
Nutritive value 0175 1019 1030 1045 1090 1401
Protein content 0175 1019 1030 1090 1319 1401

Cassava meal 0220 1151 1208 1215 1221 1237 1242 1248 1249 1256 1266 1275 1288 1302 1343 1349 1358 1359 1368 1543 1702 1777 1798 1946
Boiling 1240
Composition 0141 0232 0532 1019 1021 1024 1056 1078 1085 1089 1091 1094 1095 1114 1127 1131 1149 1152 1160 1204 1209 1210 1222 1223 1235 1245 1257 1261 1271 1282 1289 1291 1301 1323 1332 1348 1356 1363 1369 1383 1429 1512 1522 1525 1596 1677 1745 1827 1862 1883 1964
Concentrates 1089 1236 1305 1364
Consumption 1512 1714 1827 1850 1859 1867
Deterioration 1056
Detoxification processes 1391
Digestibility 1066 1091 1094 1204 1223 1241 1257 1261 1272 1277 1279 1335 1364 1419 1512
Drying 1019 1021 1089 1129 1131 1419 1505 1628 1630 1657
Egg production 1299 1318
Fattening 1187 1205 1207 1210 1223 1231 1233 1254 1257 1289 1301 1310 1335 1342 1353 1355 1367
Feed mixtures 1282 1364
Industrialization 0232 1429 1505 1506 1512 1517 1522 1539 1628 1643 1677 1678 1714 1738 1782 1787 1850 1882 1883
Factories 0232 1506 1539 1677 1714
Nutritive value 0141 1019 1056 1085 1089 1114 1129 1131 1149 1152 1187 1207 1222 1225 1236 1245 1253 1254 1283 1309 1310 1313 1320 1320 1332 1333 1335 1342 1356 1361 1363 1429 1512 1782 1883
Organoleptic examination 1596
Palatability 1024 1187 1203 1206 1310
Pellets, comparative dietary value 1204 1230 1235
Prices 0232 1210 1347 1677 1811 1826 1850 1867 1883 1885
Processing 0279 0532 1019 1021 1041 1127 1129 1131 1240 1253 1257 1419 1429 1505 1506 1512 1517 1522 1525 1579 1596 1600 1628 1630 1643 1657 1678 1699 1738 1745 1787
Storage 0587 1021 1056 1505 1525 1782
Swine 1187 1203 1205 1207 1210 1223 1225 1231 1233 1235 1236 1244 1261 1271 1289 1291 1301 1308 1310 1335 1336 1342 1345 1347 1351 1353 1355 1363 1367 1862 1867 1964
Trade 1235 1429 1505 1600 1643 1657 1677 1714 1811 1826 1827 1839 1850 1859 1862 1867 1874 1882 1883

Cassava mosaic virus 0225 0288 0300 0551 0578 0587 0600 0608 0700 0703 0708 0714 0715 0716 0721 0731 0732 0734 0737 0740 0744 0749 0754 0759 0762 0764 0767 0769 0911 0971 1936 1957 1961
Bemisia 0328 0733 0735 0742 0746 0750 0753 0756 0763 0776 0850 0930 0969
Disease control 0587 0589 0592 0593 0596 0601 0706 0708 0714 0716 0720 0733 0743 0745 0756 0758 0763 0770 0773 0898 0930 0942 0956
Effect on leaf anatomy 0741
Etiology 0592 0593 0601 0704 0735 0736 0756
Maps 0707
Photosynthesis 0748 0906
Resistance 0604 0698 0701 0702 0704 0723 0725 0726 0727 0728 0738 0751 0760 0768 0770 0776 0891 0898 0903 0906 0913 0926 0935 0939 0948 0956 0957 0958 0962 0963 0964 0967 0973 0978 0980 0984 1946
Vectors 0328 0733 0735 0742 0746 0750 0753 0756 0761 0768 0775 0850
Virus inhibition 0242 0733 0743 0756

Cassava pastes 0176 0208 0220 0284 0453 1131 1419 1512 1560 1660 1683 1699 1751 1787

Cassava products 0013 0036 0179 0252 0284 0305 0314 0337 0438 0469 0826 1025 1053 1054 1087 1121 1141 1379 1525 1571 1577 1605 1619 1660 1697 1718 1722 1742 1748 1751 1800 1818 1829 1845 1864 1871 1872 1887 1896 1904 1910 1946 1953 1957 1986 1987 1989 1994 1997
Fresh products 0145 1289 1555
Cassava leaves (vegetable) 1030 1045 1147
Cassava tubers (vegetable) 0811 1045 1355 1401 1875
Processed products 0332 1212 1542
Casave 0230 0532 1028 1146
Cassareep 0230 1721 1740
Cassava beer 1029 1542 1598
Cassava bread 0230 0532 1028 1029 1044 1146 1558
Cassava cheese 1775
Cassava chips 0145 1151 1235 1243 1399 1496 1517 1579 1826 1867 1875 1883 1901
Cassava flour 0145 0174 0219 0230

0231 0232 0349 0456 0811 1016 1023 1028 1029 1031 1044 1045 1065 1101 1104 1144 1146 1147 1150 1153 1158 1160 1217 1225 1226 1243 1399 1401 1497 1499 1501 1503 1514 1515 1539 1550 1558 1579 1598 1599 1615 1714 1729 1741 1775 1783 1812 1824 1826 1839 1875 1879 1885 1901 1996
Cassava meal 0220 0232 0532 1041 1066 1114 1151 1160 1202 1204 1206 1207 1210 1223 1225 1235 1242 1282 1299 1309 1332 1355 1358 1369 1429 1512 1517 1539 1579 1699 1714 1811 1826 1839 1859 1867 1883 1885
Cassava milk 1160
Cassava starch 0230 0232 0340 0532 1023 1066 1146 1147 1399 1405 1409 1406 1411 1426 1430 1431 1452 1496 1509 1517 1540 1558 1634 1656 1687 1721 1739 1746 1769 1773 1783 1812 1819 1859 1867 1875 1901 1905 1988 1996
Dumboi 1699
Farinha 0330 0349
Foo-foo 1631
Gaplek 1147 1515 1598
Gari 0174 0219 1066 1401 1429 1512 1631 1775 1783 1883
Landang 1114
Pellets 1204 1235 1496 1826 1867 1883
Pulp 0145 0249
Tapioca 0219 0230 0231 0232 0330 0456 0532 1023 1041 1497 1515 1555 1579 1714 1721 1812 1859 1875 1901 1988

Cassava programs 0252 0321 0345 0457 0557 0923 1045 1087 1566 1577 1659 1769 1809 1817 1822 1851 1853 1864 1875 1892 1893 1935 1969
Animal nutrition 0272 1382 1802 1866 1868 1887 1911 1994
Developmental research 0003 0221 1846 1898 1908
Germplasm 0910 0947 0970 1382 1890 1913
Human nutrition 0951 1012 1020 1032 1155 1382 1802 1868 1887 1898 1911
Plant breeding 0221 0423 0526 0909 0910 0915 0947 0951 0955 1155 1898 1994

Cassava starch 0088 1146 1428 1435 1440 1526 1544 1553 1589 1599 1737 1742 1807 1821 1838
Alcohol 1423 1506 1540 1574 1681 1683 1694 1731 1790 1831
Analysis 0074 0084 0137 0167 0187 0209 0275 1023 1060 1076 1140 1405 1406 1407 1411 1412 1416 1422 1425 1427 1430 1431 1432 1433 1434 1436 1437 1438 1442 1443 1444 1446 1447 1451 1452 1453 1454 1455 1457 1458 1459 1460 1461 1463 1468 1473 1474 1475 1476 1477 1479 1481 1482 1483 1484 1488 1489 1490 1509 1519 1528 1574 1586 1625 1633 1656 1683 1698 1730 1739 1746 1752 1754 1757 1766 1773 1841
Consumption 1299 1496 1546 1547 1817 1850 1867 1875 1886 1958
Content in cassava chips 1399 1496 1517 1571 1622 1645 1790 1867 1875 1882 1895 1901
Costs 0227 0229 0532 1352 1496 1505 1535 1557 1561 1620 1663 1769 1783 1819 1830 1875 1886 1895 1901 1905 1981 1988
Deterioration 1402 1430 1571
Dextrins 1409 1410 1423 1493 1656
Digestibility 1066 1069 1076 1091 1140 1419
Drying 0230 0275 1419 1492 1505 1529 1546 1622 1633 1634 1656 1692 1726 1770 1988
Enzymes 0074 0084 0136 0137 0167 0187 1069 1076 1399 1419 1421 1433 1436 1447 1454 1471 1480 1755 1766
Ethanol 1423 1989
Factories 0232 0265 0275 1413 1414 1493 1496 1506 1520 1529 1535 1547 1561 1580 1583 1587 1590 1591 1593 1609 1616 1620 1624 1652 1663 1687 1726 1727 1744 1769 1770 1783 1817 1819 1875 1886 1903 1988 1989
Fermentation 1023 1054 1066 1419 1423 1540 1574 1652 1681 1683 1773 1785 1790 1989
Fibre content in 1054 1416 1455 1519
Gelatinization 1412 1438 1454 1455 1465 1476 1484 1486 1488 1490 1609 1695 1739 1754
Glucose 0209 1410 1413 1419 1449 1546 1547 1731 1744
Hydrolysis 0209 1419 1433 1490 1574 1755 1761 1766 1773 1886
Industrial machinery 0229 0230 0265 0275 1492 1496 1505 1517 1520 1535 1545 1546 1622 1645 1675 1727 1886 1989
Industrial starches 1458 1459 1561 1547 1570 1583 1587 1590 1591 1616 1675 1730 1739 1744 1752 1831 1882 1886 1989
Industrialization 0223 0229 0232 0275 1147 1413 1414 1418 1441 1458 1465 1492 1493 1496 1505 1506 1509 1517 1520 1529 1535 1545 1546 1547 1561 1562 1563 1566 1580 1583 1591 1604 1609 1620 1622 1636 1643 1663 1678 1681 1687 1698 1726 1727 1730 1739 1744 1752 1754 1769 1770 1790 1817 1819 1831 1850 1875 1882 1886 1891 1895 1903 1905 1988 1989 1996

Maltose 0209 1419
Marketing 0223 0229 0232 0244 1409 1414 1444 1496 1505 1509 1546 1547 1558 1561 1562 1643 1721 1812 1831 1850 1853 1861 1867 1872 1874 1875 1882 1886 1895 1901 1903 1981 1988 1989
Metabolism 0074 0079 1407 1436
Milk flocculation 1432
Moulds 1402 1423 1430
Packaging 1546 1875
Particle size 1140 1412 1422 1425 1442 1447 1474 1484 1485 1565 1582 1633 1698 1727 1754
Prices 0223 0229 0232 1496 1505 1547 1620 1803 1817 1819 1830 1835 1850 1867 1872 1875 1901 1905 1988 1989
Processing 0223 0229 0230 0265 0275 0305 0344 0532 0919 1023 1141 1147 1409 1410 1412 1413 1414 1417 1419 1423 1447 1456 1457 1465 1492 1496 1505 1506 1509 1517 1529 1535 1540 1545 1546 1547 1557 1558 1562 1563 1565 1566 1570 1574 1582 1583 1587 1590 1591 1604 1609 1613 1616 1620 1622 1623 1624 1634 1636 1643 1652 1656 1663 1675 1678 1681 1683 1687 1692 1698 1721 1726 1727 1730 1731 1739 1744 1752 1754 1755 1758 1761 1769 1770 1783 1790 1817 1875 1895 1958 1988 1989
Storage 1402 1430 1505 1571 1625 1633 1726 1744 1757 1773 1853 1875 1981
Textiles 1458 1547 1752
Trade 0344 1409 1414 1493 1496 1505 1547 1558 1623 1643 1663 1681 1721 1812 1830 1831 1835 1850 1859 1861 1867 1872 1874 1875 1882 1895 1901 1903 1905 1988 1989 1996
Uses 0227 0265 0340 1066 1141 1147 1408 1409 1413 1418 1426 1434 1450 1458 1459 1461 1470 1505 1517 1563 1570 1643 1681 1683 1687 1733 1752 1766 1770 1785 1831 1850 1859 1882 1895 1958 1988 1989
Viscosity 0275 1405 1421 1438 1447 1454 1455 1456 1457 1458 1459 1461 1463 1465 1471 1472 1476 1480 1486 1490 1509 1546 1547 1698 1739
Water requirements (processing) 1417 1492 1675 1727

Cassava tubers (vegetable) 0811 1355 1875
Amino acids 1401
Animal nutrition 1296
Composition 1045 1401

Cassava vein mosaic virus 0592

Cattle 1002 1285 1328 1340 1341 1403 1833 1958 1969
Cassava meal 1235 1261 1283 1359 1364 1368 1862 1867
Fattening 1218 1339
Feeds and feeding 1218 1228 1239 1243 1261 1283 1292 1295 1315 1317 1325 1339 1359 1364 1862
Leaves 1235

Ceará rubber 0007 0281 0602 0706 0892

Cecidomyidae 0806 0852
Eudiplosis brasiliensis 0732 0788 0810 0853 0857

Cellulose 0192 1047 1214 1246 1549 1767

Cellular hydraemia 1178

Cercospora caribaea 0585 0650 0655 0656 0666 0674 0686 0690 1960 1961
Disease control 0280 0294 0589 0592 0593 0596 0625 0677 0678
Etiology 0592 0593 0625 0678

Cercospora henningsii 0072 0578 0581 0600 0602 0604 0608 0650 0652 0655 0664 0666 0674 0680 0686 0690 0712 0812 0969 1936 1957
Disease control 0280 0294 0589 0592 0593 0596 0625 0677 0678 0898 0930 0956 1962
etiology 0592 0593 0625 0668 0678 0683

Cereals 0211 0236 0382 0383 0558 0579 0842 1009 1016 1034 1037 1038 1059 1085 1152 1191 1214 1220 1230 1294 1330 1402 1440 1457 1459 1755 1827 1879 1954 1990 1999

Chicks 1006 1306 1357 1621
Cassava meal 1204 1208 1215 1222 1230 1241 1242 1249 1257 1271 1275 1279 1282 1288 1299 1332 1333 1343 1349 1361 1368
Diets 1204 1222 1230 1241 1242 1249 1262 1269 1275 1279 1282 1288 1311 1332 1333 1338 1343 1349
Fattening 1257

Chickwangue 0453
Composition 0176

Chlorosis 0350 0764 0812

Chromosomes 0027 0040 0057 0064 0069 0885 0888 0890 0893 0896 0899 0928 0929 0930 0945 0954 0987 0988 0989 0990 0991 0993 0994 0995 0996 0997 0999

Climatic requirements 0091 0204 0234 0239 0241 0249 0262 0270 0293 0300 0319 0322 0323 0331 0342 0348 0356 0377 0412 0941

1880 1929 1940 1943 1959 1974 1984 1985
Growth 0378 0391 0427
HCN 0114 0287 1375 1953 1973
Productivity 0232 0240 0268 0274 0276 0286 0287 0291 0312 0314 0335 0345 0366 0378 0379 0383 0385 0387 0391 0438 0471 0475 0499 0544 1803 1946 1953 1968

Clones 0052 0056 0142 0169 0201 0315 0402 0491 0548 0549 0571 0702 0715 0755 0823 0889 0890 0902 0903 0905 0913 0921 0927 0929 0933 0958 0939 0941 0942 0961 0963 0966 0973 0975 0980 0986 0990 1101 1375 1393 1565 1945 1956 1978 1994
Hybridizing 0908 0917 0957 0974
Identification 0053 0287 0313 0917 0923 0931 0977

Cocoyams 0203 0891 1123 1396 1454 1641 1869

Coeloginus fulvus 0883

Coelosternus granicollis 0803 0844
Insect control 0820 0833 1962 1976

Colchicine 0929 1375
Polyploidy 0890 0896 0928 0988 0993

Colocasia 0444 0558 1089 1419 1440 1513 1975

Composite flours 1012 1016 1025 1034 1038 1042 1049 1051 1060 1065 1067 1071 1073 1081 1107 1113 1117 1137 1145 1159 1161 1427 1501 1538 1581 1621 1637 1643 1734 1751 1753

Composition
Cassava flour 0145 0149 0153 0174 0176 0232 0271 0275 0290 0349 0652 1016 1029 1031 1033 1039 1042 1044 1045 1046 1047 1051 1055 1067 1071 1073 1077 1078 1085 1095 1106 1107 1111 1113 1115 1117 1134 1146 1157 1160 1276 1325 1341 1399 1401 1495 1501 1525 1530 1534 1564 1584 1598 1599 1663 1677 1698 1700 1733 1751 1792 1793
Cassava meal 0141 0232 0532 1019 1021 1024 1056 1078 1085 1089 1091 1094 1095 1114 1127 1131 1149 1152 1160 1204 1209 1210 1222 1223 1235 1245 1257 1261 1271 1282 1289 1291 1302 1323 1332 1348 1356 1363 1369 1383 1429 1512 1522 1525 1596 1677 1745 1827 1862 1883 1964
Cassava starch 0209 0229 0232 0275 0532 1054 1069 1076 1091 1146 1399 1408 1412 1416 1418 1430 1437 1461 1481 1519 1546 1547 1562 1587 1590 1591 1616 1633 1656 1663 1675 1692 1698 1733 1744 1754 1755 1803 1886 1981 1988
Leaves 0037 0072 0108 0122 0124 0140 0142 0144 0145 0148 0149 0152 0155 0158 0161 0162 0168 0169 0170 0174 0178 0182 0183 0188 0199 0204 0206 0211 0281 0287 0316 0372 0384 0556 0561 0747 0767 0890 0938 1014 1021 1054 1058 1092 1093 1109 1116 1124 1125 1130 1135 1209 1223 1232 1235 1262 1268 1269 1281 1323 1332 1338 1363 1369 1429 1748 1883 1918 1953 1981
Tapiocas 0232 0275 0431 0532 1054 1069 1325 1416 1445 1530 1534 1537 1547 1677 1698 1733 1771 1988
Tubers 0042 0083 0108 0129 0130 0138 0140 0144 0145 0148 0153 0154 0165 0174 0175 0179 0193 0203 0204 0211 0222 0281 0287 0316 0369 0372 0384 0431 0503 1021 1040 1046 1054 1062 1211 1216 1260 1261 1289 1323 1325 1350 1501 1676 1953 1955 1969
Stems 0009 0037 0152 0155 0193 0281 0372 0384 0488 0503 0561 0889 0890 0938 1021 1209 1232 1235 1319 1767 1953

Concentrates 1089 1220 1228 1236 1278 1281 1293 1305 1364 1550 1632

Confectioneries 0275 1497 1696 1708 1716 1737 1759

Cooked starch 1469

Cooking 0145 0176 0203 0330 1014 1110 1321 1401 1939
Effects on nutritive value 1014 1137 1401

Copper 0138 0155 0178 0197 0420

Cortex 0014 0015 0016 0114 0127 0901 1624
Composition 0131 0145 0165 0174 0179 1501
HCN content 0131 0145 0165 0174 0179
HCN content as affected by fertilizers 0131
Uses 1227

Corynebacterium 1054 1056 1658 1776 1784 1788 1791

Cottage machinery 0229 0343 1595

Cretinism
Clinical manifestations 1172 1191 1193
Endemic goitre 1172 1191 1193

Crossbreeding 0225 0894 0928 0929 0940 0974 0979 1936 1994

Cassava mosaic virus (resistance) 0903 0926 0935 0957 0962
Plant fertility 0924 0957

Cultivars
Adaptation 0339 0541
Ecology 0006 0029 0037 0286 1379 1896 1946
Germplasm 0217 0910 0931 0949 0950 0970 0983 1890 1950 1995
Identification 0005 0014 0015 0016 0025 0027 0028 0037 0042 0048 0049 0054 0055 0057 0060 0061 0063 0065 0067 0150 0204 0281 0286 0288 0306 0313 0333 0471 0895 0914 0919 0920 0931 0934 0936 0981 1936 1957 1973 1988
Selection 0169 0242 0243 0296 0304 0315 0327 0339 0349 0391 0536 0540 0701 0723 0898 0902 0903 0904 0911 0930 0946 0957 0958 0973 0986 1936 1961 1988
Starch productivity 0224 0243 0252 0268 0298 0310 0313 0315 0320 0345 0354 0391 0403 0432 0436 0471 0537 0539 0540 0544 0565 0889 0902 0911 0958 0969 1110 1435 1441 1509 1803 1905
Tuber productivity 0005 0056 0105 0108 0224 0232 0269 0292 0310 0313 0345 0346 0354 0405 0407 0416 0436 0451 0459 0471 0527 0530 0537 0539 0541 0544 0551 0555 0562 0567 0574 0889 0898 0914 0930 0949 1547 1988
Toxicity 0028 0139 0140 0146 0165 0194 0207 0225 0240 0278 0427 0555 0986 1056 1379 1953 1988

Culture media 0078 0083 0092 0093 0109 0128 1407 1408 1434 1450 1773 1944

Cuttings
Germination 0392 0717
Timing 0424 0546
Grafting 0529
Propagation 0076 0097 0099 0100 0269 0280 0313 0443 0479 0480 0482 0488 0490 0491 0493 0494 0512 0513 0514 0524 0529 0570 1994
Rooting 0082 0086 0099 0104 0105 0113 0304 0359 0450 0458 0486 0488 0491 0507 0570
Spacing 0224 0244 0245 0289 0314 0322 0339 0341 0342 0349 0359 0402 0429 0432 0460 0470 0479 0501 0502 0506 0524 0529 0956 1962 1989 1994
Storage 0276 0424 0434 0476 0479 0489 0512 1981 1994
Tuber productivity 0097 0105 0224 0269 0313 0359 0416 0429 0455 0467 0470 0475 0488 0493 0506 0529 0541 0546 0547 0551 0956
Virus inhibition 0733 0743 0752

Cyanides 1223
Detoxification 1164 1167 1380 1381 1386 1394
Human health 1162 1164 1167 1186 1189 1196 1380 1386 1404
Malnutrition 1164 1184 1188
Metabolism 0125 1164 1165 1182 1189 1196 1390 1394
Rhodanese 0191 1167
Thiocyanates 0191 1162 1164 1165 1177 1179 1180 1182 1184 1188 1189 1196 1380 1381 1390 1397 1400
Toxicity 0180 0215 1167 1177 1178 1180 1182 1188 1189 1332 1380 1382 1386 1394 1400 1404
Toxicology 1162 1165 1166 1179 1180 1182 1186 1188 1189 1196 1381 1390 1404

Cyanocobalamin 1381

Cyanogen 0180 1379

Cyanogenesis 0115 0116 0117 0118 0119 0120 0125 0128 0173 0180 1392 1401
Climatic requirements 0114
Cortex 0114 0127
Fertilizers 0114 0123
Leaves 0114 0121 0122 0127 0200
Plant development 0114 0121
Soil fertility 0114
Tubers 0114 0123 0127

Cyanogenic glycosides 0114 0115 0116 0118 0119 0120 0121 0122 0123 0125 0127 0134 0142 0151 0163 0174 0179 0180 0215 1014 1112 1171 1184 1186 1197 1373 1379 1384 1386 1387 1392 1399 1709 1776

Cystine 0124 1059 1381 1390
Analysis 1040 1062 1780

Cytogenetics 0019 0141 0885 0890 0891 0892 0896 0898 0899 0929 0930 0987 0988 0990 0991 0992 0993 0994 0995 0996 0997 0999 1001

Cytology 0027 0036 0040 0064 0066 0089 0102 0122 0734 0884 0887 0893 0900 0943 0944 0954 0987 0989 0991 0992 0995 0996 0998 0999 1000 1757

Dasyprocta variegata 0883

Deficiency diseases 0557 1010 1163 1170 1172 1173 1177 1190 1191 1192 1193 1194 1195 1197 1198 1200 1201 1397

Deterioration
Cassava flour 1071 1543 1571 1651 1700 1725 1764

Cassava meal 1056 1543
Cassava starch 1402 1430 1571
Tubers 0598 0605 1402 1494 1571 1572 1592 1594 1606 1617 1648 1651 1654 1725 1747

Detoxification 0142 0330 1029 1054 1164 1167 1327 1379 1380 1385 1386 1392 1394 1607 1788

Developmental stages
Branching 0037 0054 0056 0068 0513 0717 0938 0949
Flowering 0040 0058 0068 0110 0544 0949 0952 0959 1978 1994
Fruiting 0110
Germination 0040 0094 0122 0392 0424 0544 0563 0717 0885 0897 0900
Rooting 0073 0078 0082 0086 0093 0099 0103 0104 0105 0113 0128 0304 0458 0486 0491 0507 0570 0905
Tuber development 0041 0068 0073 0075 0076 0087 0095 0098 0100 0106 0389 0542 0949 0958

Dextrins 0275 1409 1410 1413 1423 1493 1561 1589 1656 1710 1716
Dextrose 1450 1547

Diets
Dietary value 0124 0973 1009 1024 1025 1035 1036 1037 1039 1048 1052 1058 1068 1075 1076 1091 1099 1101 1110 1112 1118 1136 1143 1146 1150 1152 1154 1157 1158 1173 1187 1204 1205 1206 1212 1213 1214 1215 1216 1217 1220 1223 1226 1228 1229 1230 1231 1235 1241 1242 1244 1247 1248 1251 1254 1257 1259 1261 1263 1267 1269 1271 1272 1273 1276 1277 1278 1279 1281 1282 1288 1291 1294 1295 1298 1314 1321 1326 1328 1336 1338 1349 1357 1359 1363 1364 1376 1401 1615 1748 1776 1879 1918
Manutrition 1010 1015 1164 1170 1178 1181 1188 1199 1354
Nutritive value 0206 1016 1022 1027 1030 1038 1040 1049 1057 1071 1073 1089 1113 1119 1120 1135 1159 1191 1199 1202 1207 1222 1236 1238 1245 1283 1290 1292 1297 1310 1311 1312 1316 1318 1320 1332 1333 1335 1342 1350 1352 1356 1866

Digestibility
Cassava flour 1037 1048 1217 1220 1226 1276 1341 1401
Cassava leaves (vegetable) 1030 1401
Cassava meal 1066 1091 1094 1204 1223 1241 1257 1261 1272 1277 1279 1330 1335 1364 1419 1512
Cassava starch 1066 1076 1091 1419
Composite flours 1037 1159

Disease control 1939 1940

Bacterioses 0280 0294 0296 0427 0579 0589 0592 0593 0594 0595 0596 0601 0611 0612 0614 0617 0618 0619 0622 0623 0624 0625 0626 0627 0629 0633 0636 0639 0659
Mycoplasmoses 0589
Mycoses 0280 0294 0296 0329 0427 0578 0580 0587 0588 0589 0592 0593 0594 0596 0625 0643 0659 0660 0665 0669 0673 0676 0677 0678 0681 0695 0898 0930 0956 1402 1571 1654 1732 1962
Viroses 0296 0578 0587 0589 0592 0593 0594 0596 0601 0659 0705 0706 0708 0714 0716 0720 0730 0733 0743 0745 0752 0756 0758 0763 0770 0773 0898 0930 0942 0956

Dried tubers
Distribution 1496 1659 1680 1800 1867 1875
Marketing 0284 0456 1235 1391 1496 1555 1567 1659 1745 1800 1866 1867 1875 1881 1883

Drying
Cassava chips 0145 1548 1576 1595 1597 1607 1622 1657 1680 1705
Cassava flour 0176 0230 0275 0343 1025 1111 1138 1401 1501 1514 1526 1530 1621 1711 1729 1742 1764
Cassava starch 0230 0275 1419 1492 1505 1526 1529 1546 1622 1633 1634 1656 1692 1726 1742 1770 1988
Industrial machinery 0230 0275 1019 1414 1492 1505 1526 1595 1597 1622 1632 1657 1711 1762
Pellets 0179 1597
Tapiocas 0230 0275 1530 1726 1742 1988
Water content 1109 1501 1530 1576 1628 1633 1656 1692

Dumboi
Processing 1699

Ecology 0004 0007 0009 0038 0127 0366 0413 0476 0521 0553 0750 0856 0955 1005 1192 1194 1358 1521 1832 1843 1922 1928 1929 1946 1974 1975 1984
Cultivars 0006 0029 0037 0286 1379 1946 1986

Eggs 0149 1070 1093 1266 1337
Production 1299 1318

Endemic goitre 1190
Clinical manifestation 1084 1172 1173 1174 1175 1180 1183 1191 1193 1194 1197 1198 1201 1380

Cyanogenic glycosides 0120 1171 1197
Etiology 1172 1174 1175 1191 1194 1195 1197 1198

Endocrine disorders 1163 1172 1178 1191 1192 1193 1194 1197 1198 1354 1381

Erinnyis alope 0589 0845 1994

Erinnyis ello
Biological control 0329 0817 0831
Trichogramma minutum 0809 0813
Insect agents 0809 0813 0817 0831
Insect control 0294 0317 0341 0589 0809 0812 0813 0815 0817 0824 0831 0839 0846 0849 0851 0856 0859 0863 0872 0873 0875 0877 1962 1976 1994

Erwinia cassavae 0577 0904

Ethanol 1423 1508 1671 1676 1989

Eudiplosis brasiliensis 0788 0853 0857
Insect control 0732 0810 0830

Euthrips manihotis 0732 0810 0830

Factories
Cassava chips 1243 1496 1595 1756 1819 1875
Cassava flour 0232 0275 1071 1099 1243 1495 1516 1539 1544 1627 1639 1663 1677 1714 1742 1753 1783 1838 1875 1989
Cassava starch 0232 0265 0275 1413 1414 1493 1496 1505 1506 1520 1529 1535 1544 1547 1553 1561 1580 1583 1587 1590 1591 1599 1609 1616 1620 1624 1652 1663 1687 1717 1726 1727 1742 1744 1769 1783 1817 1819 1838 1875 1886 1903 1988 1989
Gari 1511 1532 1575 1618 1620 1626 1662 1667 1677 1684 1783
Pellets 1496
Tapiocas 0232 0275 0348 1547 1652 1677 1714 1726 1742 1875 1988 1989

Farinha
Processing 0349 1498 1506 1596 1636 1673

Fattening
Cattle 1218 1339
Chicks 1204 1208 1222 1257 1275 1288
Swine 1187 1205 1207 1210 1223 1226 1231 1233 1247 1250 1252 1254 1270 1281 1286 1289 1294 1301 1303 1310 1330 1335 1342 1346 1350 1353 1355 1365 1367

Feed constituents 1037 1078 1101 1187 1202 1205 1206 1207 1208 1209 1210 1214 1215 1217 1220 1222 1223 1226 1230 1231 1233 1238 1248 1252 1263 1264 1271 1274 1276 1278 1280 1281 1282 1283 1292 1293 1301 1303 1304 1308 1309 1310 1311 1315 1316 1317 1320 1322 1334 1338 1339 1341 1346 1347 1348 1355 1359 1363 1364 1862 1964

Feed mixtures 1016 1071 1077 1220 1282 1339 1357 1364

Fermentation 0036 0196 0208 1023 1054 1056 1066 1072 1079 1104 1373 1419 1423 1467 1508 1511 1524 1527 1532 1540 1574 1599 1603 1605 1626 1628 1632 1652 1653 1658 1662 1664 1679 1681 1683 1724 1764 1773 1774 1775 1776 1784 1785 1786 1787 1788 1790 1791 1792 1794 1953 1970 1989

Fermented products 1023 1056 1066 1079 1104 1141 1540 1574 1603 1605 1618 1653 1681 1683 1685 1701 1724 1773 1786 1831 1944

Flowering 0040 0058 0068 0110 0118 0544 0949 0952 0959 1978 1994

Flowers 0009 0014 0015 0016 0020 0026 0044 0049 0050 0052 0054 0056 0058 0059 0064 0065 0076 0102 0281 0333 0894 0896 0897 0934 0957 0977 0988 0991 1104 1953

Foliage
Forage 0369 0459 1232 1253 1313
Production 0445 0459 0520
Storage 0427 1021

Fomes lignosus 0225 0274 0288 1936
Disease control 0589

Food enrichment 1035 1045 1068 1071 1074 1075 1081 1099 1127 1137 1144 1236 1538 1779 1789 1795
Amino acids 1024 1033 1040 1049 1119 1129 1152 1155 1157 1158 1256 1780 1782 1953 1970
Economics 1084 1087 1119 1550 1777 1782 1783 1787 1804 1972 1994
Fermentation 1054 1056 1072 1773 1774 1775 1787 1792 1793 1794 1953 1970
Marketing 1804 1994
Patents 1794

Food products 0171 0208 0219 0220 0251 0265 0275 0328 0342 0553 0969 1002 1012 1026 1035 1054 1055 1056 1064 1072 1075 1077 1083 1085 1086 1087 1091 1092 1094 1128 1131 1138 1141 1143 1161 1164 1371 1373 1391 1401 1419 1424 1429 1432 1442 1448 1461 1469 1491 1495 1497 1498 1501 1510 1511 1512 1524 1525 1527 1530 1532 1547 1552 1560 1571 1575 1581 1584 1589

1598 1605 1610 1618 1620 1624 1625 1626 1628 1630 1631 1632 1643 1647 1650 1653 1658 1662 1664 1667 1684 1696 1708 1712 1716 1733 1735 1737 1751 1755 1762 1766 1774 1775 1776 1778 1784 1785 1786 1787 1791 1792 1847 1850 1861 1880 1888 1895 1957 1972

Food stabilizers 1054 1448 1469 1491 1716

Food thickeners 1442 1469 1491 1625

Foo-foo
Composition 0176 1094
Processing 0176 0251 1141 1498 1560 1631

Forage 0369 0459 0554 0556 1232 1252 1253 1255 1262 1302 1306 1307 1313 1380

Formic acid 1791

Fructose 0192 0209

Fruiting 0110

Fruits 0009 0020 0061 0066 0155 0333 0900 0908 0938 0977

Fusarium 0679
Disease control 0596

Galls 0294 0329 0341 0732 0794 0810 0830 0852 0857

Gaplek 0284 0305 1147 1391 1515 1598 1649 1718 1745
Production 1515
Trade 0284 0456 1515 1567
Uses 0284 1147 1555

Gaplek meal 1346 1829

Gari
Composition 0171 0174 0176 0208 1026 1035 1050 1054 1056 1083 1091 1094 1108 1401 1429 1512 1527 1650 1662 1664 1677 1751 1803 1883
Detoxification 1035 1054 1401 1776 1788
Digestibility 1066 1075 1091 1094 1401 1419 1512
Factories 1511 1532 1575 1618 1620 1626 1662 1667 1677 1684 1783
Fermentation 0208 1066 1072 1419 1511 1524 1527 1532 1605 1626 1632 1653 1662 1664 1751
Aspergillus 1787
Corynebacterium 1054 1056 1658 1776 1784 1788 1791
Geotrichum candidum 1054 1056 1776 1788 1791
Rhizopus stolonifer 1775 1787
HCN content 0171 0174 0205 1035 1050 1054 1056 1108 1401 1429
Industrial machinery 1524 1532 1575 1610 1626 1632 1645 1783
Mechanization 1026 1532 1575 1626 1658 1662 1664 1667
Nutritive value 0208 1026 1054 1056 1075 1083 1108 1253 1371 1401 1429 1512 1883
Organoleptic examination 1128 1776
Packaging 1527 1632
Processing 0176 0251 1072 1075 1108 1141 1253 1371 1419 1429 1498 1511 1512 1524 1527 1532 1560 1575 1605 1618 1620 1626 1631 1632 1643 1653 1658 1662 1664 1667 1751 1775 1776 1783 1787 1791
Proteins 1026 1050 1075 1094 1512 1620 1626 1632 1684 1775 1783 1787
Storage 0176 1056 1401 1571 1650
Mycoses 1571
Sugars 1419

Gelatinization 1025 1075 1412 1422 1438 1443 1447 1454 1455 1465 1609 1632 1664 1739 1751 1754

Geotrichum candidum 1054 1056 1658 1776 1788 1791

Germination
Cuttings 0392 0424 0546 0717
Seed composition 0094 0122
Timing 0094 0424 0546

Germplasm 0217 0256 0289 0910 0922 0925 0942 0947 0949 0950 0953 0970 0975 0976 0977 0983 1382 1890 1913 1950 1995

Gloeosporium manihotis 0329 0578 0596 0659 0685 0812 1960 1973

Glomerella cingulata 0554 0589 0593 0596 0643 0654 0655 1936

Glucose 0114 0119 0192 0209 0275 1132 1391 1410 1413 1419 1420 1449 1546 1547 1561 1570 1589 1682 1696 1731

Grafting 0508 0529 0756 0762 0768 0930 0939

Grinding 0230 0275 1526 1530 1621 1622 1634 1635 1771

Growth 0026 0078 0087 0092 0094 0097 0098 0106 0108 0112 0113 0126 0150 0209 0225 0378 0389 0391 0407 0416 0427 0498 0542 0543 0547 0556 0949 0956 0990

Harvesting 0209 0222 0224 0229 0234 0241

0245 0251 0257 0259 0263 0269 0270 0274 0276 0278 0279 0280 0281 0282 0283 0284 0290 0291 0292 0293 0296 0298 0300 0309 0310 0312 0313 0316 0318 0320 0322 0323 0327 0331 0335 0341 0342 0343 0348 0351 0407 0426 0427 0430 0432 0434 0436 0437 0439 0440 0442 0449 0451 0452 0454 0455 0460 0461 0466 0475 0483 0485 0486 0492 0495 0499 0501 0507 0519 0520 0526 0533 0545 0554 0562 0598 0956 0958 0962 1006 1056 1323 1494 1505 1526 1529 1733 1803 1833 1855 1856 1880 1950 1952 1953 1957 1962 1987 1988 1989

HCN absorption 1164 1259 1381 1394 1403

HCN content
Cassava chips 0145 1235 1399
Cassava flour 0145 0174 0232 1029 1047 1399 1401 1495 1526 1584 1733
Cassava meal 0232 1056 1210 1235 1383 1596
Cassava starch 0229 0232 1054 1399 1429 1526 1675 1733 1988
Cortex 0042 0131 0145 0165 0174 0177 0179 1050
Leaves 0005 0009 0072 0140 0142 0144 0145 0148 0162 0169 0174 0199 0204 0287 0403 0556 0658 0885 0938 1054 1109 1125 1235 1281 1429 1748
Pulp 0145 0165 0177 0179
Roots 0004 0009 0055 0403 0658 1056 1235 1596
Stems 0005 0009 0193 0889 0938 1235
Tubers 0005 0042 0083 0130 0140 0142 0144 0145 0146 0148 0150 0154 0165 0169 0174 0179 0184 0193 0204 0207 0210 0369 0938 1054 1393 1526 1748

Hepatic disorders 0569 1068 1174 1176 1178 1354 1390

Herbicides 0104 0313 0346 0422 0428 0440 0441 0444 0445 0446 0463 0469 0474 0487 0504 0515

Hunger oedema 1010 1169 1178 1199

Hybrids
Productivity 0225 0296 0436 0527 0891 0912 0930 0933 0939 0956 0958 0962 0975 0980 1945 1956 1961
Resistance to cassava mosaic virus 0751 0891 0903 0930 0956 0957 0958 0962 0980
Cassava brown streak virus 0701 0939 0964
Selection 0296 0701 0903 0930 0933 0946 0956 0957 0958 0962 1945 1956 1961
Tuber productivity 0436 0527 0930 0956 0962

Hydrolysis
Cassava starch 0209 1419 1433 1574 1755 1766 1773 1886

Hydroxocobalamin 1165

Hyperdiplosis 0852

Hypoalbuminaemia 1178

Illumination 0092
Rooting effects on 0093

Income 1496 1588 1842 1864 1870 1914 1916

Industrial machinery 0229 0230 0265 0275 1019 1415 1492 1495 1496 1505 1517 1520 1524 1526 1532 1535 1541 1544 1545 1546 1552 1575 1595 1597 1610 1622 1626 1632 1635 1636 1642 1645 1649 1657 1675 1696 1703 1711 1727 1743 1762 1772 1783 1798 1816 1841 1886 1989

Industrial starches 1420 1421 1428 1445 1458 1459 1461 1478 1491 1502 1547 1570 1583 1587 1589 1590 1591 1593 1602 1616 1668 1671 1675 1682 1688 1696 1707 1710 1720 1730 1739 1744 1752 1807 1831 1847 1882 1886 1900 1989

Inflorescences 0009 0026 0040 0057 0065 0068 0952

Injurious insects 0009 0296 0335 0344 0587 0588 0594 0761 0785 0790 0792 0796 0797 0799 0801 0804 0806 0807 0808 0811 0818 0821 0823 0825 0826 0827 0829 0832 0834 0837 0838 0840 0841 0842 0847 0848 0852 0858 0860 0861 0864 0865 0866 0868 0878 0880 0884 0942 1384 1464 1571 1924 1937 1939 1943 1965 1968 1973 1986 1988 1989

Anastrepha pickeli 0110 1994
Aonidomytilus albus 0225 0589 0793 0800 0819 0854 0898 0930 1960 1961
Bemisia 0280 0329 0585 0776 0787 0791 0822 0849 0850 0870 0930 1960

Carpolonchaea chalybea 0224 0294 0313 0329 0418 0794 0795 0798 0812 0843 0877
Coelosternus granicollis 0803 0820 0833 0844 1962 1976
Erinnyis alope 0589 0845 1994
Erinnyis ello 0224 0294 0317 0329 0341 0589 0809 0812 0813 0815 0817 0824 0828 0831 0839 0844 0846 0849 0851 0856 0859 0863 0870 0872 0875 0877 1938 1962 1976 1994
Eudiplosis brasiliensis 0732 0788 0810 0820 0853

Euthrips manihot 0732 0810 0830
Lagochirus obsoletus 0280 0329 0786 0812
Leucophallis vorida 0862
Microgaster flaviventris 0812
Scirtothrips manihoti 1976

Injurious mites 0349 0789 0867 0869 087, 0877 0898 1994
Mononychellus tanajoa 0814 0836 0855 0876
Tetranychus telarius 0329 0589 0812 0816 0827 0835 0849 0930 0956

Insecticides 0212 0280 0294 0313 0341 0589 0793 0800 0809 0813 0815 0817 0818 0824 0826 0831 0834 0837 0838 0839 0843 0846 0849 0854 0856 0863 0864 0867 0868 0869 0872 0873 0875 0877 0882 0898 1799 1924 1964

Intercropping 0322 0339 0344 0345 0419 0427 0502 0529 0580 0669 0930 0956 1006 1919 1920 1922 1923 1924 1926 1927 1928 1930 1931 1945 1946 1969

Iodine 0216 1163 1171 1172 1183 1185 1190 1191 1194 1195 1197 1198 1201 1397

Iron 0138 0144 0147 0168 0197 0350 0734 0747 1017 1034 1035 1093 1440 1512 1526 1883 1977

Irrigation 0096 0111 0224 0396 0525

Isolation
Diseases and pathogens 0620 0626 0627 0628 0632 0641 0649 0684

Kakayake 1498

Kpokpo gari
Composition 1056 1108
Nutritive value 1056 1108

Kwashiorkor 1170 1200

Labour 0231 0428 0430 1599 1627 1805 1842 1870 1875 1904 1914 1934

Lactic acid 1628 1727

Lagochirus obsoletus 0280 0329 0786 0812

Land preparation
Agricultural equipment 0355
Mechanization 0274 0355 0449
Tuber productivity 0355 0455 0563

Landang 1114

Lasiodiplodia 0225 0681

Leaf area 0051 0080 0106 0108 0112 0316 0498 0529 0542 0767 0906 1984
Aminoacids 0037 0072 0121 0122 0124 0148 0149 0162 0206 1027 1058 1092 1109 1124 1129 1130 1135 1136 1223 1268 1269 1332 1363 1748 1953
Analysis 0037 0051 0069 0072 0074 0089 0108 0114 0121 0122 0137 0140 0143 0145 0147 0152 0158 0167 0174 0178 0182 0183 0188 0195 0199 0200 0204 0216 0350 0372 0556 0590 0734 0757 0763 0890 0985 1129 1135 1232 1262 1332
Animal nutrition 0218 0556 1021 1027 1058 1209 1223 1232 1235 1237 1253 1259 1262 1266 1268 1269 1273 1281 1306 1313 1321 1323 1332 1338 1363 1369 1376 1419 1523 1636 1883 1981 1994
Brans from 1363 1523
HCN content 0005 0009 0072 0140 0142 0144 0145 0148 0162 0169 0174 0199 0204 0287 0403 0556 0658 0885 0938 1054 1109 1125 1235 1281 1429 1748
Mineral content 0124 0155 0158 0168 0747 0777 1014 1036 1054 1093 1135 1269 1748
Mineral deficiencies 0085 0350 0363 0384
Nutritive value 0149 0161 0211 1008 1014 1027 1036 1054 1109 1116 1129 1130 1135 1136 1232 1253 1313 1332 1363 1429 1523 1883 1981
Production 0218 1021 1209 1429 1383 1981
Protein content 0037 0124 0144 0148 0162 0168 0169 0170 0182 0183 0188 0206 1021 1054 1058 1109 1130 1135 1209 1223 1232 1235 1262 1268 1369 1748 1883
Rhodanese 0143 0191
Vitamin content 0148 0161 1014 1036 1054 1130 1135 1268 1748 1883

Legal aspects 0239 1439 1444 1495 1496 1502 1522 1530 1547 1601 1623 1640 1697 1698 1702 1704 1723 1735 1738 1762 1769 1816 1817 1823 1860 1862 1867 1871 1875 1876 1877 1897 1946

Leucopholis rorida 0862

Linamarase 0114 0118 0119 0121 0122 0127 0134 0163 0180 0215 1379 1399

Linamarin 0114 0115 0116 0118 0119 0120 0121 0122 0125 0134 0142 0163 0180 0215 1112 1171 1172 1375 [illegible] 1379 1392 1399

Lodging 0921

Lotaustralin 0114 0119 [illegible] 0127 0392

Lysine 0124 1030 1059 1129 1135 1136 1155 1333 1964

Magnesium
  Absorption 0359 0372
  Tuber productivity 0359 0488

Malnutrition 1010 1015 1074 1164 1169 1170 1176 1178 1181 1184 1188 1199 1200 1354

Maltose 0192 0209 1419

Manganese 0132 0138 0147 0155 0158 0168 0197 0350 1035 1093 1929

Manihot angustiloba 0182

Manihot carthagenensis 0002 0004 0029 0119

Manihot dichotoma 0007 0182 0609 0653 0718 0394 0926 0935 0939 0960 0972 1936

Manihot glaziovii 0007 0029 0043 0050 [illegible] 0281 0349 0527 0529 0583 0646 0664 0690 0704 0712 0718 0762 0891 0892 0894 0897 0900 0908 0929 0930 0932 0935 0939 0940 0957 0959 0960 0964 0972 0975 0979 0981 0994 0997 1403 1932 1936 1946

Manihot heptaphylla 0007

Manihot jolyana 0019 0064

Manihot melanobasis 0719 0886 0924 0926 0935 0939 0957 0972 0978 1936

Manihot oil 0007

Manihot piauhyensis 0007

Manihot saxicola 0029 0894 0908 0935 0939 0940 0972 0975 0979 1936

Manihot tweedicana 0029 0182 1586

Marketing
  Cassava chips 1391 1496 1597 1659 1756 1816 1821 1826 1866 1867 1875 1881 1882 1883 1895 1901
  Cassava flour 0223 0232 0456 1031 1555 1558 1600 1677 1714 1738 1798 1800 1804 1806 1808 1812 1821 1824 1826 1828 1831 1834 1839 1850 1861 1863 1865 1874 1875 1879 1882 1885 1901 1909 1989
  Cassava meal 0232 1235 1391 1505 1600 1643 1677 1714 1738 1745 1811 1826 1827 1839 1841 1850 1862 1867 1874 1882 1883 1885
  Cassava starch 0223 0229 0232 0344 1409 1414 1496 1505 1509 1546 1547 1558 1561 1562 1643 1721 1806 1807 1812 1821 1831 1835 1841 1850 1853 1861 1867 1872 1874 1875 1882 1886 1895 1901 1903 1981 1988 1989
  Gari 1632 1643 1677 1883
  Leaves 1235 1883 1981 1994
  Pellets 1235 1496 1597 1659 1823 1826 1867 1883
  Tapiocas 0456 1537 1547 1555 1567 1600 1677 1714 1721 1800 1806 1808 1809 1812 1821 1828 1829 1835 1850 1861 1863 1875 1895 1901 1912 1988 1989
  Tubers 1260 1496 1505 1632 1661

Maturation 0891 0950 1260

Mechanization 0274 0295 0296 0355 0426 0430 0435 0439 0442 0449 0466 0483 0485 0509 1007 1026 1532 1545 1575 1621 1626 1635 1658 1662 1664 1667 1743 1772 1856 1956 1962 1973

Methionine 0124 1027 1030 1033 1040 1058 1059 1097 1119 1129 1135 1155 1158 1223 1256 1273 1301 1318 1320 1333 1343 1400 1550 1780 1804 1964

Microgaster flaviventris 0812

Microsporogenesis 0102 0888 0896 0991 0993 0995 1001

Mineral deficiencies 0085 0197 0350 0363 0384

Mite control
  Acaricides 0816 0835 0836 0855 0869 0876 0879
  Mononychellus tanajoa 0836 0855 0876 0879
  Tetranychus telarius 0812 0816 0835 0849 0956

Molybdenum 0155 0420

Mononychellus tanajoa 0814 0836 0855 0876 0879

Morphogenesis 0026 0068 0073 0077 0109 0943 1399

Moulds 0647 0681 0693 1402 1423 1430 1606 1628 1650 1725 1764 1793

MSG 1547 1785

Mutation 0027 0885 0889 0945 0954

Mysore flour 1012 1034 1159

Nitrogen 0004 0085 0089 0106 0123 0131 0147 0152 0155 0158 0159 0175 0176 0177

0182 0183 0197 0198 0213 0261 0269 0274 0296 0313 0314 0324 0350 0353 0354 0355 0357 0358 0360 0362 0365 0367 0368 0370 0376 0378 0381 0382 0384 0385 0389 0397 0400 0401 0403 0404 0405 0406 0407 0408 0409 0414 0416 0417 0419 0420 0446 0451 0488 0543 0552 0556 0647 0767 0930 1004 1021 1037 1040 1048 1054 1056 1062 1095 1102 1111 1116 1149 1220 1246 1260 1278 1323 1335 1375 1416 1569 1624 1774 1787 1793 1804 1883 1973 1981 1988 1994
    Absorption 0214 0244 0351 0352 0372 0387 0390 0898 0956

Nematodes 0296 0589 0596 0778 0779 0780 0781 0782 0783 0784 0805

Oidium 0294 0592 0601 0682

Organoleptic examination
    Cassava flour 1042 1067 1081 1119 1137 1138 1698
    Cassava meal 1596
    Cassava starch 1698
    Composite flours 1042 1081 1137 1538
    Gari 1128 1776
    Pellets 1597
    Tapiocas 1445 1698
    Tapioca macaroni 1613

Ovaries 0058 0059 0064 0066 0155 0377 0886 1953

Oxalic acid 0211 1093 1131

Phosphorus 0106 0124 0131 0144 0147 0152 0155 0158 0176 0197 0261 0269 0274 0277 0296 0313 0314 0324 0350 0353 0354 0355 0357 0358 0362 0367 0368 0370 0371 0376 0378 0381 0382 0384 0385 0388 0389 0397 0400 0401 0403 0404 0405 0406 0407 0408 0416 0417 0419 0420 0488 0543 0552 0556 0734 0747 0930 1034 1035 1048 1051 1056 1093 1116 1220 1273 1294 1355 1520 1526 1774 1883 1973 1977 1981 1988 1994
    Absorption 0071 0214 0244 0351 0352 0372 0387 0390 0898 0956

Packaging 1525 1527 1546 1628 1630 1632 1637 1697 1702 1706 1768 1816 1875

Palatability 0527 0973 1024 1025 1039 1052 1075 1110 1120 1138 1154 1158 1187 1203 1206 1213 1269 1310 1314 1326 1377 1716 1776

Paper Industry 1458 1547 1549 1742 1752 1767 1807
Particle size
Cassava starch 0962 1412 1422 1425 1440 1442 1443 1447 1474 1485 1582 1633 1698 1727 1754

    Screening for 1582 1762

Patents 1426 1543 1794
    Food products 1424 1552 1716
    Industrial machinery 1545 1552 1642
    Tapiocas 1552 1642

Peeling 0036 0230 0275 1492 1526 1607 1634 1743 1771

Pellets 0179 1204 1230 1233 1235 1360 1496 1597 1619 1645 1659 1723 1823 1826 1867 1883

Petioles 0005 0014 0015 0016 0025 0048 0054 0056 0064 0065 0073 0147 0155 0158 0182 0195 0204 0281 0306 0350 0458 0610 0675 0684 0767 0927 0977 1232 1237 1323 1369

pH 0363 0420 1136 1281 1522 1542 1593 1628 1658 1664 1771 1788 1791
    Cassava flour 1096 1153 1416 1525 1530 1698 1793
    Cassava starch 0084 1416 1417 1433 1455 1547 1587 1590 1616 1633 1698 1744
    Soil 0375

Phoma 0294

Photoperiod 0076 0103 0121 0391 1984

Photosynthesis 0089 0112 0748 0906

Phyllosticta 0592 0593 0596 0601 0682 1061

Phytophthora dreschsleri 0585 0593 0596 0644 0671 0676

Piauhy rubber
    Marketing 0007

Piglets 1236 1244

Pigments 1266

Plant assimilation 0071 0080 0108 0152 0352 0387 0498 0756 0906

Plant-growth substances 0073 0082 0083 0099 0100 0104 0105 0109 0113 0128 0458 0480 0570 0898 0930 0956 1244

Plant height 0005 0046 0056 0097 0313 0350 0389 0405 0407 0422 0440 0544 0889 0912 0938 0949

Plant physiological processes 0071 0072 0074 0080 0089 0091 0108 0122 0128 0152 0498 0748 0767 0856 0906

Plant reproduction 0078 0086 0109 0110 0349 0363 0481 0887 0947 0957 0966 1001

Plant respiration 0090 0122 0734 0748 0767

Plant tissues 0078 0088 0115 0122 0155 0180 0757 0759 0887 0988

Plant vascular system 0058 0073

Planting
Agricultural equipment 0333 0430 0483 0496 0516 1989
Costs 0222 0270 0274 0276 0296 0309 0312 0335 0408 0430 0449 0502 0525 1505 1883 1988
Labour 0430
Mechanization 0274 0296 0430 0435 0449 0483 0509 1956 1962
Spacing 0220 0222 0224 0241 0244 0245 0270 0281 0283 0291 0294 0310 0312 0314 0320 0324 0334 0339 0341 0342 0348 0349 0407 0408 0427 0429 0431 0432 0448 0451 0460 0462 0470 0479 0495 0501 0502 0506 0516 0529 0542 0898 0996 1962 1988 1989
Tuber productivity 0224 0310 0324 0407 0429 0431 0448 0451 0470 0506 0518 0529 0542 0898 0956 1988

Pollen 0884 0886 0894 0896 0897 0908 0984 0991 0998 1000

Pollination 0110 0349 0908 0939 0966 0984

Polyploidy 0069 0890 0893 0896 0899 0928 0945 0988 0990 0992 0993 0999

Potash 0314 0359 0383 0393 0419

Potassium chloride 0314 0368 0392 0397 0402

Pressing 0230 0343 1104 1374 1524 1526 1551 1595 1729

Prices 0223 0229 0232 0252 0271 0382 0438 0455 0568 0569 1210 1255 1347 1350 1435 1496 1505 1547 1550 1559 1620 1659 1677 1803 1810 1811 1815 1817 1819 1826 1830 1835 1844 1849 1850 1864 1867 1870 1871 1872 1873 1875 1876 1877 1878 1879 1883 1884 1885 1887 1888 1889 1896 1899 1905 1909 1914 1916 1947 1988 1989

Processing
Boiling 1111 1240 1631
Centrifuging 1622 1656 1664 1771
Drying 0176 0230 0275 0343 1019 1021 1025 1111 1129 1131 1415 1419 1492 1501 1505 1526 1529 1530 1546 1548 1595 1597 1607 1608 1621 1622 1628 1630 1632 1634 1656 1657 1680 1692 1704 1710 1711 1726 1729 1742 1762 1763 1764 1770 1988
Fermentation 0036 1023 1072 1104 1419 1423 1467 1508 1511 1524 1527 1532 1540 1599 1605 1626 1628 1632 1652 1653 1662 1664 1681 1683 1724 1751 1764 1775 1776 1786 1787 1790 1791 1792 1793 1989
Gelatinization 1025 1075 1412 1422 1443 1447 1465 1609 1632 1664 1739 1751 1754
Grinding 0230 0275 0902 1526 1530 1621 1622 1634 1635 1771
Peeling 0036 0230 0275 1492 1526 1607 1634 1743 1771
Pressing 0230 0343 1104 1524 1526 1551 1595 1729
Pulping 1711
Rasping 0036 0229 0275 0343 1492 1524 1529 1622 1634 1664 1673 1711 1729 1762 1770 1772 1988
Screening 0230 0275 1492 1524 1526 1529 1582 1621 1622 1634 1664 1711 1729 1762 1770 1771 1988
Silting 0230 0275 1417 1457 1485 1492 1526 1565 1583 1622 1634 1675 1711 1723 1727 1762 1770 1771 1988
Steeping 0176 0275 1492 1770
Washing 0230 0275 1492 1526 1529 1607 1622 1634 1673 1675 1711 1729 1762 1771 1988

Propagation 0073 0076 0097 0099 0100 0109 0269 0270 0280 0313 0387 0443 0479 0480 0482 0488 0490 0491 0493 0494 0497 0508 0512 0513 0514 0524 0529 0570 0905 0947 0965 0969 1994

Protein content
Leaves 0037 0124 0144 0148 0162 0168 0169 0170 0182 0183 0188 0206 1021 1054 1058 1109 1130 1135 1209 1223 1232 1235 1262 1268 1369 1748 1883
Stems 0037 0503 1021 1209 1232 1235 1319
Tubers 0144 0148 0168 0169 0175 0182 0203 0207 0213 0369 0370 0503 1021 1046 1054 1059 1078 1111 1149 1260 1268 1501 1748

Protein deficiencies 1018 1031 1074 1129 1169 1200 1795 1953
Diets 1010 1022 1049 1080 1118 1157 1170 1354

Proteins
Amino acids 0118 1004 1024 1027 1040 1049 1053 1062 1078 1113 1136 1155 1158 1174 1199 1363 1780 1782 1964
Analysis 0074 0089 0118 0186 1004 1040 1048 1050 1053 1062 1078 1113 1138 1156 1161 1407 1432 1512 1773 1779 1780 1793 1964

Composite flours 1034 1037 1038 1042 1049 1081 1113 1161
Dietary value 1024 1037 1048 1068 1075 1099 1101 1113 1136 1158 1187 1199 1214 1220 1244 1271 1281 1321 1357 1359 1363 1364 1376
Digestibility 1027 1037 1048 1062 1069 1075 1094 1136 1214 1220 1364 1512
Food enrichment 1024 1033 1040 1045 1049 1068 1074 1075 1081 1099 1144 1155 1158 1236 1550 1773 1774 1775 1777 1779 1780 1782 1783 1787 1789 1792 1793 1794 1795 1804
Industrial microbiology 1612 1679 1773 1774 1775 1777 1779 1780 1782 1786 1787 1789 1792 1793 1794 1795

Pruning 0009 0245 0269 0322 0400 0427 0431 0503 0520 0556 0568 0573

Pseudomonas 0294 0589 0593 0626

Pulp 0114 0145 0165 0166 0177 0179 0349 1771

Pulping 0114 0348 1711

Rasping 0036 0114 0229 0275 0343 1492 1524 1529 1622 1664 1673 1711 1729 1734 1762 1770 1772 1988

Resistance
Diseases and pathogens 0242 0244 0313 0349 0427 0589 0598 0604 0610 0617 0633 0635 0639 0651 0698 0700 0701 0702 0704 0709 0713 0718 0719 0723 0725 0726 0727 0728 0738 0751 0760 0768 0770 0776 0838 0891 0898 0902 0903 0904 0906 0913 0914 0926 0930 0934 0935 0939 0948 0956 0958 0960 0962 0963 0964 0967 0973 0978 0980 0984 0986 1464 1747 1941 1946
Injurious insects 0155 0313 0776 0801 0823 0838 0898 0930 1384 1464

Rhizopus stolonifer 1650 1775 1787 1793 1794

Rhodanese 0143 0191 1167 1174

Riboflavin 1079 1883

Rodents
Coeloginus fulvus 0883
Dasyprocta variegata 0883

Rooting 0073 0078 0082 0086 0093 0099 0103 0104 0105 0113 0128 0304 0359 0439 0450 0458 0486 0488 0491 0493 0507 0570 0905

Roots
Growth 0026 0078 0092 0098 0542 0990
HCN content 0004 0009 0055 0403 0658 1056 1235 1596
Plant anatomy 0009 0026 0037 0041 0046 0047 0055 0076 0098 0100 0182 0313 0316 0901 0988
Plant physiology 0041 0068 0076 0092 0093 0098 0100 0155 0363 0658 0890
Production 0095 0218 0291 0445 1021 1056
Tuber development 0041 0068 0076 0095 0098 0100 0542

Rosellinia 0294 0329 0589 0592 0593 0596 0655 0670 0673 0686 0688

Rotational crops 0267 0277 0312 0327 0345 0357 0374 0399 0427 0455 0505 1769 1919 1921 1925 1946 1957 1973

Sulphur 0197 0350 0420

Scirtothrips manihoti 1976

Sclerotium rolfsii 0592 0593 0650 0682 0686 1957

Seed
Composition 0094 0118 0122 0156 0173 0281 0291 0335 0924 0938
Fat content 0094 0173
Germination 0040 0094 0101 0121 0122 0957
Protein content 0094 0173 0924
Soluble carbohydrates 0094
Starch content 0094 0938
Clones 0169 0315 0902 0903 0905 0933 0942 0957 0961 0973 0986 1393 1945 1956 1978
Cultivars 0169 0242 0243 0296 0304 0315 0327 0339 0349 0391 0536 0540 0701 0723 0898 0902 0903 0904 0911 0930 0946 0957 0958 0973 0986 1936 1961 1988

Shifting cultivation 0472 1423 1918 1919 1929

Shoots 0080 0082 0086 0087 0097 0099 0363 0420 0443 0467 0470 0480 0491 0497 0498 0542 0612 0929 0938 0977 1122 1295 1375

Silage 1209 1270 1272 1281 1289 1295 1302 1554 1773 1978

Silba pendula 0288 0589 0798 0803 0808 0818 0821 0849 1962 1994

Silting 0230 0275 1417 1457 1485 1492 1526 1565 1583 1622 1633 1634 1675 1711 1723 1727 1762 1770 1771 1998

Sodium 0124 0168 0176 0747 1035 1929

Sodium nitrate 0392

Sodium stearyl lactylate 1734

Soil analysis 0096 0232 0358 0369 0373 0375 0377 0400 0411 0413 0415 0459 0462 0471 0651 0956 1984

Soil fertility 0114 0147 0152 0195 0219 0233 0234 0240 0242 0245 0262 0270 0271 0274 0276 0280 0286 0287 0288 0291 0293 0298 0300 0312 0314 0319 0326 0331 0332 0335 0347 0348 0351 0353 0356 0357 0358 0360 0363 0366 0372 0374 0380 0383 0385 0386 0388 0390 0394 0398 0399 0401 0404 0406 0410 0411 0415 0417 0419 0420 0427 0437 0438 0472 0505 0511 0517 0544 0559 0571 1375 1462 1797 1880 1928 1940 1946 1953 1957 1961 1968 1973 1974 1976 1981 1984

Soil impoverishment 0195 0276 0312 0351 0358 0372 0374 0390 1018 1988

Soil requirements 0111 0232 0274 0276 0277 0300 0322 0341 0342 0345 0348 0357 0358 0360 0361 0375 0377 0379 0398 0399 0413 0415 0530 1791 1929 1943 1987

Soil water 0377 0856

Solar drying 1232 1492 1548 1595 1608 1630 1680 1706 1729 1764 1770

Soluble carbohydrates 0094 0192 0209 0275 0647 1094 1268 1271 1302 1354 1419 1440 1619 1780 1795 1990

Spacing 0130 0220 0222 0224 0244 0245 0261 0270 0281 0283 0289 0290 0291 0293 0294 0297 0310 0333 0339 0402 0408 0429 0460 0462 0470 0479 0482 0501 0506 0529 0567 0898 0956 1920 1962
- Stamens 0050 0052 0058 0059 0064 0884 0897

Starch content 0094 0150 0160 0175 0177 0181 0192 0194 0198 0207 0217 0223 0289 0290 0296 0304 0309 0370 0379 0391 0403 0431 0432 0532 0543 0624 0885 0890 0903 0938 0950 0954 0974 1026 1043 1056 1062 1102 1110 1134 1210 1331 1440 1501 1526 1547 1562 1599 1619 1664 1666 1676 1745 1754 1771 1803 1883 1988

Starch Productivity
- Climatic requirements 0269 0345 0391 0471 0544 1803
- Cultivars 0224 0243 0252 0268 0298 0310 0313 0315 0320 0345 0346 0354 0391 0403 0432 0436 0443 0471 0537 0539 0540 0544 0565 0889 0902 0911 0958 0969 1110 1435 1441 1509 1803 1905
- Fertilizers 0224 0313 0320 0345 0347 0352 0354 0362 0365 0393 0403 0406 0432 0506 0891 1803
- Harvesting 0224 0298 0310 0313 0320 0432 0436 0958 1803
- Irrigation 0224
- Soil fertility 0298 0347 0406 0544
- Timing 0224 0252 0298 0313 0391 0432 0436 0506 0546 1319 1435 1803

Steeping 0145 0176 0275 1492 1770

Stems
- Analysis 0037 0074 0147 0152 0350 0372 0416 0890 1232 1436
- Brans from 1523
- Cassava meal from 1021 1209 1235 1313
- Cellulose 1549 1767
- Forage 1232 1313
- HCN content 0005 0009 0193 0889 0938 1235
- Mineral deficiencies 0085 0350 0363 0384
- Paper industry 1549 1767
- Plant Development 0005 0009 0026 0057 0075 0078 0087 0281 0313 0350 0363 0407 0416 0889 0938
- Production 0218 0490 0573 1021 1209

Stomata 0069 0126 0988

Storage 0024 0053 0176 0179 0270 0276 0427 0475 0489 0587 0598 0599 0811 0826 0866 1006 1021 1042 1056 1071 1430 1494 1505 1514 1525 1538 1554 1572 1573 1614 1625 1637 1646 1648 1650 1654 1666 1725 1728 1732 1750 1757 1773 1950 1968 1981

Sucrose 0192 0209

Sugars 0072 0187 0192 0209 0648 1102 1132 1419 1624 1731

Sulphuric acid 1599 1739

Superelongation 0593

Swine
- Fattening 1187 1205 1207 1210 1223 1226 1231 1233 1247 1250 1252 1254 1270 1281 1286 1289 1294 1301 1303 1310 1330 1335 1342 1346 1350 1353 1355 1365 1367
- Finishing 1187 1205 1223 1229 1231 1233 1250 1254 1265 1270 1281 1289 1294 1303 1308 1327 1235 1355 1365
- Leaves 1223 1235 1259 1269 1273 1281 1363 1981 1994
- Pellets 1233 1235 1867
- Tubers 1187 1212 1216 1227 1229 1261 1265 1269 1289 1293 1297 1298 1325 1350 1366

Tapioca flakes 1515 1808

Tapioca macaroni 1012 1016 1054 1065 1071 1073 1077 1538 1637 1734 1875

Tapioca pearls 0456 1552 1555 1652 1808 1850 1912

Tapiocas
- Analysis 0275 1023 1416 1439 1444 1445 1522 1534 1698 1742 1771
- Confectioneries 0275 1497
- Consumption 1547 1714 1821 1850 1859 1875 1888 1912
- Dietary value 1036 1143
- Digestibility 1069
- Drying 0230 0275 1530 1726 1742 1988
- Industrial machinery 0230 0275 1541 1552 1642 1989
- Industrialization 0232 0239 0275 0348 0438 1088 1522 1530 1541 1547 1555 1566 1635 1669 1677 1698 1714 1726 1742 1771 1801 1845 1850 1875 1888 1895 1988 1989
- Legal aspects 1439 1444 1522 1530 1547 1698 1735 1875
- Nutrient loss 1416
- Nutritive value 1036 1054 1069 1143
- Patents 1522 1642
- Processing 0230 0231 0275 0305 0532 1023 1041 1088 1515 1518 1522 1530 1533 1537 1541 1547 1552 1556 1566 1579 1600 1642 1644 1647 1652 1670 1698 1721 1726 1735 1742 1771 1775 1895 1988 1989
- Storage 0147 1571 1875
- Trade 0239 0301 0456 1547 1555 1567 1600 1677 1714 1721 1800 1808 1809 1812 1821 1828 1829 1835 1845 1850 1859 1861 1863 1875 1888 1895 1901 1912 1988 1989
- Uses 0219 0227 0330 1041 1143 1497 1518 1555 1733 1845 1850 1859 1895 1988 1989
- Viscosity 1069 1445 1522 1530 1547 1698 1771
- Vitamin content 1036 1054
- Water content 0532 1054 1416 1522 1530 1534 1537 1547 1698

Tetranychus telarius 0329 0589 0812 0816 0827 0835 0849 0930 0956

Textiles 1428 1458 1502 1547 1707 1710 1742 1752

Therapeutants 1760

Thiamin 1883

Thiocyanates 0171 0397 1162 1164 1165 1171 1172 1173 1174 1177 1179 1180 1184 1185 1188 1189 1191 1194 1195 1196 1197 1380 1381 1390 1397 1400

Threonine 0849 1030

Tissue culture 0078 0107 0887 1363

Toxicity 0023 0028 0114 0115 0127 0134 0139 0140 0146 0165 0180 0194 0196 0207 0215 0225 0240 0278 0290 0427 0555 0693 0975 0986 1054 1056 1087 1108 1131 1167 1168 1172 1174 1177 1180 1181 1182 1188 1189 1232 1246 1259 1273 1282 1290 1313 1322 1326 1330 1371 1373 1374 1375 1377 1378 1379 1380 1382 1384 1385 1386 1391 1392 1393 1394 1395 1396 1400 1401 1403 1404 1514 1563 1847 1865 1938 1953 1972 1983 1988

Toxicology 1162 1165 1166 1168 1171 1172 1173 1175 1179 1180 1182 1185 1186 1188 1189 1195 1196 1197 1198 1249 1376 1381 1385 1389 1390 1404

Trade
- Cassava chips 1235 1496 1657 1659 1756 1816 1821 1826 1866 1867 1875 1881 1882 1883 1895 1901
- Cassava flour 0456 1555 1558 1578 1600 1663 1677 1714 1798 1800 1808 1821 1828 1831 1834 1839 1850 1861 1863 1865 1874 1875 1876 1882 1888 1901 1912 1989 1996
- Cassava meal 1235 1505 1600 1643 1657 1677 1714 1811 1826 1827 1839 1850 1859 1867 1874 1876 1882 1883
- Cassava starch 0344 1409 1414 1429 1435 1493 1496 1505 1547 1558 1589 1623 1643 1663 1681 1721 1807 1812 1821 1830 1831 1835 1850 1859 1861 1867 1872 1874 1875 1882 1895 1901 1903 1905 1988 1989 1996
- Gari 1429 1643 1677 1883
- Pellets 1235 1496 1659 1823 1826 1867 1883
- Tapiocas 0239 0301 0456 1547 1555 1567 1600 1677 1714 1721 1800 1808 1809 1812 1821 1828 1829 1835 1845 1850 1859 1861 1863 1875 1888 1895 1901 1912 1988 1989
- Tubers 1435 1496 1505 1661

Trichogramma minutum 0809 0813

Tryptophane 1030 1059 1062 1333 1780

Tuber development 0041 0068 0073 0075 0076 0087 0095 0098 0100 0106 0108 0109 0314 0389 0391 0508 0542 0930 0949 0956 0958

Tuber productivity 0005 0056 0080 0097 0098 0105 0106 0108 0112 0214 0224 0227 0232 0260 0269 0287 0292 0310 0313 0324 0326 0345 0346 0352 0354 0355 0359 0361 0365 0373 0387 0390 0393 0400 0405 0407 0416 0422 0429 0431 0436 0440 0448 0451 0455 0459 0467 0470 0471 0475 0488 0493 0498 0503 0506 0520 0525 0527 0529 0530 0537 0538 0539 0541 0542 0543 0544 0546 0547 0548 0549 0550 0551 0555 0556 0557 0560 0562 0563 0567 0568 0571 0572 0573 0574 0699 0772 0889 0898 0905 0914 0927 0930 0949 0956 0959 0962 1547 1988

Tubers
Analysis 0074 0084 0108 0114 0138 0140 0145 0146 0153 0154 0166 0174 0179 0181 0182 0184 0187 0195 0204 0207 0213 0372 1040 1062 1078 1978 1111 1260 1388 1415 1436 1565 1573 1651 1757 1762
Biochemistry 0074 0136 0166 0187 0647 1059 1185 1436
Deterioration 0598 0605 1402 1494 1571 1572 1592 1594 1606 1617 1648 1651 1654 1725 1747
Dietary value 1187 1212 1216 1229 1261 1267 1269 1279 1295 1298 1582 1748
Drying 0114 0145 0176 0179 1021 1089 1111 1415 1501 1505 1526 1607 1632 1706 1762
HCN content 0005 0042 0083 0130 0140 0142 0144 0145 0146 0148 0150 0154 0165 0169 0174 0179 0184 0193 0204 0207 0210 0369 0938 1054 1393 1526 1748
Nutritive value 0129 0141 0175 0211 1027 1040 1054 1062 1089 1149 1187 1253 1297 1350 1978
Packaging 1632 1706
Palatability 0527 1187 1269
Silage 1289 1295 1554 1978
Starch content 0150 0175 0181 0192 0207 0370 0391 0624 0938 1062 1501 1526 1666 1676
Storage 0176 0179 0434 0598 0687 0811 0842 1021 1402 1494 1505 1554 1571 1572 1573 1592 1594 1606 1607 1617 1648 1651 1654 1661 1666 1706 1719 1725 1732 1747 1750 1757 1978
Trade 1435 1496 1505 1661

Tyrosine 0115 1040 1059 1062 1333

Urea 1274 1292 1317 1359

Uromyces manihotis 0329 0592 0655 0685 1976

Vascular streaking 0598

Virus inhibition 0733 0743 0752 0756 0758

Virus transmission 0578 0710 0760 0769
Cuttings 0733
Grafting 0756 0762 0768 0930
Vectors 0733 0735 0742 0746 0753 0756 0768

Viscosity
Cassava starch 1405 1421 1428 1438 1443 1447 1454 1455 1456 1457 1458 1459 1461 1465 1471 1480 1509 1546 1547 1698 1739

Vitamin content 0129 0141 0148 0161 0164 0208 1014 1034 1036 1042 1054 1077 1085 1090 1091 1127 1130 1135 1157 1159 1160 1246 1257 1268 1512 1538 1748 1883 1977

Vitamin deficiencies 1010 1174 1189

Waste utilization 1208 1227 1238 1303 1337 1418 1500 1599 1686 1687 1691 1694 1760

Water absorption
Cassava starch 1406 1430 1451 1482

Water requirements (plant) 0096 0111 0112 0126 0204 0276 0289 0366 0367 0377 0378 0379 0475 0747 0856 0958 1034 1039 1182 1323 1522 1530 1803

Water requirments (processing) 1240 1417 1492 1526 1631 1642 1675 1727 1738 1771

Water content
Cassava chips 1576
Cassava flour 0153 0868 1039 1046 1047 1051 1416 1501 1525 1530 1534 1698
Cassava meal 0532 1024 1056 1210 1223 1512 1522 1628
Cassava starch 0532 1054 1416 1430 1547 1633 1656 1692 1698
Gari 0171 1054 1056 1512 1527 1650 1664
Leaves 0182 0211 0747 1054 1093 1109 1223 1268
Stems 0488
Tapiocas 0532 1054 1416 1522 1530 1534 1537 1547 1698
Tubers 0130 0150 0153 0165 0182 0211 0369 1040 1046 1054 1268 1501

Weeding 0274 0331 0341 0342 0343 0422 0428 0437 0440 0441 0445 0446 0455 0463 0474 0487 0504 0505 0509 0510

Weeds 0104 0274 0296 0346 0422 0441 0444 0445 0446 0463 0469 0487 0504 0510 1929 1973

Xanthophylls 1266