Series HE-31
December, 1977

ABSTRACTS ON CASSAVA

(*Manihot esculenta* Crantz)

Volume III

CASSAVA INFORMATION CENTER
CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

CIAT is a nonprofit 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 on several of its experimental stations and similar work is done with national agricultural agencies in other Latin American countries. CIAT is financed by a number of donors represented in the Consultative Group for International Agricultural Research. During this year these donors were 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 Inter-American Development Bank (IDB) and the governments of Australia, Belgium, the Federal Republic of Germany, Japan, the Netherlands, Switzerland and the United Kingdom. In addition, special project funds are supplied by various of the aforementioned entities plus the International Development Research Centre (IDRC) of Canada and the International Board for Plant Genetic Resources (IBGPR). Information and conclusions reported herein do not necessarily reflect the position of any of the aforementioned agencies, foundations or governments.

FOREWORD

CIAT's Scientific Information Center covers the following areas: cassava, beans under tropical conditions, tropical pastures and forages, and agricultural economics within the Latin American context.

The Center offers a variety of services: Monthly, subscribers receive all abstracts that have been processed by the Center during that period. In addition, by means of a mechanized system, specific searches can be made on any topic or combination of topics, and abstract cards on all documents dealing with that particular subject are provided. Users can then request photocopies of the original documents in which they are interested.

These compilations of abstracts include materials that have already been delivered in card form to subscribers. Whereas abstract cards provide the reader with a current awareness service, cumulative volumes such as these constitute a more permanent record of information. The use made by scientists of these two types of information tools is quite different —both equally important in providing scientists with the data required for their research activities.

CIAT's Scientific Information Center is financed by special project funds, such as grants provided by the International Development Research Centre (IDRC) of Canada for cassava and the Ford Foundation for agricultural economics, as well as by CIAT's core budget. Special mention should be made, however, of the scientific and technical collaboration of CIAT scientistis who work continuously in close collaboration with our documentalists and information processors.

It is our constant hope that services provided by CIAT's Scientific Information Center will be a major supporting pillar for research that will contribute to ameliorate the problem of food production for the world.

Fernando Monge, Ph.D
Scientific Information Center
CIAT

CIAT INFORMATION CENTER PERSONNEL

Fernando Monge, *PhD, Information Scientist, Coordinator*
Trudy Brekelbaum de Martínez, *MA, Editor*
Marlene Cardona G., *Typesetting*
Manuelita de Chacón, *Information input*
Stella Gómez, *BA, Bibliographer*
Marilú Ostertag de Hensel, *BS, Documentalist*
Jorge López S., *Documentalist*
Gladys de Ramos, *Secretary*
Julia Emma de Rodríguez, *Ing. Agr., Documentalist*
Guillermo Solís, *Layout*
María Isabel de Zapata, *BS, Translator*

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 from 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 4

C00 PLANT PHYSIOLOGY 5

C01 Plant Development 9
C02 Cyanogenesis 12
C03 Chemical Composition, Methodology and Analyses 13

D00 CULTIVATION 20

D01 Soil, Water, Climate and Fertilization 28
D02 Cultivation Practices: Propagation, Planting, Weed Control and Harvesting 37
D03 Energy Productivity and Yields 46

E00 PLANT PATHOLOGY

E01 General Descriptive Studies 52
E02 Bacterioses 54
E03 Mycoses 56
E04 Viroses 59
E05 Nematodes 63

F00 PEST CONTROL AND ENTOMOLOGY 64

F01 Injurious Insects and their Control 68

G00 GENETICS AND PLANT BREEDING 74

G01 Breeding, Germplasm, Varieties and Clones, Selection 75
G02 Cytogenetics 83

H00 NUTRITION 84

H01 Cassava Foods and Nutritive Value 85
H02 Nutritive Disorders in Humans 91
H03 Animal Feeding 93
H04 HCN Toxicity and Detoxification
(For HCN content, see C03) 105

I00 PROCESSING, PRODUCTS AND USES 107

I01 Cassava Starch and its Properties 108
I02 Uses, Industrialization, Processing and Storage 112
I03 Industrial Microbiology 128

J00 ECONOMICS AND DEVELOPMENT 132

K00 OTHER ASSOCIATED COMMODITIES 152

K01 Rotational Schemes and Intercropping 153
K02 Descriptive and Comparative Studies 157

Z00 GENERAL 158

AUTHOR INDEX 163

SUBJECT INDEX 167

A00 BOTANY, TAXONOMY AND GEOGRAPHICAL DISTRIBUTION

0001-4545 BIANCHINI, M. La geografia della mandioca. (The geographical distribution of cassava). Bollettino della Societa Geografica Italiana (Ser. 8) 4:26-53 1971 Ital., Sum. Engl., 112 Refs., Illus.

Cassava. *Manihot esculenta* Plant geography. History. Ecology Tuber composition. Production. Trade. Uses.

The general distribution and climatic requirements of cassava, root composition and uses (foodstuffs and industrial by-products) are discussed briefly Data are given on world production, area under cultivation and the market situation (*Summary by T M*) A00

0002-7570 HOOKER, W.J. *Janipha maniot.* Eatable-rooted, physic-nut, bitter cassada, manioc or tapioca. Botanical Magazine 58:3071-3075. 1831. Engl.

Cassava. *Manihot esculenta.* Taxonomy.

The anatomy and morphology of cassava are given. Bitter cassava is used as a poison or medicine by some indigenous tribes. The leaves are eaten as a vegetable; the roots are used to make meal and cassareep. (*Summary by T.M.*) A00

0003-2547 JENNINGS, D.L. Cassava, *Manihot esculenta* (Euphorbiaceae). *In* N W. Simmonds ed. Evolution of Crop Plants. London, Longman, 1976 pp.81-84. Engl , 10 Refs , Illus.

Cassava. History. Plant geography. Plant breeding.

The cytotaxonomic background, early history and potentials of cassava are discussed. There will probably be changes in breeding objectives since there is a need for mechanizing harvesting, which would require a plant with more compact roots without excessive lateral or vertical growth The ecological adaptation of cassava could be extended by crossbreeding with *Manihot* species adapted to drought, lower temperatures and acid soils Emphasis is being placed on the selection of clones with minimum levels of HCN (*Summary by A.J Trans. by I.B Z*) A00

0004-7676 KIOK, W. Der maniok; ein Beitrag zur Wirtschafts geographie der Warmen Länder.*(Cassava· contribution to the economic geography of the tropics)* Ph: D Thesis

Greifswuald, German, Universitat zu Greifswald, Fakultät der Ernst - Moritz - Arndt, 1934. 75p Germ , 146 Refs , Illus

Cassava. Plant geography. Ecology. Maps. Production. Trade. Consumption. Statistical data.

A general description is given of the cassava plant its origin, taxonomy, ecological conditions, soil and rainfall requirements, and principal products. Using numerous maps, graphs and statistical tables, a study is made of zones where cassava is cultivated in Latin America, Africa, meridional Asia, Australia and Oceania, giving production and export data for the main countries for the period 1910-30. An annex provides data on area planted to cassava in relation to the climate, production and exports (Java is the leader) and consumption in producing countries, as well as in the USA, the main importer *(Summary by H.P. Trans. by T M)* A00 J00

0005-4415 KOCH, L. **Het onderkennen van cassave varieteiten.** (*Distinguishing between cassava varieties*). Korte berichten uitgaande van de selectie en zaadtuinen voor Rijst en andere éénjarige Inlandsche Landbouwgewassen no 14:1-11. 1920 Dutch

Cassava. Cultivars. Identification. Leaves. Stems. Tubers.

A list of 11 characteristics are given for distinguishing between different varieties of cassava Two characteristics—pubescense or lack of it on the upper surface of expanding leaves and the color of cortex of mature parts of the stem—are classified as being constant The others— based on color of different parts of the stem, branches and leaves—may vary. As an example, the characteristics of 9 Brazilian varieties are given. (*Summary by R. van G*) A00

0006-8009 LEON, J. **Origin, evolution, and early dispersal of root and tuber crops.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp 20-36. Engl , Sum Engl , 59 Refs.

Cassava. History. Plant geography.

A historical and geographical recount is given of tropical root and tuber crops, most of which are polyploids that are propagated vegetatively. Early man learned how to remove the poisonous or bitter qualities from these crops As regards cassava, it is clear that it has been used more intensively in South than in Central America. There is a strong correlation between the geographic distribution of sweet cassava (western side of South and Central America and Mexico) and bitter cassava (eastern side of South America and the Antilles), with an overlapping area in between (*Summary by I B Z*) A00

0007-1782 ROGERS, D J. and APPAN, S.G. ***Manihot* and *Manihotoides* (Euphorbiaceae): a computer-assisted study.** New York. Organization for Flora Neotropica. Monograph no. 13. 1973. 278p. Engl., 62 Refs. Illus

Cassava. *Manihot. Manihot esculenta.* Taxonomy. Developmental research. Plant geography. Identification. Flowers. Leaves. Stems. Tubers. Fruits. Inflorescences. South America. Central America.

This monograph is intended as a guide for biosystematic studies and as a source of information for breeders working on varietal improvement of *Manihot esculenta.* In studying the evolution of

M. esculenta, it was found necessary to make a modern classification of the variants within the genus *Manihot.* This exhaustive taxonomic classification, employing a consistent biological species concept (the species is a closed gene pool), is supported by 3 computer programs TAXIR, an information retrieval system; CHARANAL, for study of the significance and value of characters; and GRAPH, a clustering method The following systematic criteria were used growth habit, pigmentation, roots, stems, pubescence of plants, leaves, inflorescence, staminate and pistillate flowers, fruit and seed The systematic position of the genus, as well as a key to *Manihot* and *Manihotoides* and the sections of the former, is given. For each of these sections, there is a morphological description; and geographic distribution, synonymy and beginnings of cultivation are discussed. (*Summary by T.M.*) A00

B00 PLANT ANATOMY AND MORPHOLOGY

0008-0160 VIEGAS, A P. **Anatomia da parte vegetativa da mandioca.** *(Anatomy of the vegetative part of cassava).* Campinas, São Paulo, Brasil Secretaria da Agricultura, Indústria e Comércio. Instituto Agronômico. Boletim Técnico no 74. 1949. 102p Port , 9 Refs., Illus.

Cassava. *Manihot esculenta.* **Plant anatomy. Fruits. Plant vascular system. Roots. Stems. Brazil.**

The following parts of the cassava plant (*Manihot esculenta* Crantz) are described and illustrated in detail the seed, the primary and secondary structures of the stem, root and vascular system. Aspects of phyllotaxy are also included. *(Summary by T.M.)* B00

C00 PLANT PHYSIOLOGY

0009-7951 COCK, J.H. **El tipo ideal de yuca para rendimiento máximo.** (*A cassava ideotype for maximum yield*). Cali, Colombia, Centro Internacional de Agricultura Tropical Series SE-01-77. 1975. 27p. Span., Sum. Span., 14 Refs., Illus.

Cassava. Plant physiology. Plant physiological processes. Growth. Plant development. Leaves. Leaf area. Tuber productivity. Tuber development. Developmental stages. Cassava programs. Colombia.

The Cassava Program at CIAT has been working on a high-yielding cassava ideotype for several years. The following results have been obtained (1) DM production. Leaf area index and growth: Maximum growth rate is reached at an LAI of 4; the subsequent decline is probably due to a short leaf life (Leaf angle does not appear to be an important factor in cassava growth whereas LAI is.) Rate of root growth was optimum with an LAI of 2.5-3.5, beyond which the marginal increase of DM was used to produce leaves but not roots. (2) Root growth in relation to leaf and stem growth. A decrease in root no. has no effect on growth of the aerial part unless the decrease is drastic. Stem girdling and shading trials showed that roots accumulate excess carbohydrates from the aerial part only when the latter has reached maximum development (3) LAI development. Leaf size increases up to 4 mo after planting and then declines. Maximum size is a varietal character. The rate of leaf formation, which was similar in all lines studied, decreases with time Leaf life without excessive shading is a varietal characteristic ; when shading is higher than 95%, leaf fall occurs sooner The most common branching pattern is 3 branches at each branching point. Time to each branching is also a varietal characteristic. (4) Cassava growth model. Growth rate is a function of LAI and may be determined from the rate of leaf production/apex, no of apices/m, leaf size with time and leaf life (which is a constant). Stem weight is determined by multiplying node wt + leaf wt by the rate of leaf formation. The rate of root growth may be determined from the difference between total growth rate and stem growth rate Model results were very similar to those obtained in the field recently, thus a rather accurate description of plant growth can be made Simulation showed that branching (disastrous when it occurs early), leaf size, leaf life and wt/node influence yield. Based on the results of simulation, it appears that a cassava plant that combines branching at 20 wk, a leaf life of 15-20 wk, a maximum leaf size of 500 cm^2 and planting density of 20,000 plants/ha, together with sound management and protection methods, can be expected to yield 30 tons of dry roots/ha/yr. This model makes it possible for breeders to define which characters should be changed to increase yield (*Author's summary. Trans. by I.B Z*) C00 C01

0010-8017 HOLMES, E B. and WILSON, L A. **Total dry matter production, tuber yield, and yield components of six local cassava cultivars in Trinidad.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings Ottawa, Canada, International Development Research Centre, 1977 pp.84-88. Engl., Sum. Engl., 10 Refs

Cassava. Cultivars. Dry matter. Production. Tuber productivity. Tubers. Stems. Petioles. Leaves. Trinidad and Tobago.

Dry matter production, quantitative shoot morphology, DM distribution, root yield and yield components of 6 representative cassava cultivars in Trinidad are presented Results are discussed in relation to the yield performance of elite cassava cultivars and the yield potential of the cassava species. A cassava type on which improvement of yield potential of the species might be based is identified. (*Author's summary*) C00 D03

0011-7916 HUME, D.J. **Translocation of ^{14}C- labelled photo-synthetic assimilates in cassava (*Manihot esculenta* Crantz).** Ghana Journal of Agricultural Science 8(1) 69-75. 1975. Engl , Sum. Engl., Fr., 7 Refs., Illus.

Cassava. Plant assimilation. Photosynthesis. Plant respiration. Translocation. Tracers. CO_2. Analysis. Timing. Field experiments. Ghana.

Leaves of cassava (*Manihot esculenta* Crantz cv. Ankra) plants were allowed to assimilate $^{14}CO_2$ in photosynthesis. Following labeling with ^{14}C at 6 mo of age, plants were harvested after 7 days and after 6 mo, near maturity Additional plants were labeled at 8 and 12 mo of age and harvested immediately after 7 days, or near maturity. ^{14}C in individual plant parts at each harvest was determined by liquid scintillation counting Radioactive assimilates were recovered primarily in leaves exposed to $^{14}CO_2$, in stems between these labeled leaves and the tubers, and in the tubers. All plants had 2 stems. Very little of the ^{14}C assimilated by leaves on 1 stem was translocated into the other stem. Up to 60% of assimilated ^{14}C went to the tubers when plants were growing rapidly ^{14}C assimilated during the dry season was recovered mainly in aboveground parts Two separate estimates indicated that 40% of the assimilated ^{14}C was lost in respiration and leaf abscission during the 1st week after labeling. (*Author's summary*) C00

0012-7986 HUNT, L.A., WHOLEY, D.W. and COCK, J.H. **Growth physiology of cassava (*Manihot esculenta* Crantz).** Field Crop Abstracts 30(2): 77-91. 1977. Engl., 76 Refs., Illus.

Cassava. *Manihot esculenta*. Plant physiology. Plant development. Growth. Branching. Tuber development. Plant physiological processes. Productivity.

The present review was made to draw together information currently available in the Documentation Center at the Centro Internacional de Agricultura Tropical, Palmira, (Colombia). There is a high degree of repetition in cassava research, resulting from the fact it has been conducted in separate countries and different languages. Therefore, there is as urgent need for better communication among researchers. Comparisons of results are difficult because of inadequate description of cultivars. There is a need for an international agreement on a numerical system for cultivar description, which could be based on the system used by Rogers and Fleming (1973). A no. of gaps in research are related to (1) factors influencing storage root no., (2) leaf production and life, (3) interrelationship between sink activity and leaf activity, (4) capacity of the translocation system, (5) water relations of the plant, (6) periodicities of growth. (*Summary by I.B.Z.*) C00

0013-8016 LOOMIS, R S and RAPOPORT, H. **Productivity of root crops.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976

Proceedings Ottawa, Canada, International Development Research Centre 1977 pp.70-84 Engl, Sum Engl, 82 Refs, Illus

Cassava. Plant physiology. Plant physiological processes. Productivity.

The role of an underground storage organ as a sink for photosynthates in competition with leaf and stem growth and its influence on plant productivity are discussed. The extended periods of time over which bulking may occur and its indeterminant nature means that the competition for substrate influences the dynamics of plant growth over much of the life cycle It is important to understand the controls that balance bulking with other growth activities of the plants The influence of peak irradiances on primary production in plant communities, especially in tropical regions is explained These regions are limited by short days, cloudiness and humidity, but are favored by low evaporative demands. Their chief advantage is the long growing season, especially of perennial crops like cassava with underground storage organs of long growth duration. Root crops involve special problems in partitioning of photosynthates; other aspects of their production processes seem to be similar to most other higher plants. The dynamics of partitioning to storage organ growth and its control are considered. (*Summary by I.B.Z.*) C00

0014-7909 MAHON, J. D., LOWE, S B. and HUNT, L. A. **Photosynthesis and assimilate distribution in relation to yield of cassava grown in controlled environments.** Canadian Journal of Botany 54(12):1322-1331. 1976. Engl., Sum. Engl, Fr.. 22 Refs., Illus.

Cassava. *Manihot esculenta* Photosynthesis. Plant assimilation. Leaf area. Tuber development. Productivity. Plant development. Growth. Photoperiod. Temperature. Growth-chamber experiments. Timing. Analysis.

Cassava (*Manihot esculenta* Crantz) plants were grown for 52 wk in controlled-environment growth rooms with day/night (14/10 h) temperatures of 29/24 and 24/19°C Plants were sampled for growth analysis at monthly intervals for 36 wk and at 52 wk. At intervals the photosynthetic CO_2 uptake by leaf parts and the respiration were measured in situ by using infrared CO_2 analysis Growth rate at both temperatures was directly related to the product of leaf photosynthesis and total leaf area, and the decreasing NAR of the high-temperature plants was reflected in the declining mean photosynthetic rate of the leaf tissue The rate of photosynthetic CO_2 uptake was between 9 and 18 mg $dm^{-2}h^{-1}$, depending on leaf position During the early stages of growth, the relationship between root wt and total wt was unaffected by temperature As the plants increased in size, the proportion of DM in the roots increased in low-temperature plants but remained constant in high-temperature plants The estimated plant respiration averaged 45% of the total assimilation In high-temperature plants root respiration was equivalent to 0.7% of the root dry wt/day, and after 36 wk the total root respiration exceeded root growth *(Author's summary)* C00

0015-8063 NARTEY, F. **Lipase activity and the conversion of fat to carbohydrate in cassava.** *In* Symposium of the International Society for Tropical Root Crops, 4th, Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.270-273. Engl., Sum. Engl, 5 Refs, Illus.

Cassava. *Manihot esculenta.* Plant physiology. Seeds. Enzymes. Growth. Germination. Hydrolysis. Carbohydrates. Metabolism. Lipids.

The activities of lipase, isocitrate lyase and malate synthetase were investigated in cassava. The enzymes were present in mature dry seeds Their activities increased gradually during the initial phase of germination. In the postgermination period of growth in the dark, however, the activity of these enzymes increased rapidly, reaching their peaks at the period of maximum carbohydrate

synthesis and storage, which nearly coincided with the period of maximum lipid degradation. This indicates that the fat-carbohydrate mechanism in cassava involves the key enzymes of the glyoxylate cycle. (*Author's summary*) C00

0016-8040 NINAN, C.A. *et al.* **Lipid metabolism in mosaic-infected cassava.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.173-174. Engl., Sum. Engl., 10 Refs.

Cassava. Lipids. Metabolism. Cassava mosaic virus. Plant physiology. India.

Two varieties of cassava, M4 and H.165, were selected for studies on lipid metabolism in cassava mosaic-infected plants. There was a decrease in total lipids, phospholipids and triglycerides in the leaves and petioles of both varieties. (*Author's summary*) C00 E04

0017-7920 ROCHA, Z.M M.DA Estudo comparativo da tolerancia à desidratação em cacaueiro (*Theobroma cacao* Linn.) e plantas de sombreamento. (*Comparative study of tolerance to dehydration in cacao and shade plants*). Tese Mag Sc. Itabuna, Brasil, Universidade Federal da Bahia, 1976. 22p. Port., 30 Refs.,Illus.

Cassava. Plant physiology. Stomata. Water requirements (plant). Photosynthesis. Brazil.

To determine the capacity of the cacao plant and different shade plants (among them cassava) to survive under conditions of soil water deficiency, a study was conducted at the Centro de Pesquisas do Cacau in Bahia (Brazil). The following factors were evaluated: resistance of leaves to dehydration, stomatal behavior and xeromorphic characteristics. As regards cassava, the stomata presented relatively high resistance even with a high water potential (-4.0 atm) Photosynthetic activity decreased rapidly with dehydration, reaching an equilibrium between CO_2 absorption and release also when water potential was high, ranging from -3.5 to -5 5 atm The av no. of stomata/mm^2 was 682 on the under leaf surface (*Summary by I B Z Trans by T.M.*) C00

0018-7664 ROSAS, C., COCK,J H. and SANDOVAL, G **Leaf fall in cassava.** Experimental Agriculture 12: 395-400 1976 Engl., Sum. Engl., II Refs , Illus

Cassava. Plant development. Leaves. Abscission. Field experiments. Timing. Plant-growth subtances. Illumination. Colombia.

Trials on leaf abscission of cassava led to the conclusion that the leaf lamina is necessary and must receive light to prevent abscission of the petiole The abscission rate of old leaves is increased by the presence of an active apex but is not affected by the carbohydrate requirements of the roots. (*Author's summary*) C00

See also 0160

C01 Plant Development

0019-7675 BARRIOS R., J R. Contribuição ao estudo do vigor e do desenvolvimento inicial em estacas de mandioca (*Manihot esculenta* Crantz). *(Study on initial vigor and development of cassava cuttings).* Tese Mag Sc. Piracicaba, Brasil, Universidade de São Paulo. Escola Superior de Agricultura "Luiz de Queiroz", 1975. 99p Port., Sum. Port., Engl., 42 Refs., Illus.

Cassava. *Manihot esculenta*. Cuttings. Shoots. Germination. Plant development. Dry matter. Stems. Leaves. Tubers. Leaf area. Plant physiology. Statistical analysis. Field experiments. Brazil.

A trial was carried out with cassava at the Escola Superior de Agricultura Luiz de Queiroz in Piracicaba (Brazil) to determine the influence of cutting size (5, 10, 15 and 20 cm) on both vigor and initial development of the shoots. The percentage of sprouting, rate of emergence, total DM wt, dry wt of the aerial part, dry wt of total roots, av dry wt of leaves, av dry wt of stem shoots, av leaf area and total leaf area were evaluated at 2 different stages of shoot growth Results showed that vigor during initial development was directly related to the size of cassava cutting (*Author's summary*) C01

0020-7480 COCK, J. H. Adaptabilidad de la yuca. (*Adaptability of cassava*). *In* Curso sobre producción de yuca. Ed. prelim Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp.140-141. Span.

Cassava. Field experiments. Cultivars. Adaptation. Productivity. Climatic requirements. Photoperiod. Temperature. Water requirements (plant). Plant development. Ecology. Colombia.

The adaptability of cassava to different temperatures, drought and photoperiod is discussed At lower temperatures, the rate of leaf formation/apex is lower and time to 1st branching, longer. Therefore, a vigorous variety under warm conditions would be ideal under colder conditions Of the little information available on changes in photoperiod, there is some indication that long days may suppress formation of swollen roots, reducing harvest index and yield slightly. Cassava is resistant to drought, and some reports indicate that frequent irrigation may cause yield reductions (*Summary by A.J. Trans. by T M.*) C01

0021-7499 COCK, J.H. Fisiología de la yuca. (*Cassava physiology*). *In* Curso sobre producción de yuca Ed. prelim. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp.127-139. Span., Illus.

Cassava. Plant physiology. Plant development. Field experiments. Leaves. Leaf area. Growth. Roots. Branching. Cultivars. Productivity. Timing. Climatic requirements. Colombia.

Developments in the field of cassava physiology are discussed, specifically for conditions at CIAT, where most of the work was done. Factors controlling the formation of LAI, as well as the relationship between growth rate and LAI and their interactions, are discussed in the efforts to define a plant ideotype for cassava. Factors determining LAI are leaf size, no. of leaves/apex, no of apices/unit of land area, and leaf life The ideal plant should have (1) more than 10 swollen roots/plant, (2) branching at 30 and 45 wk without suckers, (3) large leaves (maximum 500 cm^2), and (4) a leaf life of 15 wk or more and light nodal units *(Summary by A.J. Trans by T M)* C01

0022-7913 DAS GUPTA, H. P. **Effects of Cycocel on crop plants in Sierra Leone. II. Cassava.** *(Manihot esculenta).* Experimental Agriculture 12:321-328. 1976. Engl , Sum. Engl., 16 Refs.

Cassava. Tuber productivity. Plant-growth substances. Timing. Field experiments. Analysis. Plant development. Growth. Tubers. Composition. Sierra Leone.

The response of cassava to Cycocel, a plant growth regulant, was studied by applying concentrations of 0, 500, 1000, 1500 and 2000 ppm, 2-4 times as a foliar spray At 1500 ppm, 4 applications of Cycocel gave the best increase in root yield Cycocel applications also tended to increase RGR and root DM production. *(Summary by T M)* C01

0023-1615 GOPINATAN NAIR, V and KUMARA PILLAI, P. **Spontaneous development of a normal branch from a variegated scion in a tapioca graft hybrid.** Madras Agricultural Journal 51(12):514. 1964. Engl., Illus.

Cassava. *Manihot esculenta.* **Hybrids. Branching. Grafting. India.**

A graft hybrid was produced with a ornamental variety of cassava (variegated leaves and yellow stem) and a normal variety. A no. of shoots of both types were produced from the stock (normal) as well as the scion(variegated). Of the 8 branches produced by the scion, one was different from the others. Its early stages were variegated; but as it grew, variegation decreased and development was normal when it reached 9 m in length. There are probably cytoplasmic factors in the stock that acted on the variegated scion, leading to normal development. *(Summary by A.J. Trans by I.B Z)* C01

0024-7668 KARTHA, K. K. **Meristem culture..** *In* Gamborg, O L. and Wetter, L. R., eds. **Plant tissue culture methods.** Saskatoon, Saskatchewan, National Research Council, 1975. pp. 39-43. Engl., 3 Refs ,Illus.

Cassava. Tissue culture. Plant-growth substances. Growth-chamber experiments. Culture media. Shoots.

Guidelines are given for selecting culture media, growth hormones and environmental conditions for growing meristematic tissue. Descriptions are given of equipment, material and reagents (plant material, growth hormones, nutrient agar media and growth conditions), and procedures (preparation of sterilized tissue and dissection of meristematic domes) It was possible to obtain plants from the shoot apical meristems of cassava on an MS medium supplemented with

benzyladenine (5 x 10^{-7}M), naphthaleneacetic acid (10^{-6}M) and gibberellic acid (10^{-7}M). *(Summary by A J. Trans. by T.M.)* C01

0025-8203 MARTIN, F.W. and RUBERTE, R. **Germination and longevity of cassava seeds.** Tropical Root and Tuber Crops Newsletter no. 9:54-56. 1976. Engl.

Cassava. Seed. Germination. Timing. Storage.

Germination percentage and rate of freshly harvested cassava seeds were 70% and 16 1 days, respectively, and were decreased by soaking in H_2SO_4 Removal of the testa decreased germination to 38% and germination rate to 11.8 days. Germination of seeds stored for 0-24 mo in 4 environments decreased with time, the decrease being greatest in seeds exposed to room temperature and RH and least in seeds exposed to room temperature and low RH. (*Summary by Field Crop. Abstracts*) C01

0026-1799 STATION AGRONOMIQUE DU LAC ALAOTRA. **Activités; année 1949-1950.** (*Activities: 1949-1950*). Agronomie Tropicale 7(2):157-159. 1952. Fr.

Cassava. Hybrids. Productivity. Seed. Germination. Timing. Selection. Cassava programs. Malagasy Republic.

The results are given of research work on cassava at the Lake Alaotra experimental station from 1949-50. Plant breeding experiments were continued, and 20 out of 42 clones retained in 1948 were selected for their high yield and satisfactory planting density. To increase the percentage of natural germination of seeds, both chemical agents (sulfuric acid and hydrogen peroxide) and mechanical means (filing and perforating the seed or removing the caruncle) were used. Only removal of the caruncle increased the percentage of germination in the soil; and the effect of most of the other agents was unfavorable (*Summary by S.S. de S. Trans. by I.B.Z.*) C01 G01

See also 0009 0042 0074 0095 0102 0106 0117 0139 0140 0166 0179 0217 0218 0222

C02 Cyanogenesis

0027-7539 DUSTAN, W.R *et al.* **Cyanogenesis in plants. VI. On phaseolunatin and the associated enzymes in flax, cassava, and the "Lima bean."** Proceedings of the Royal Society of London B. Biological Sciences 79 315-322. 1907. Engl.

Cassava. Cyanogenesis. Lima beans.

Aspects of the characterization of phaseolunatin (which the authors equate with linamarin) and associated enzymes found in lima beans (*Phaseolus lunatus*), flaxseed and cassava are discussed, with emphasis on the 1st. It was determined that as the enzymatic preparation of *P. lunatus* decomposes amygdalin and salicin, it must contain a β-enzyme identical or similar to emulsin. Since α-dextrose is also produced and the glucoside is decomposed by yeast maltase, the α-enzyme is identical or similar to yeast maltase. A combination of the same 2 enzymes must also occur in cassava and flaxseed since their enzyme preparations act the same way. (*Summary by A.J. Trans. by T.M.*) C02

0028-8403 SINHA, S.K. **Cyanogenic glucoside production and its possible control in cassava.** Indian Journal of Plant Physiology 12(1/2).140-147. 1969. Engl , Sum. Engl., 8 Refs.

Cassava. Field experiments. N. Fertilizers. HCN content. Timing. Leaves. Tubers. Cultivars. India.

The problem of cyanoglucosides in cassava is discussed. It is shown that there is no relationship between cyanide content in leaves, peel and flesh of roots, suggesting that the site of cyanoglucoside synthesis in leaves and roots might be independent Therefore, a change in the method of N application, from soil to foliar, might check enhanced cyanide synthesis caused by higher applications of N. Foliar application of urea reduced cyanoglucoside synthesis in roots, compared to full or partial soil application of N. The preplanting treatment of stem cuttings with NAA also reduced the HCN content of leaves and roots The results are of practical value for cassava cultivation under high fertility conditions. (*Author's summary*) C02 C03

C03 Chemical Composition, Methodology and Analyses

0029-7908 BOEY, C. G., YEOH, H.H. and CHEW, M.Y. **Purification of tapioca leaf rhodanese.** Phytochemistry 15(8):1343-1344. 1976. Engl., Sum. Engl., 10 Refs.

Cassava. Leaves. Enzymes. Rhodanese. Analysis. Laboratory experiments.

Cassava (*Manihot esculenta*, var. Kekabu) leaf rhodanese was purified 7.8-fold by column chromatography on Sephadex G-10, acetone fractionation and gel electrophoresis The purified enzyme was homogeneous in sedimentation velocity studies and analytical gel electrophoresis, and hetero-dimer was demonstrated by SDS gel electrophoresis. The enzyme kinetics were also studied. *(Author's summary)* C03

0030-6387 COSTA, A.P DA *et al.* **Determinação, por difusão, do HCN da mandioca** (*Manihot esculenta* Crantz). (*Determination of HCN in cassava by diffusion*). Arquivos da Universidade Federal Rural do Rio de Janeiro 3(1).75-78. 1973. Port , Sum. Port., Engl , 4 Refs., Illus

Cassava. Tubers. HCN content. Analysis. Brazil.

A diffusion method is described for determining the HCN content in cassava. The diffused HCN was 1st collected in an alkaline solution and then analyzed by spectrophotometry. Results were similar to those obtained by the classic methods based on steam distillation. (*Author's summary*) C03

0031-7542 GOPAL, T.K.S. and SADASIVAM, R. **A note on the variability of claynogenic glucoside content in cassava tuber var. Malavella at different stages of maturity.** South Indian Horticulture 21(3):111-112. 1973. Engl., 7 Refs.

Cassava. Tubers. HCN content. Timing. Analysis. Detoxification processes. India.

Using Indira and Sinha's method, an analysis was made of HCN content in the peel and pulp of cassava roots var. Malavella at 7-11 mo of age. Greatest HCN content in the pulp (45 mg/kg) was found at 9 mo. It was observed that HCN content increased from the 7th mo on, reaching maximum value in the 9th mo, when it decreased The peel had higher levels of HCN (260 mg/kg at 8 mo). Steam treatment of the roots for 20 min reduced HCN 100% in the pulp and 90% in the peel; longer treatments lowered root quality. (*Summary by A.J Trans. by T.M.*) C03

0032-7906 HALL, N T., NAGY, S and BERRY, R. E. **Leaves for food: protein and amino acid contents of leaves from 23 tropical and subtropical plants.** Proceedings of the Florida State Horticultural Society 88:486-490. 1975. Engl., Sum. Engl., 32 Refs, Illus.

Cassava. Cassava leaves (vegetable). Protein content. Amino acids. Analysis. Laboratory experiments. Nutritive value. Food products.

Leaves are a potential source of low-cost protein. By dry wt, leaves of 23 plant types contained protein from 6-41%, of which 14 contained 20% or more. Notable were castor bean *(Ricinus communis)* 41%, balsam pear *(Momordica charantia)* 33%, cowpea *(Vigna sinensis)* 32%, and cassava *(Manihot esculenta)* 32%. The leaves had large quantities of the essential amino acids lysine, leucine and isoleucine; moderate amounts of valine, threonine and phenylalanine; and minor amounts of methionine and tryptophan. Many nonessential amino acids were found in moderate quantities. Tyrosine and histidine were low, and cysteine and cystine were detected at levels that were less than 1% of the total amino acids recovered. Leaves were essentially similar in their amino acid compositions, although several cultivars showed notable variations in methionine. *(Author's summary)* C03 H01

0033-7907 HELLENDOORN, E.W., NOORDHOFF, M.G. and SLAGMAN, J. **Enzymatic determination of the indigestible residue (dietary fibre) content of human food.** Journal of the Science of Food and Agriculture 26(10/12):1461-1468. 1975. Engl., Sum. Engl., 30 Refs.

Cassava. Cassava leaves (vegetable). Fibre content. Analysis. Laboratory experiments. Food products. Digestibility.

A simple *in vitro* method using pepsin and pancreatin is proposed for the determination of the indigestible residue (dietary fiber) content of human food. Results of analyses of some groups of foods are given; e.g., legumes, cereal products, potatoes, some fruits and vegetables, and onions. The discrepancies between crude fiber and values for indigestible residue are great in leguminous seeds and whole cereal products. As regards vegetables, the discrepancy is greatest in potatoes, endive, curled kale and cassava leaves. *(Author's summary)* C03 H01

0034-4331 JONG, A W K. DE **Het zetmeelgehalte van den cassavewortel.** *(The percentage of starch in cassava roots)* Mededeelingen van het Agricultuur Chemisch Laboratorium no 5.1-18. 1913 Dutch

Cassava. Cultivars. Tubers. Analysis. Composition. Starch content. Dry matter. Manures.

The percentage of starch and dry matter (DM) and the specific gravity of peeled roots of 63 cassava varieties were determined to see whether there was a correlation among these factors It appeared that the higher the specific gravity, the higher the percentage of starch, however, there were too many exceptions to be sure A more regular correlation was found between percentage of DM and percentage of starch For certain purposes determination of the percentage of starch based on the percentage of DM will be sufficient. The effect of different manures on the percentage of starch was also investigated Since there was little influence of manuring on the percentage of DM, it follows that the percentage of starch does not change much either. *(Summary by R van G)* C03

0035-7903 MOH, C. C **Correlation between hydrocyanic acid levels in leaf and root of cassava** *(Manihot esculenta Crantz)*. Turrialba 26(2).132-133. 1976. Engl., Sum. Span., Engl., 3 Refs.

Cassava. Leaves. Tubers. Cortex. HCN content. Cultivars. Analysis. Laboratory experiments.

An experiment was carried out to study the correlation between the HCN levels in the leaves and the peels of the roots in 26 cassava cultivars. It was found that the correlation coefficient was r= 0.59 It thus seems feasible to use leaves for screening HCN content in a cassava breeding program. (*Author's summary*) C03

0036-7553 MUTHUSWAMY, P. *et al.* **Composition and nutritive value of certain cultivars of cassava tubers (*Manihot esculenta* Crantz).** Madras Agricultural Journal 62(2):68-70. 1975. Engl., 4 Refs.

Cassava. Cultivars. Tubers. Composition. Nutritive value. Analysis. India.

A chemical analysis was made of 45 cassava varieties grown in the state of Tamil Nadu. Contents of N, P, K, Ca, Mg and ash were determined in roots on a dry wt basis. The variety Vellaimuttan had the highest crude protein content (3.46%) and Parakattu Vellai, the highest ash content (4.52%). (*Summary by A.J. Trans. by T.M.*) C03 H01

0037-8328 NARTEY, F. **Aflatoxins of *Aspergillus flavus* grown on cassava.** Physiologia Plantarum 19(3):818-822. 1966. Engl., Sum. Engl , 10 Refs., Illus.

Cassava. Moulds. Aflatoxins. Analysis. Laboratory experiments.

Aspergillus flavus was grown on cassava and Czapek-Dox media at 31 ± 1°C and 90% RH for 8 wk. Isolation and purification of the toxic and carcinogenic metabolic products of the mold by paper and thin layer chromatography are described. High concentrations of aflatoxin B_1, B_2, G_1 and G_2 were synthesized by the mold grown on cassava for 4 wk. In addition to these 4 major toxic components, 9 other fluorescent materials were observed in the chromatograms of crude products from cassava. It is concluded that the high moisture, high polysaccharide and low N content of cassava constitute a favorable nutritional condition at high temperatures and high RH for the growth of *A. flavus* and the synthesis of relatively high concentrations of aflatoxin. This could represent a serious health hazard in the moist tropics. (*Author's summary*) C03

0038-7821 NASSAR, N.M A. and COSTA, C.P. **Tuber formation and protein content in some wild species of cassava (mandioca) native of Central Brazil.** Goiânia, Brasil Universidade Federal da Goiás, Instituto de Ciências Biológicas, 1977 5p Engl., Sum Engl , 9 Refs., Illus.

Manihot. Cultivars. Protein content. Fibre content. Brazil.

Of 4 wild *Manihot* species screened for protein content, *M oligantha* Pax emend Nassar subsp *nesteli* and *M. tripartita* had a notable percentage of protein on a DM basis (7 10 ± 0 58 and 6 88 ± 1.48%, respectively). (*Summary by T.M.*) C03

0039-4745 PAYEN, M. **Composition et produits du manioc. (*Composition of cassava and its products*).** Journal de la Société Nationale d'Horticulture de France 3 183-189. 1857. Fr.

Cassava. Composition. Cassava products. Uses.

Physicochemical properties of cassava are described. The preparation of alcohol from cassava is discussed briefly. The use of cassava as an animal feed is recommended. (*Summary by I.B.Z.*) C03

0040-0173 PRUDHOMME, E. **Note sur la composition de six échantillons de manioc du Cambodge.** (*Analysis of six cassava samples from Cambodia*). Bulletin Agricole de l'Institut Scientifique de Saigon 2:196-199. 1920. Fr.

Cassava. Cultivars. Tubers. Composition.

Results are given of physicochemical analyses of 6 cassava root samples sent from Phnom Penh (Cambodia) to the Jardin Colonial de Nogent-sur-Marne. These recently developed varieties were selected for their high yields and early maturity. The best was 158A, which was outstanding for its low cellulose and high N contents. (*Summary by S.S. de S. Trans. by T.M.*) C03

0041-7819 RAJENDRAN, N., NAIR, P.G. and KUMAR, B.M. **A modified colorimetric method for the determination of starch in cassava tubers.** Trivandrum, India. Central Tuber Crops Research Institute. Contribution no.4. 1973. 8p. Engl., 5 Refs , Illus.

Cassava. Tubers. Starch content. Analysis. Laboratory experiments.

A rapid method for determining the starch content of cassava roots was developed. To 100 mg pure dry cassava starch was added 5 ml of 30% perchloric acid, together with distilled water to make 50 ml. Known quantities of supernatant liquid (0 5-4.0 mg starch) were diluted with 5 ml distilled water. A drop of phenolphthalein was added with *2N* sodium hydroxide to make the solution alkaline. The solution was then made acidic by adding an excess of *2N* acetic acid (2 ml). For final color development, 0.5 ml of iodine potassium iodide reagent was added to the solution. After 10 min the intensity of color was measured in a photoelectric colorimeter using a red filter. A standard curve indicated that the best range for determining starch concentration was 0-3 mg/50 ml. Starch recovery ranged from 97.4-100%. It is concluded that this method is quicker, consistant and more accurate than Fehling's reduction method. (*Summary by A.J. Trans. by T.M.*) C03

0042-8079 RAMOS-LEDON, L.J. **Composition of *Manihot* plants as related to growth, development and certain other factors.** Mag. Sc. Thesis. Coral Gables, Florida, University of Miami, 1969. 92p. Engl , Sum. Engl , 120 Refs., Illus

Cassava. *Manihot. Manihot esculenta.* Cultivars. Leaves. Petioles. Tubers. N. Analysis. Protein content. Ash content. Plant development. Growth. Timing. Fertilizers.

Several cultivars of *Manihot esculenta* and *Manihot* spp. were studied in relation to growth, development and certain other variables that determine changes in levels of N, protein and other leaf components. Differences in protein concentration were found, ranging from 2.92-7.76 g/100 g on a fresh wt basis. *M. flabellifolia* and *M. glaziovii* had levels similar to cassava (7.5 and 7.13) whereas *M. dichotoma* had the lowest protein level Eleven 4-mo-old cassava cultivars grown on poor, unfertilized soils had protein levels ranging from 6.29-8.3 g/100 g during the winter. The high protein levels on poor soils are an indication of cassava's capacity for N uptake and protein synthesis, independent of geographical origin However, growing season and different stages of development affect leaf compostion. In general protein content decreased as the growing season progressed, it also decreased during the fruiting stages in those cultivars producing flowers.

During anthesis, N did not decrease appreciably. In all cases where root enlargement occurred, there was a decrease in leaf protein content. The possibility of leaching of N-soluble compounds from leaves during the rainy season should also be considered. Ash content fluctuated during the growing season but decreased in the mature plant; it may also be related to external environmental factors, i.e., temperature, rainfall and day length. The cultivars studied showed remarkable phenotypic differences in leaf morphology, growth habits and root morphology; they were, however, uniform in composition for other constituents, the greatest variation being for ash content and the least for water content Composition of petioles was also studied. They contain about 1/6 as much crude protein as the leaf blades. Variation in crude protein content among petioles was far greater than that among leaf blades Diurnal changes in concentrations of N, protein, dry wt, water and carbohydrates were found when sampling was done during the vegetative stage of growth. Nitrogen and protein increased during the day and decreased at night, Dry wt increased significantly during the day and decreased at night in relation to changes in carbohydrate concentration. Physiological explanations are given for these changes. Composition of cassava leaves also changed according to their position on the stem, as this represents successive stages of development Protein, N and water content decreased while dry wt, carbohydrates and ash increased, the farther the leaves were from the top of the plant It is concluded that maximum protein content would be obtained by harvesting the youngest leaves from the youngest plants late in the afternoon. Although N fertilization would not increase protein/unit wt of leaves greatly, it would certainly increase the amount of protein/ha. Since N decreases considerably in mature plants after fruiting or root enlargement, early and mid-season samplings are more reliable than late-season ones for reflecting the N and protein status of the cassava crop. (*Summary by T.M.*) C03 C01

0043-4848 ROSSEM, C. VAN De samenstelling van cassaveworteis bij toenemenden leeftijd. (*The composition of cassava roots with increasing age*) Mededelingen van het Algemeen Proefstation voor den Landbow no. 28:14-25. 1932. Dutch.

Cassava. Cultivars. Tubers. Analysis. Composition. Starch content. Water content. Timing.

Changes in the composition of cassava roots were determined at different ages for 4 varieties (São Pedro Prêto, Tapicuru, Valenca and Mangi) with very different qualities. The percentage of pure starch in the dry, peeled root was the highest at 7 mo for all varieties and remained constant during the rest of the growing period for 3 of the 4 (for Tapicuru, the percentage fell from month 16 to 17). Several formulas are given for determining the percentage of starch in fresh peeled and unpeeled roots In both cases it was found that by determining the percentage of moisture, it was possible to determine the percentage for starch (*Summary by R. van G.*) C03

0044-7408 SANTANA, A.M. Estudo da toxicidade. (*Estudio de toxicidad*). *In* Cruz das Almas, Brasil Universidade Federal da Bahia Escola de Agronomia. Convênio U.F.Ba./BRASCAN Nordeste. Projeto Mandioca Relatorio Semestral de Pesquisas no 2 1973. pp.74-75. Port.

Cassava. Cassava programs. HCN content. Timing. Field experiments. Brazil.

The HCN content of the aerial part and roots of several cassava varieties was analyzed at 8, 12, 16, 20 and 24 mo of growth HCN content increased in the aerial part from the 8th-12th mo and then decreased, in the roots, it decreased with age. The variety Margogipe had the smallest amount of HCN and Salangorzinha, the most (*Summary by I.B.Z.*) C03

0045-2549 SOLORZANO V., N. and BORNEMISZA, E. Estudios del cultivo de de yuca en Costa Rica. II. Composición química y producción de tres cultivares. (*Cassava cultivation*

in Costa Rica. II. Chemical composition and production of three cultivars). Turrialba 26(3):261-264. 1976. Span., Engl., Span., 10 Refs.

Cassava. Field experiments. Cultivars. Productivity. Leaves. Roots. Stems. Analysis. Minerals. Absorption. P. K. Ca. Magnesium. Costa Rica.

The chemical composition of the leaves, stems and roots of 3 cassava cultivars (Mangi, Valencia and Bayuna Dulce) was studied at the Fabio Baudrit Experiment Station of the Universidad de Costa Rica. The extraction of P, K, Ca and Mg from the the soil by these cultivars and productivity were also investigated. It was found that the 3 cultivars had similar chemical compositions. The level of elements was lower in the stems than in the leaves; roots had an even lower concentration, except for K. A considerable variation (between 1.36 and 3.05) was noted for the ratios of aerial part (leaves + stems) / roots for this experiment, which lasted 1 yr. Higbest yield corresponded to the lowest ratio. K was the nutrient with the highest level of extraction from the soil (246 and 582 kg/ha for the 3 cultivars) This value depended mainly on the amount of vegetative growth. About 3 times more Ca than Mg was absorbed; these amounts, as well as that of extracted P, depend mainly on vegetative growth. Yields ranged from 23.7-28.1 tons/ha of roots; this is better than average but only somewhat above half the potential yield of cassava. *(Author's summary)* C03 D03

0046-7569 VAN VEEN, A. G. and LANZING, J. C. Over het koolhydraat en het eiwit van cassave. *(Carbohydrates and protein in cassava roots).* Geneeskundig Fijdschrift voor Nederlandsch - Indië 81:2330-2342. 1941. Dutch, Sum Dutch, Engl

Cassava. Tubers. Composition. Carbohydrate content. Protein content. Gaplek meal. Wastes. Analysis. N. Proteins.

The percentage of digestible carbohydrates (starch) in cassava meal (gaplek) and ampas (residue of the root after the meal has been processed) was determined by hydrolysis with diluted hydrochloric acid, as well as by pancreas juices The results were almost the same; i.e., dry gaplek 60-70% and ampas 50-60% of available carbohydrate. Both gaplek and ampas therefore contain a rather high percentage of substance not consisting of digestible carbohydrate, protein, fat or minerals. That is why ampas are not easily digestible. The "true" protein content was determined by 3 different methods in a no of gaplek samples (both washed and unwashed) and 2 samples of yam meal. It appears that only about 50% of the cassava nitrogen and 50-60% of the yam N is derived from true protein. The true protein content of gaplek is 0.5-0.6% and that of the yam, a good 3%. The nitrogen-containing substances not consisting of protein or proteóses are easily extracted by means of hot water (at least from gaplek) and consist of only a very small part of ammonia, asparagine and glutamine. The washing during the process thus eliminates principally the nonprotein N (as well as sugars, minerals and vitamins), but this method has no effect on the true protein. The total N content of the roots apparently consists of about only 50% true protein N *(Author's summary)* C03 H01

0047-7905 YEOH, H.H. and CHEW, M. Y. Protein content and amino acid composition of cassava leaf. Phytochemistry 15(11).1597-1599. 1976. Engl., Sum. Engl , 19 Refs.

Cassava. Leaves. Protein content. Amino- acids. HCN content. Analysis. Laboratory experiments. Cultivars. Productivity.

On the basis of leaf dry wt, the protein content of 6 varieties of cassava varied from 29.3-38.6%, and the estimated leaf protein production ranged from 242-953 kg/ha. On the basis of leaf fresh wt, the total amino acids ranged from 8.42-9.4% while the essential amino acids averaged 4.21%

and the sulfur-containing amino acids only 0.25%. The amino acid composition profiles for the 6 varieties was similar. (*Author's summary*) C03

See also *0028* *0085* *0126* *0238* *0289*

D00 CULTIVATION

0048-8363 **EL A,B,C de la yuca.** (*Basics of cassava cultivation*). **Agroconocimiento no.17:8-9, 48. 1977. Span., Illus.**

Cassava. Cultivation. Dominican Republic.

Cassava is the 2nd most important food consumed by people in the Dominican Republic. Basic cultural practices are given, as well as the varieties of commercial importance in the different zones of the country. N,P and Ca (1:1:2 or 3:1:2) fertilization is recommended at planting. Principal pests include mites, the cassava hornworm, thrips and the shoot fly. Symptoms of bacterial blight, bacterial stem rot and brown leaf spot are described. (*Summary by T.M.*) D00

0049-7744 AGUILAR F., P., LEON E., F. DE and CITALAN L., W. **Yuca, su cultivo en la región del Soconusco.** (*Cassava cultivation in the region of Soconusco, Mexico*). Chapingo, México. Instituto Nacional de Investigaciones Agrícolas. Centro de Investigaciones Agrícolas del Sureste. Circular CIASE no. 36. 1975. 10p. Span., Illus.

Cassava. Cultivation. Mexico.

Orientation is provided for farmers of Soconusco (southeastern Mexico) on each step of cassava cultivation including fertilization, pests and diseases. Its nonindustrial uses are discussed as well. Suitable soils and climatic requirements are indicated. A description is given of the varieties best suited to this region (Tapachulteca, var. 63 and var. Ceen 2) (*Summary by L.A. Trans. by I.B.Z.*) D00

0050-3266 BANCO DO NORDESTE DO BRASIL. **Aspectos da cultura e da industria da mandioca.** (*Cassava cultivation and processing*) Fortaleza, Ceará, Brasil, 1960. 289p Port., 300 Refs., Illus.

Cassava. Cassava programs. Production. Tuber productivity. Taxonomy. Identification. Ecology. Maps. Cultivars. Adaptation. Selection. Soil analysis. Soil fertility. Nutritional requirements. Planting. Field experiments. Fertilizers. Minerals. Manures. Starch content. Cassava flour. Cassava meal. Factories. Cassava starch. Costs. Processing. Development costs. Uses. HCN content. Analysis. Forage. Nutritive value. Brazil.

This report presents the results of the research on problems of cassava growing and processing in the states of Bahia, Sergipe and Pernambuco (Brazil) and compares the situation of these 3 states to that of Paraíba and São Paulo. The study is divided into 2 main parts. The 1st part discusses the present status of cassava cultivation (applied botany, varieties, harvesting, diseases and pests,

crop association, etc.), the most appropiate regions for growing this crop, the need of selection, soil treatments and improved agronomic practices and an analysis of the soils of Bahia and Sergipe, where cassava is being grown. The 2nd part gives the situation of the factories that make cassava flour, starch and other by-products and analyzes the industrial possibilities of this crop including flour enrichment. Finally, several alternatives regarding the utilization of cassava by-products as forage for livestock feeding are considered. An annex with information on the production of dehydrated stem bran from cassava to replace alfalfa in the tropical countries is included. The main conclusions drawn from this study are (1) Pests and diseases and the lack of agricultural, selection, fertilization and irrigation techniques are responsible for the decline of cassava cultivation in the northeastern states. (2) The best planting system is the use of double rows leaving a small distance between plants and a large one between rows to be able to intercrop. (3) The utilization of peat as organic fertilizer would help to improve the soils of the region. (4) The introduction of the species *Manihot saxicola* would increase the protein content of flour. (5) Diversified factories that produce as many cassava products as possible should be established to be able to guarantee the stability of this agro-industrial complex. (6) The encouragement of forage production would open up a new market for cassava and would solve the problems of forage scarcity. (7) There is a felt need for specialized technical assistance. (8) Soybeans can be used as a source of vitamins and proteins to enrich cassava flour. *(Summary by S.S. de S.)* D00 102

0051-0312 CASSAVA. South Pacific Commission Technical Paper no. 94:21-23 1956. Engl. Illus

Cassava. Cultivation. Tuber composition. Nutritive value. Polynesia.

General considerations on cassava growing in the South Pacific islands are presented. After making a brief reference to its origin, morphological description, soil requirements, yields and methods of conservation, the importance of cassava from a nutritional point of view is analyzed There is a need to conduct agronomic research in the region, with emphasis on rotation, because the cultivation of cassava will most probably be increased as a result of its high yields and facility to cultivate, which might cause soil impoverishment *(Summary by A.J. Trans. by S.S de S.)* D00

0052-6188 DE LA CRUZ, E T. **Root and tuber crops of the Trust Territory of the Pacific Islands.** *In* International Symposium on Tropical Root and Tuber Crops. 2nd., 1970. Tropical root and tuber crops tomorrow. Honolulu, University of Hawaii. College Tropical Agriculture, 1970. v.2. pp. 77-86. Engl 14 Refs.

Cassava. Sweet cassava. Bitter cassava. Cultivation. Tuber productivity. Uses. Oceania.

The cultural practices, yields and utilization of cocoyams, tania, yams, cassava and sweet potatoes in the Trust Territory (Mariana, Marshall and Caroline Islands) are described. A list of indigenous varietal names of the crop in each district of the territory is given. *(Summary by Field Crops Abstracts)* D00

0053-8281 GUIDOLIN, J.A. **Aspectos da cultura da mandioca.** (*Cassava cultivation*). Revista Livroceres 2(4):5-8. 1977. Port., 6 Refs.

Cassava. Cultivars. Tuber productivity. Production. Cultivation. Brazil.

Brief information is given on the cultivation of cassava. Production statistics are given for 20 zones. The var. Vassourinha is being replaced because of its susceptibility to bacterial blight. (*Summary by I.B.Z.*) D00

0054-5406 KUNJU, U.M. **You can count on tapioca.** Intensive Agriculture 13(1):5-7. 1975. Engl., Illus.

Cassava. Climatic requirements. Soil requirements. Land preparation. Planting. Cuttings. Fertilizers. Harvesting. India.

Cultivation of cassava in India, including climate and soil requirements, new high-yielding varieties (H. 97, 165 and 226, and M. 4), planting material, soil preparation, planting, cultural practices, manuring and harvesting is described briefly. (*Summary by A.J. Trans. by I.B.Z.*) D00

0055-7522 LACAYO L, E J. **Cultivo de la yuca.** (*Cassava cultivation*). Nuestra Tierra 8(76):124-126. 1964. Span.

Cassava. Cultivation. Nicaragua.

The basic techniques for cassava cultivation are briefly described. The entire production cycle, from recommended varieties to harvesting of roots, is included. Sweet varieties such as Cubana and Sabana Grande are recommended. Planting should be done at the beginning of the rainy season since late planting (in Aug.) diminishes yields. Main pests and diseases are the cassava hornworm, lace bugs, white and brown leaf spots Control measures are given. (*Summary by L.A. Trans by I.B Z*) D00

0056-7981 LAMBERT, M. **Culture, improvement and utilization of root crops in the South Pacific.** *In* International Symposium on Tropical Root and Tuber Crops, 2nd. 1970. Tropical root and tuber crops tomorrow. Honolulu, University of Hawaii. College of Tropical Agriculture 1970. v.2. pp.70-73. Engl, 2 Refs.

Cassava. Cultivation. Productivity. Oceania.

The cultural practices, yields and uses of crops including cocoyams, tania, yams, cassava and sweet potatoes in the South Pacific are discussed briefly. (*Summary by T. M.*) D00

0057-5814 LUDECKE, H. and MULLER, A.V. **Maniok und batate** (*Manihot esculenta* und *Ipomoea batatas*). (*Cassava and sweet potatoes*). Handbuch der Pflanzenernahrung und Düngung 3(1):752-756. 1965. Germ., 15 Refs., Illus.

Cassava. Sweet potatoes. Cultivation. Water requirements. Fertilizers. Absorption. Manures. Productivity. Harvesting. Timing.

In this chapter of a manual on edible plants, cassava and sweet potatoes are compared on the basis of the following aspects: development and growing period; the relationship between mineral uptake and growing period; av yield and fertilizer requirements, water requirements, photoperiod, cultivation, characteristic stages of growth and harvesting dates in different

countries; quality standards, manuring, manuring and yield; manuring and quality. *(Summary by H.P. Trans. by T.M.)* D00

0058-1648 **NOTES SUR le manioc, l'igname et les arrow-roots d' Indochine.** (*Notes on cassava, yam and arrowroot in Indochina*). *In* Congres du Manioc et des Plantes Feculentes Tropicales, Marseille, 1949. Marseille, Institut Colonial, 1949. pp.137-142. Fr.

Cassava. Cultivars. Cultivation. Indochina.

Cassava is grown widely in Indochina on small parcels of land. Data on area planted to cassava and export volumes are given for the period. Cultural practices, the main sweet and bitter varieties and cassava by-products are described. Results are given of some yield and manuring trials with local and introduced varieties. (*Summary by I.B.Z.*) D00

0059-4588 PICKEL, D.B. **Cultura e industria da mandioca no século 17, segundo Piso.** (*Growing cassava in the 17th century, according to Piso*). Revista de Agricultura 13(3/4):99-106. 1939. Port.

Cassava. History. Cultivation. Brazil.

Morphological, agronomic and botanical characteristics of cassava are described, as well as some 17th century cultural practices for several Pernambuco varieties. Methods for making cassava meal and other cassava based foods (i.e., tapioca) are explained. (*Summary by L.A. Trans. by I.B.Z.*) D00

0060-7279 SAMPAIO, C. V. Estudo do ciclo de cultivares de mandioca tardios e precoces no nordeste brasileiro. *(Study of the growing cycle of late- and early-maturing cassava cultivars in northeastern Brazil). In* Projeto mandioca; subprojetos de pesquisas para o nordeste do Brasil. Cruz das Almas, Brasil, Universidade Federal da Bahia. Escola de Agronomia. Convenio U.F. Ba./BRASCAN Nordeste, 1974. pp. 29-41. Port., 20 Refs.

Cassava. Cassava programs. Cultivation. Cultivars. Selection. Experiment design. Brazil.

The fundamental objective of this subproject is to select the best late-and early-maturing cultivars in northeastern Brazil in order to determine ideal growing cycles, yield and susceptibility to pests and diseases The work to be done includes the (1) selection of the area, (2) preparation of the soil, (3) planting dates, (4) fertilization and application of amendments, (5) selection of cultivars, (6) selection and preparation of planting material, (7) planting systems, (8) cultural practices, (9) control of pests and diseases, (10) recording of climatological data, (11) evaluation of growing cycle at 6 mo, (12) production of cuttings to repeat experiments, and (13) harvesting and determination of weight of the aerial part, roots, etc. The experimental model is described and illustrated. *(Summary by A.J. Trans. by T.M.)* D00

0061-3858 SANTOS, E.O., BESSA, M. and LIMA, P.B. DE *Mandioca; recomendações tecnológicas. (Cassava: technical recommendations)* Brasil. Ministerio de Agricultura. Departamento Nacional de Pesquisa Agropecuária. Instituto de Pesquisa Agropecuária do Nordeste. Circular no. 8. 1972. 11p. Port.

Cassava. Cultivation. Planting. Spacing. Soil requirements. Propagation. Harvesting. Fertilizers. Cultivars. Injurious insects. Diseases and pathogens. Brazil.

Technical recommendations are given for cassava cultivation in Brazil. Varieties are recommended according to soil texture. The following aspects are also discussed: soil requirements, planting methods and distances, selection of cuttings, cultural practices, fertilization harvesting and storage. A brief description is given of insect damage caused by *Erinnyis ello, Coelosternus granicollis, Silba (Lonchaea) pendula* and *Atta* spp. and disease symptoms of cassava bacterial blight, witches'-broom, root rots and Cercospora leaf spots. Some control measures are also given. *(Summary by A.J. Trans. by T.M.)* D00

0062-3665 SCHMIEDEL, O. **La mandioca; su cultivo y su industrialización.** *(Cassava cultivation and industrialization).* Agronomía (Argentina) 18 543-558. 1925. Span.

Cassava. Tubers. Composition. Timing. Bitter cassava. Sweet cassava. Cultivars. Tuber productivity. Costs. Cassava starch. Cassava flour. Consumption. Argentina.

This study presents some aspects of cassava production for industrial purposes with the purpose of promoting cassava growing in Argentina, thus decreasing the imports of cassava by-products. Variations in starch content among varieties or within the same variety, planting depth and distances, yields, production costs, etc. are discussed. Emphasis is placed on the need to industrialize this crop to produce starch, flour and tapioca and several starch by-products (alcohol, dextrin, glucose, etc.). Given its high-yielding potential, Misiones is recommended as the best region for the intensive planting of cassava, drying will be done in this same region and processing in Buenos Aires and Rosario Formosa and Chaco and the provinces of Corrientes, Tucumán, etc., are other regions recommended for its cultivation *(Summary by A.J. Trans. by S.S. de S.)* D00 J00

0063-5823 SILVA, J R. DA. **Solução radical só na técnica; mandioca.** (*The technical improvement of cassava production*). *In* Guia da Produção Rural, 1970. São Paulo, Coopercotia, 1970 pp.126-140 Port., Illus.

Cassava. Cuttings. Planting. Timing. Soil requirements. Cultivars. Selection. Tuber productivity. Nutritional requirements. Harvesting. Cuttings. Injurious insects. Diseases and pathogens. Brazil.

Although cassava is a hardy plant, modern cultural practices will improve yields greatly. The following agronomic practices are discussed: grading the land to control erosion; planting dates; cutting size (20 cm), transportation and storage, preparation of the land (ridges, NPK fertilizers herbicides), mechanized planting and spacing for fertile and infertile soils; weeding, pruning, intercropping and rotation, and harvesting. Characteristics to be taken in account when selecting varieties are discussed. Iracema is recommended for industrial use; Mantiqueira for forage; and Guaxupe for foodstuffs. Pests include *Erinnyis ello, Coelosternus* spp., *Eulechriops* spp. Larvae attacking shoots include *Antherigona excisa, Euxesta eluta, Lonchaea chalybea* and *Silba pendula.* Diseases include bacterial blight (*Xanthomonas manihotis*) and leaf spots caused by *Cercospora henningsii* and *C. caribaea.* (*Summary by I.B.Z. Trans. by T.M.*) D00

0064-7354 SILVESTRE, P. **Aspects agronomiques de la production du manioc à la ferme d'état de Matsumba. (République Populaire du Congo); rapport de mission.** (*Report on cassava production at the government farm in Matsumba*). Nogent-sur-Marne, France,

Institut de Recherches Agronomiques Tropicales et de Cultures Vivrieres, Division d'Economic Rurale et des Applications de la Recherche, 1972. 32p. Fr.

Cassava. Cassava programs. Cultivation. Cultivars. Fertilizers, N. P. K. Field experiments. Harvesting. Tuber productivity. Zaire.

An agro-industrial unit was created at Matsumba for producing cassava, mainly for export. Results are given of the exploitation of 1560 ha, on which cassava and *Stylosanthes* are rotated (2 yr each). Projected yields were 30 tons roots/ha and 6,240 tons cassava flour/yr; however, results have not been satisfactory. There is a need for better management, decreasing costs, opening up new markets and adapting production to local needs. Data are given on rainfall, clonal multiplication, varietal comparisons, mineral fertilization, starch production, response to N, K and Ca, and manual and chemical weeding. (*Summary by I.B.Z.*) D00

0065-7351 SILVESTRE, P. **Aspects agronomiques de la production du manioc a la ferme d' Etat de Matsumba (Republique Populaire du Congo). Rapport de mission.** (*Cassava production on a governmental farm in Matsumba, Zaire*). Nogent-sur-Marne, France, Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres. Division d' Economie Rural et des Applications de la Recherche, 1973. 33p. Fr.

Cassava. Cassava programs. Cultivars. Tuber productivity. Starch productivity. Timing. Cultivation. Production. Costs. Field experiments. Fertilizers. Harvesting. Maize. Zaire.

A governmental agro-industrial complex was created in Matsumba (Zaire) to produce and process cassava. The 1st plantings (80 ha) of cassava were made in 1972, using the following rotation: one 18-mo crop of cassava, 1-2 crops of maize and 1 of *Stylosanthes*. In 3 trials, a study was made of harvesting dates x variety, and varieties were evaluated and compared In all cases, Mouhondzi was more productive than Tsibissi, the variety most widely grown in the area. Although low-yielding, Loulombo was very high in starch content and should be used in hybrid breeding programs. Yields of 25 tons/ha are possible with careful selection of propagation material, cultural practices, harvesting, partial mechanization, and the amendment and conservation of soil fertility. Priority will be given to studying the mechanization of harvesting, scheduling work to make the most of available machinery, fertilizer trials, weed control, harvesting dates x variety, and type of fertilization x variety. To meet the objective of 15,000 tons fresh roots/yr on the basis of yields of 25-30 tons/ha, 1,000-2,000 ha should be planted. An analysis of prices and yields of cassava and maize shows that the gross margin left by cassava is better than that of maize. *(Summary by S.S. de S. Trans. by T.M.)* D00

0066-4439 SIQUEIRA, L.A Mandioca: resultados experimentais. (*Cassava. experimental results*). Cruz das Almas, Brasil Ministério de Agricultura Instituto de Pesquisas Agropecuárias do Leste Circular no. 36. 1973: 34p. Port., 5 Refs

Cassava. Cassava programs. Field experiments. Cultivars. Productivity. Planting. Spacing. Fertilizers. N. P. K. Statistical analysis. Cuttings. Experiment design. Brazil.

The results are given of experiments on varietal performance, spacing, planting systems and fertilization conducted by the Instituto de Pesquisas Agropecuárias do Leste in the municipality of Nossa Senhora das Dores. The best varieties were Aipim Bravo, Cigana Prêta, Mamão and Escondida. No statistically significant differences were found for planting distances, but leaving 1 m between rows and 0.80 m between plants is recommended Propagation material should be taken from healthy, mature branches, approx. 12 mo old; cuttings should measure 20 cm without taking into account the no. of buds. Soils were clearly deficient in P. Yields of 24 tons roots/ha

were obtained with simple phosphate fertilization, whereas the checks (no fertilizer) yielded only 7.7 tons/ha. In Capela the phosphate treatment surpassed the complete NPK treatment. (*Summary by S.S. de S. Trans. by T.M.*) D00

0067-3058 SPRINGENSGUTH, W. **Die Kultur des Manioks, seine Krankheiten und Schädlinge im Litoral des States Sta. Catharina (Brasilien).** *(Cassava cultivation, its diseases and pest in the coastal region of Sta. Catarina, Brazil).* Tropenpflanzen 43(9):286-306. 1940. Germ.

Cassava. Sweet cassava. Bitter cassava. Cultivars. Identification. HCN content. Starch content. Uses. Diseases and pathogens. Injurious insects. Brazil.

Cassava and maize are the principal crops of the region. Sweet varieties are grown more because of their low HCN content. A few bitter varieties are grown for their starch production. Identifying characteristics of different varieties are given, as well as their German names. Since cassava is grown on the same soil year after year, it is susceptible to many diseases and insects. The sweet varieties are susceptible to *Cercospora henningsii*, but the bitter variety is resistant *(Summary by Tropical Abstracts)* D00 E01 F01

0068-7672 ULATE M., J.L. and AVILES, A., C.L. **Cultivo de la yuca.** *(Cassava cultivation).* Quesada, Costa Rica. Ministerio de Agricultura y Ganadería Centro Agricola Regional de la Zona Norte Bulletin no 51. 1975. 7p. Span.

Cassava. Cultivars. Cultivation. Cuttings. Land preparation. Planting. Timing. Weeding. Soil requirements. Diseases and pathogens. Disease control. Injurious insects. Insect control. Costa Rica.

The following aspects of cassava cultivation are discussed briefly: varieties, selection of cuttings, adequate soils, preparations of the land, planting, weed control, fertilization and hilling Symptoms and methods of control are given for diseases caused by *Sphaceloma* sp., *Cercospora* spp., *Uromyces* sp., *Oidium manihotis, Rosellinia* sp. and *Fusarium* and the pests *Anastrepha* sp., *Erinnyis ello, Bemisia* sp. and mites. *(Summary by A.J. Trans by T.M.)* D00 E01 F01

0069-8014 **LA YUCA "Llanera Mocana" se somete a la prueba máxima: la evaluación del agricultor.** (*Results of field trials using the cassava variety Llanera Mocana*). Santiago de los Caballeros. República Dominicana Secretaría de Estado de Agricultura. Centro de Desarrollo Agropecuario. Cenda Informa no. 2. 1976. 4p. Span., Illus

Cassava. Cultivation. Dominican Republic.

The results are given of several field trials evaluating the cassava variety Llanera Mocana. In interviews held with different farmers, it was found that Llanera Mocana outyielded local varieties (20-30 quintals/625 m²). Its main characteristics are also given. (*Summary by I.B.Z.*) D00

0070-4488 ZIJL, C.E. VAN DER **Verbetering der cassave cultuur door middel van proefvelden.** (*Field experiments to improve cassava cultivation*) Wageningen. Netherlands H.Veenman & Zonen, 1930. 127p. Dutch. 63 Refs

Cassava. Field experiments. Land preparation. Planting. Timing. Spacing. Cuttings. Fertilizers. Green manures. Cultivars. Starch content. Java.

As a result of field experiments, the following cultural practices are made. (1) Tilling the soil to a depth of ¾ to 1 ft is sufficient. (2) Good drainage of surface water appears to increase the percentage of starch content slightly. (3) There is a marked influence of planting date on production. For the conditions of the study (Java), Nov. is optimal. The difference between starch yield when planting in Nov. and Feb. is 34% (4) It is difficult to determine optimum planting distance. When spacing is reduced, root production/plant decreases but output increases, so starch yield remains about the same. (5) Cuttings from plants 17½ mo were better than from older plants. Stem cuttings from a standing crop can reduce starch yield; therefore, only a few should be cut about 5 mo before harvesting. The effects of fertilizing and green manure are given for the soils of Soekamandi and Poerwadadi. Several varieties were evaluated for yield Basioras was the best; Itaparica and Tapicuru are also promising for their high percentage of starch. (*Summary by R van G.*) D00

See also *0376* *0389* *0396* *0399* *0408*

D01 Soil, Water, Climate and Fertilization

0071-5513 BERLIER, Y. Essai d'engrais sur maniocs. *(Cassava fertilization trial)* Abidjan, Ivory Coast, Centre d'Adiopodoumé Institut d' Enseignement de Recherches Tropicales, 1955. 3p. Fr.

Cassava. Field experiments. Fertilizers. Minerals. N. P. K. Tuber productivity. Ivory Coast.

The purpose of this cassava fertilization trial was to determine, under the climatic and edaphic conditions of Adiopodoumé (Ivory Coast), the effect of different fertilizers on the yield of Tabouca, a variety adapted to the region and with a good average yield The following fertilizers were used in 6 different treatments with only one application each: Bactergan, ammonium sulfate, dibasic calcium phosphate and potassium nitrate. The application of potassium nitrate alone or with dibasic calcium phosphate was significantly better than the other treatments (P = 0.01) except Bactergan However, the application of K in the form of potassium nitrate is uneconomical, producing considerable losses per ha. Other sources of K should be tested and optimal rates of application determined. *(Summary by S.S. de S Trans. by T.M.)* D01

0072-7468 BOTTON, H. and PERRAUD, A. **Expérimentation fumure organique (gadoues-fumier) sur manioc.** (*Effect of organic manures on cassava yield*). Adiopodoumé, IDERT, n.d. 9p. Fr.

Cassava. Field experiments. Experiment design. Manures. Dung. Pruductivity. Ivory Coast.

The effect of organic fertilizers (home sewage and farmyard manure) on, cassava was evaluated. A random design with 8 replications, 4 treatments and one control was used. The application of FYM gave yields 20.8% higher than the control; this difference was significant. The sewage treatment, which yielded 5-10% more than the control, was also significant. Chemical analyses were made of the 2 manures and the soil. (*Summary by I.B.Z. Trans. by T.M.*) D01

0073-7278 CAMPOS H. DOS R. **Respostas de cultivares de mandioca** *(Manihot esculenta* **Crantz) a suplementação hídrica, mediante irrigação por aspersão.** *(Response of cassava varieties to hydric supplementation by spray irrigation). In* Projeto mandioca, subprojetos de pesquisas para o nordeste do Brasil. Cruz das Almas, Brasil, Universidade Federal da Bahia Escola de Agronomia. Convênio U.F. Ba./BRASCAN Nordeste, 1974. pp.42-50 . Port., 15 Refs.

Cassava. Cassava programs. Irrigation. Water requirements (plant). Experiment design. Field experiments. *Manihot esculenta* **Brazil.**

The purpose of this subproject is to determine the response of cassava cultivars to irrigation and to establish the costs of its implementation during the dry season. On the basis of climatological data from the region and Blanney and Criddle's formula, the monthly consumption of water/crop was determined. Accordingly. spray irrigation will be done every 18 days, applying 35 mm of water. Harvest index will be determined as well The experimental model is described. *(Summary by T.M.)* D01

0074-8184 CHEW, W Y. **Yield and growth responses of some leguminous and root crops grown on acid peat to magnesium lime.** Malaysian Agricultural Journal 48.142-158. 1971. Engl , Sum Engl., 14 Refs., Illus.

Cassava. Soil requirements. Minerals. Tuber productivity. Plant height. pH. Field experiments. Rainfall data. Malaysia.

Experiments were conducted from 1968-71 to study the response of 2 leguminous crops (peanuts and soybeans) and 3 root crops (sweet potatoes, cassava and taro) to magnesium lime on acid peat. Addition of magnesium lime increased the peat reaction linearly at the rate of 0.15 pH unit/ton of lime up to 6 tons/acre Beyond this level the rate of pH increase declined progressively to 0.01 pH unit/ton of lime/acre at 22 tons. Peat pH fluctuates with time but is maintained for at least 3½ yr after liming. All crops tested showed positive yield responses to added lime, except cassava, which tolerated the acid peat without liming and gave reasonably high yields (*Author's summary*) D01 D03 C01

0075-7409 CONCEIÇÃO, A.J. DA and SAMPAIO, C.V. **Tecnicas de manejo.** (*Crop management techniques*). *In* Cruz das Almas, Brasil. Universidade Federal da Bahia. Escola de Agronomia. Convênio U.F.Ba./BRASCAN Nordeste. Projeto Mandioca. Relatório Semestral de Pesquisas no.2 1973. pp.46-68 Port.

Cassava. Cassava programs. Cuttings. Planting. Spacing. Harvesting. Timing. Cultivars. Field experiments. Experiment design. Brazil.

Information is given on several experiments begun in 1969-70, in which 24 semimonthly planting seasons are being ranked. This evaluation is expected to take 5 yr because of weather variations. The variety Cigana is being used because of its high starch content, tall canopy and nonbranching pattern of growth. The experimental design used randomized blocks with 4 replications in 2 seasons (rainy and dry). Planting systems, as well as spacing, size and position of cuttings, varieties for industrial uses and forages, pruning practices, and herbicides, are being studied. (*Summary by I.B.Z.*) D01

0076-7299 EDWARDS, D.G., ASHER, C J. and WILSON, G L **Mineral nutrition of cassava and adaptation to low fertility conditions.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings Ottawa, Canada, International Development Research Centre, 1977 pp.124-130. Engl., Sum Engl , 11 Refs , Illus.

Cassava. Laboratory experiments. Nutritional requirements. Nutrient solution. pH. K. Ca. P. Culture media. Growth. Productivity. Tuber development. Australia.

In experiments using solution culture techniques, cassava was shown to be more tolerant than maize and soybeans to low pH and high levels of Al and Mn. The requirements for K, N and Ca

for maximum growth were comparable to other crops; in the case of P, needs were higher than for other crops. Nevertheless, the data show that cassava tolerates low Ca, N and K in the root zone better than other crops. The plant has an ability to bulk roots at low P levels. (*Author's summary*) D01

0077-7561 GHOSH, S.P. and GUPTA, R K. **Tapioca for Dehra Dun Valley.** Indian Farming 26(3).31-32. 1976. Engl., Illus.

Cassava. Field experiments. Fertilizers. N. P. K. Tuber productivity. Starch productivity. Climatic requirements. Cultivars.

Cassava varietal trials were conducted in Dehra Dun Valley (India) to determine production possibilities there. Varieties H-226, 165 and 97, and M-4 were planted at spacings of 90 x 90 cm in mid-June 1973. Two rates of NPK (37.5 and 75 kg N; 37.5 and 75 kg P_2O_5; 50 and 100 kg/ha K_2O), were applied 1 and 2 mo after planting. Plants were harvested at 6.5 mo because the low winter temperatures caused heavy defoliation Fertilizers increased yields from 8-12 tons to 17-18 tons/ha. Starch content ranged from 13-15% In 1974 these varieties were planted at the beginning of April and harvested 9 mo later. They were supplied with 75 kg N, 75 kg P_2O_5 and 100 kg K_2O in 2 equal split applications. There were no significant differences in yield. H-165 and M-4 were more susceptible to low temperatures H-226 and 165 were suitable for fresh consumption, the others for starch manufacturing. Yields as high as 38 tons (T-226, H-165) and the low incidence of pests show that cassava can be grown successfully in this area. (*Summary by A.J. Trans. by I.B Z*) D01 D03

0078-5582 HOVING, E. **De invloed van klimatologische faktoren op de zetmeelopbrengst van cassave, mede gezien in verbrand met plant- en oogstdatum.** *(The influence of climatological factors on cassava starch production in relation to planting and harvesting dates).* Bennekom, Netherlands, n i., 1973. 34p. Dutch, 28 Refs , Illus.

Cassava. Climatic requirements. Temperature. Rainfall data. Planting. Harvesting. Timing. Starch content.

As regards percentage of starch content, the most suitable climates for growing cassava are those that have a definite wet and dry season; i e., cool/dry and warm/wet. Under such conditions the crop has an inactive period conducive to high starch yield. Permanently warm humid climates are not ideal because the growth of aerial parts is stimulated at the expense of the storage roots. Cassava is fairly resistant to drought; however, an annual rainfall of less than 800mm or more than 7 dry months are unsuitable. The time at which starch content is highest varies with the climate. Observations are made for areas such as the Ivory Coast, Jamaica, Java and Madagascar. The best time to plant cassava is at the beginning of the rainy season so that the foliage and root system can develop well Harvesting should be done during the cool/dry season when starch yields are highest. (*Summary by R. van G.*) D01 D03

0079-7479 HOWELER, R.H. **La fertilización de la yuca.** *(Fertilization of cassava). In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp.150-162. Span., Sum. Span., 26 Refs., Illus.

Cassava. Field experiments. Soil fertility. Fertilizers. Analysis. Absorption. Timing. N. P. K. Productivity. Colombia.

Cassava does not generally respond to fertilization in fertile or fairly fertile soils, but it does respond significantly in poor soils such as oxisols and volcanic soil. In many cases the most limiting element is K since cassava requires a great deal of this element. The recommended ratio of N-P_2O_5-K_2O is usually from 1:1:2 to 3:1:2, applied at planting and around the cutting, but not in direct contact with it. An additional application of N and K may be made 2 mo later K_2SO_4 seems to be a better source of K than KCl. (*Author's summary. Trans by T.M.*) D01

0080-8024 HOWELER, R H., CADAVID, L F. and CALVO, F.A. **The interaction of lime with minor elements and phosphorus in cassava production.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977 pp 113-117. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. P. Ca. Manganese. Copper. Boron. Zn. Absorption. Mineral deficiencies. Productivy. Field experiments. Fertilizers. Colombia.

Cassava appears to be a promising food crop for the acid, infertile soils of the Llanos Orientales of Colombia because of its tolerance to soil acidity. Large numbers of varieties were screened for acid soil tolerance in plots receiving various amounts of lime. Most of them responded positively to only minor applications but showed a marked negative response to high liming rates. In a lime x minor element trial, liming significantly reduced uptake of Zn, Mn, Cu and B; high liming rates reduced yields by inducing a deficiency of Zn and possibly Mn and B Cassava appears to have a very high Zn requirement. In an experiment studying the effect of lime on P uptake, cassava responded to P mainly at low liming rates; at high liming rates the response to P was reduced. Thus liming may improve the availability of soil P and reduce the fixation of applied P. At low liming rates cassava responded markedly to applications as high as 200 kg P_2O_5/ha as triple superphosphate. Basal applications were consistently superior to split applications although the method of application did not affect yields significantly. (*Author's summary*) D01

0081-8222 HOWELER, R.H. **Respuesta de la yuca a la aplicación del fósforo.** (*The response of cassava to phosphorus*). Cali, Colombia. Centro Internacional de Agricultura Tropical Seminarios Internos Serie SE-09-77. 1977. 29p. Span., Sum. Span., 11 Refs., Illus.

Cassava. Soil requirements. Nutritional requirements. P. Fertilizers. Soil analysis. Tuber productivity. Colombia.

Cassava is among the food crops that tolerate soil acidity well; therefore, it is often planted on highly acid, unfertile soils without fertilization or liming. Nevertheless, cassava needs large quantities of P for maximum productivity. In fertilization trials at Carimagua (Llanos Orientales, Colombia), cassava responded positively to P_2O_5 applications (400 kg/ha). Rock phosphates are a good P source for cassava. The best time to apply P was at planting. Maximum yield and highest net income were obtained with 140 kg P_2O_5/ha and 180 kg K_2O. At 2 sites in the state of Valle del Cauca, there was no response to P except when combined with a large amount of K. A highly promising alternative to the application of high quantities of P is the identification of cassava varieties tolerant to low P levels CIAT germplasm material is now being evaluated for tolerance to P deficiency and Al toxicity. (*Author's summary. Trans. by T.M.*) D01

0082-8365 KANWAR, J.S. **Assessment of potassium fertilisation in the tropics and sub-tropics of Asia.** *In* Congress of the International Potash Institute, 10th., Budapest, Hungary,

1974. Potassium research and agricultural production; proceedings, Bern, Switzerland, International Potash Institute, 1974. pp.261-282. Engl., Sum. Engl., 28 Refs., Illus.

Cassava. K. Fertilizers.

The tropical and subtropical areas of Asia, where population pressures are very great, have specialized in producing crops such as rice, coconut, tea, bananas, pulses, sugar cane and cassava, which have high K requirements. Poor yields of these crops are due to low rates of fertilizer per unit area and disproportionately smaller amounts of K. High-yielding varieties, multiple cropping and irrigated farming, which are basic in the new strategy for increasing production require heavy use of balanced fertilizers. Because of the extreme deficiency of N in the soil and the traditional use of low-yielding varieties, K has been neglected. This is especially important in the case of cassava, which is planted on highly leached lateritic and very poor light-textured soils. (*Summary by T.M.*) D01

0083-2522 LONGANATHAN, S., RAVIKUMAR, V. and KRISHNAMOORTHY, K.K. **Studies on the conjoint effect of tillage and soil amendments on the yield of tapioca and physical properties of soils.** Madras Agricultural Journal 62(5):248-252. 1975. Engl., Sum. Engl., 8 Refs.

Cassava. Land preparation. Ploughing. Tuber productivity. Soil amendments. Field experiments. India.

In a trial at Coimbatore (India), cassava cv. Malavella was planted in soil plowed to depths of 10, 20, 30 or 45 cm, with addition of 25 tons FYM or composted rice husk (with addition of 100 kg N/ha at composting) or 5 tons flue dust/ha Root yields were higher with plowing to 20 and 45 cm (8 6 and 7.65 tons/ha, respectively) than to 10 and 30 cm (7 47 and 7 58 tons) but were unaffected by soil amendment (*Summary by Field Crop Abstracts*) D01 D03

0084-8026 MOHAN KUMAR, C.R. *et al.* **Effect of farm yard manure and NPK on cassava.** *In* Symposium of the International Society for Tropical root Crops, 4th, Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977, pp.122-124. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Field experiments. Dung. Fertilizers. N. P. K. Tuber productivity. Plant height. HCN content. Starch content. Tubers. India.

Exploitation of hybrid vigor in cassava showed the genetic potential for nutrient utilization and improvement of total biological yield Significant root yield increases were obtained by applying farmyard manure (FYM) in combination with NPK. FYM with N or a combination of NPK were the next best treatments. Lowest yields were recorded in the P- or K-treated plots. Bitterness of the roots was increased by the application of FYM and N whereas K reduced it. (*Author's summary*) D01

0085-8023 NGONGI, A.G.N., HOWELER, R. and MAC DONALD, H.A **Effect of potassium and sulfur on growth, yield, and composition of cassava.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings. Ottawa, Canada, International Development Research Centre, 1977 pp 107-113. Engl., Sum. Engl., 13 Refs

Cassava. Field experiments. P. S. Soil analysis. Growth. Tuber productivity. Composition. Analysis. Mineral content. Colombia.

Three field experiments were conducted in Colombia to investigate the differential effects of KCl and K_2SO_4 on cassava root yields. At Pance, where soil SO_4=-S content was 9 ppm, there were no differences in yields between KCl and K_2SO_4 plots; but at Carimagua and Tranquero, where soil SO_4=-S content was 4-4 5 ppm, K_2SO_4 produced significantly higher root yields thatn KCl. A KCl + S "source" produced yields equal to those produced by K_2SO_4 at equivalent rates of K Cassava root yields increased with K fertilization, a rate of 120 kg K_2O appeared to be adequate. Maximum root yields obtained were 40 and 20 tons/ha at Pance and Tranquero, respectively. There was a high positive correlation between cassava root yields and total plant fresh wt produced per hectare. (*Author's summary*) D01 D03 C03

0086-2971 OBIGBESAN, G.O., KETIKU, A.O. and FAYEMI, A.A. **Effects of age at harvest and fertilizer application on the yield, available carbohydrates and hydrocyanic acid content of cassava (*Manihot palmata* Pohl).** Journal of Agricultural Science 88(3):679-681. 1977. Engl., Sum. Engl., 12 Refs.

Cassava. *Manihot esculenta*. Field experiments. Experiment design. N. P. K. Timing. Harvesting. Tuber productivity. HCN content. Starch content. Fertilizers. Nigeria.

Experiments were carried out ever 2 growing seasons to find out the effects of fertilizer application and age at harvest on yield, available carbohydrates and HCN content of *Manihot palmata*. Fertilizers were applied at the following rates: 0-0-0; 45-45-0; 45-45-45; 45-45-67; and 45-45-90 kg/ha of N, P and K, respectively. Harvest were at 9 and 15 mo after planting. Application of N and P resulted in significant yield increases. Fertilizer application had no significant effect on the HCN content of the roots. Harvesting at 15 mo gave more than double the root yields and a higher percentage of HCN that harvesting at 9 mo. Therefore, efficient processing methods should be used for roots harvested at 15 mo to obtain safe products for industrial and nutritional uses. (*Author's summary*) D01 D03

0087-7550 PRIOR, A.J. Should cassava be fertilized or not? Farming in Zambia 9(2):3-4. 1975.

Cassava. Field experiments. Cultivation. Fertilizers. Spacing. Land preparation. Cultivars. Tuber productivity. Timing. Zambia.

A fertilizer trial was conducted in the district of Mwinilunga, Zambia to determine its effects on cassava root starch yields, as well as on the aerial part of the plant The varieties Kapumba and Matali were planted in hills or on ridges, with or without 400 kg "D" and 20 kg N/ha; harvesting was done at 16 or 28 mo. Fertilizer "D" was broadcast and hoed in before making the hills or ridges; ammonium nitrate was top dressed 4 wk after germination. Kapumba was by far the better variety. There was a notable response to fertilization in both harvests, planting on ridges without fertilization also gave good results. Root and starch yields of Kapumba, planted on ridges, fertilized and harvested at 28 mo, were double those obtained when harvested at 16 mo under the same conditions (49.8 vs. 19.3 tons of roots/ha and 4.9 vs. 13.9 tons starch/ha, respectively) It is concluded that cassava should be fertilized as long as the product value is greater than that of the fertilizer. (*Summary by A.J. Trans. by T M.*) D01

0088-7411 SANTANA, A.M TAVARES, F.D. and CARVALHO, J.E.B. DE. **Solos, correção e adubação.** (*Soils, amendments and fertilization*). *In* Cruz das Almas, Brasil.

Universidade Federal da Bahia. Escola de Agronomia. Convenio U.F.Ba/BRASCAN Nordeste. Projeto Mandioca Relatório Semestral de Pesquisas no 2 1973. pp.24-40. Port.

Cassava. Cassava programs. Cultivation. Soil requirements. Water requirements. Soil analysis. N. P. K. Fertilizers. Urea. Minerals. Field experiments. Experiment design. Brazil.

Several experiments are being conducted to determine actual water content of soil samples taken at different depths from nonirrigated cassava fields (var Cigana, Mamao, Salangorzinha, Aipim Maragogipe). These studies are important in irrigation control and evaluation of hydric conditions. Storage of available water and total soil porosity with relation to cassava yield are being studied, as well as efficiency of different N sources. Comparison of treatment means by means of the Tukey test was significant at both the 5 and 1% levels. The effect of urea in leaf fertilization application and the application of urea, P_2O_5 and K_2O were studied in a 3^3 factorial design. P levels and methods of application, N/S ratios and K levels are also being evaluated Results are summarized in tables. (*Summary by I.B.Z.*) D01

0089-8405 SARASWAT, V.N. and CHATTIAR, T S. **Effect of organic and inorganic sources of nitrogen on cassava** (*Manihot utilissima* L.). Indian Agriculturist 20(1).23-26. 1976. Engl , Sum Engl., 7 Refs.

Cassava. *Manihot esculenta.* **Field experiments. N. Dung. Fertilizers. Tuber productivity. India.**

The cassava variety M-4 grown in a sandy loam soil was fertilized with calcium ammonium nitrate (CAN) or farmyard manure (FYM), each at a N rate ranging from 0 to 150 kg/ha. The fertilizers were applied either singly or in different combinations. Application of N as CAN or FYM, either alone or in different combinations, significantly increased root yield as compared with the control. Yield increased with increased N rates. The highest yield of 33.4 tons/ha was obtained when 66.6% of N was applied as CAN and the rest as FYM at a rate of 150 kg/ha. A yield of 31.9 kg/ha was obtained when 33.3% of N was applied as CAN and the rest as FYM at an N rate of 150 kg/ha. Application of CAN alone at 100 and 150 kg/ha resulted in a yield of 29.3 and 29.6 tons/ha, respectively. The economic rate of inorganic N, therefore, was100 kg/ha. (*Summary by Abstracts on Tropical Agriculture*) D01 D03

0090-7413 SENA, Z.F. DE and CAMPOS, H. DOS R. **Irrigação.** (*Irrigation*). *In* Cruz das Almas, Brasil. Universidade Federal da Bahia. Escola de Agronomia. U.F.Ba./BRASCAN Nordeste. Projeto Mandioca. Relatório Semestral de Pesquisas no.2. 1973. pp.19-23. Port.

Cassava. Field experiments. Irrigation. Tuber productivity. Plant development. Timing. HCN content. Fibre content. Starch content. Brazil.

Irrigation frequency in cassava (var. Sutinga) was studied at the Universidade Federal da Bahia (Brazil) at intervals of 10, 14 and 18 days, using a randomized block design, with 12 replications. Av height, no. of roots, stems and weight, together with fiber, starch and HCN percentages, are given. (*Summary by I.B.Z.*) D01

0091-1629 SILVA, J.R. DA Efeito de certos adubos químicos sôbre o stand da mandioca. *(Effect of chemical fertilizers on cassava stand)* Ciência e Cultura 17(2)·193-194. 1965 Port.

Cassava. Field experiments. Statistical analysis. Cultivars. Adaptation. Fertilizers. Minerals. Brazil.

Results are given of 6 trials conducted in Araras (state of São Paulo) in 1963 to determine the ideal combinations of fertilizers and the best system for applying them for cassava. For 3 of the trials, a 3^3 factorial design with 3 replicates was used and for the remaining 3, a randomized block design The different rates of NPK applications are given in tables. The fertilizers and lime were soil incorporated except for ammonium sulfate, which was applied as a top dressing Results from both designs showed that simple superphosphate and potassium chloride had an adverse effect on plant stand and that the best percentage of stand was obtained on unfertilized plots. It seems that the adverse effect of these 2 fertilizers is present only during dry periods, which was the case in 1963. (*Summary by S.S. de S. Trans. by T.M.*) D01

0092-7914 SOLORZANO, N and BORNEMISZA, E. **Estudios sobre el cultivo de la yuca en Costa Rica. I. Extracción de nutrimentos del suelo.** *(Cassava in Costa Rica. I. Absorption of nutrients from the soil)* Turrialba 26(2):196-200. 1976. Span., Sum. Engl., Span., 11 Refs.

Cassava. Cultivars. Nutritional requirements. Minerals. Absorption. Soil analysis. pH. Timing. Field experiments. Costa Rica.

A study was made of the nutrient uptake patterns of 3 cassava varieties in a series Sáenz soil (Typic Ustropept) at the Fabio Baudrit Experiment Station (Costa Rica) Samples were taken from and between rows at 0-10 and 10-30 cm deep at 0, 5, 8 and 12 mo There was a rapid initial decrease in extractable P for the lst 5 mo, which leveled off; maximum P absorption was between rows at 40 cm from the plant stems. In the upper soil layer, exchangeable K content varied little; but at 10-30 cm, there was a decrease until the 8th mo, followed by an increase. Ca also presented an initial decrease and a final increase. There were only minor changes in Mg and pH. There was no varietal difference in uptake patterns. (*Author's summary. Trans. by T.M.*) D01

0093-2541 SPAIN, J.M. *et al.* **Differential species and varietal tolerance to soil acidity in tropical crops and pastures.** *In* Bornemisza, E. y Alvarado, A., eds. Soil management in tropical America Raleigh, North Carolina, University Consortium on Soils of the Tropics. Soil Science Department, 1975. pp.308-329. Engl , Sum Engl., Illus

Cassava. Field experiments. Soil fertility. Soil analysis. Minerals. Ca. Cultivars. Resistance. Productivity. Mineral deficiencies. Analysis. Fertilizers. Colombia.

The differential tolerance to soil acidity of various food crops and grasses was studied on an oxisol in Carimagua, the state of Meta (Colombia). Many species and crop varieties were screened for acid tolerance, results are given for maize, rice, grain legumes, cassava and some forage species. As regards cassava, very large differences among cultivars were observed; however, most of them responded visually to lime up to 2 tons/ ha but were adversely affected by 6 tons/ha Foliar mineral content was strongly influenced by liming even at the lowest rates. *(Summary by T.M.)* D01

0094-6960 THURY, A. **Mandioca Suruí da Lábrea.** (*A cassava variety from Lábrea*). Boletim da Associação Comercial do Amazonas 15(168).22-26. 1955. Port , Illus.

Cassava. Cultivars. Tuber productivity. Starch productivity. N. P. K. Fertilizers. Manures. Field experiments. Brazil.

A description is given of several trials with the Suruí cassava variety, discovered in Lábrea

(Amazon region) in 1934, which outyielded known varieties (66,888 kg/ha). Cassava was planted in unfertile soils and fertilized with different quantities of dung and ashes. Plants receiving larger amounts of lime, K and P developed best; however, K was effective only in the presence of N. Av starch yield was very low (6,500 kg/ha). (*Summary by I.B.Z.*) D01 D03

0095-7665 WAHAB, A.H. and HASSAN, I. Performance of Guyana's agriculturally marginal peats and peaty clays to twenty cultivars of cassava (*Manihot esculenta* Crantz).Georgetown. Guyana Sugar Corporation Ltd. Project Evaluation Unit. Crop Development Section. Cassava Project Report no. 7 1977. 20p Engl., Sum Engl , 7 Refs

Cassava. Cassava programs. Field experiments. Soil analysis. Tuber productivity. Dry matter. Plant development. Cultivars. Adaptation. Stems. Leaves. Shoots. Guyana.

Twenty cassava varieties were grown on Anira peat #20 and Inki clay #100 for 12 mo to evaluate the suitability of these marginal soils in Guyana Germplasm material was from Brazil, Colombia, Mexico, Puerto Rico and Guyana Tacana and Iracema (Brazil) ranked above all others on both soils, producing 28 tons/ha of fresh roots on the Anira peat and 24 tons/ha on the Inki clay. Introduced cultivars outperformed their local counterparts. The highest yielding indigenous cultivar was Badwoman, which produced 12 and 10 tons/ha of fresh roots on the Anira peat and Inki clay, respectively. Although varying in magnitude for the 2 soils, there was a 12% spread in root DM content among cultivars. M Col 673 had the highest root DM content, averaging 41% for both soils. Useful fresh matter content (ratio of peeled to unpeeled roots) averaged 0.85 and was essentially the same for all 20 cultivars. There was a highly significant relation between total plant wt and root yields on both soils (r=0.92 and 0 94) and between harvest index and root yield (r=0 64 and 0.81). The no. of shoots produced by a cutting and stem diameter at harvest were not related to yield. However, the no. of roots/plant was highly correlated with yield on both soils (r=0.69 and 0.54), as was root thickness (r=0.92 and 0.95) Studies on postharvest storage life indicated that all varieties stored well for 5 days under field conditions before primary deterioration began. (*Author's summary*) D01 D03

See also 0200 0391 0395 0410 0411

D02 Cultivation Practices: Propagation, Planting, Weed Control, and Harvesting

0096-0137 AN ACCIDENTAL discovery re cassava cultivation. Journal of the Jamaica Agricultural Society 41:148-151. 1937. Engl.

Cassava. Propagation.

Two new methods of growing cassava were discovered accidentally. It was found that by planting branches 1.2-1.5 m long in a vertical position, larger, good-quality roots were produced than when using the traditional 15- to 30-cm cuttings. On the other hand, planting whole plants after harvesting their roots produces a later harvest of equal quantity and in half the time of plants grown from 30-cm cuttings. *(Summary by A J. Trans. by T.M.)* D02

0097-3685 ALBUQUERQUE, M. DE, GUIMARES, M.C. DE F. and VIEGAS, R.M. F. **Epocas de plantio e de colheita em zonas mandioqueiras do leste paraense.** (*Planting and harvesting dates in cassava-growing zones in eastern Pará*). Boletim Técnico do Instituto de Pesquisa Agropecuária do Norte 60:193-221. 1974. Port., Sum. Port., 6 Refs., Illus.

Cassava. Field experiments. Experiment design. Planting. Harvesting. Timing. Soil analysis. Tuber productivity. Starch productivity. Protein content. Leaves. Brazil.

A 3-yr trial was conducted in eastern Pará to study the effect of cassava planting and harvesting dates on starch content of roots, protein content in leaves and productivity in the field. Both factors were found to affect production, but they had no effect on starch or protein content. Planting should not be done from Oct.-Jan. Harvesting at 4-9 mo is not recommended when cassava is grown for forage. For root production, harvesting may be done between 12-18 mo. (*Author's summary. Trans. by I.B.Z.*) D02 D03

0098-7817 BARRIOS, J.R **Weed control in cassava.** Maracay, Venezuela, Universidad Central de Venezuela. Instituto de Agronomía, 1973 9p. Engl., 25 Refs.

Cassava. Field experiments. Weeding. Herbicides. Tuber productivity. Colombia.

Trials on weed control were conducted at Maracay (Venezuela) with 5 preemergence herbicides to determine their effects on cassava (no. of plants harvested, yield root, foliage wt, no. and size of main stems, visible damage due to herbicides) and on weeds (wt of weeds produced). Two planting dates were used, one at the end and the middle of the rainy season. It was found that weeds affect cassava yield severely. Herbicides should be used in large cassava plantations Fluometuron (2 kg/ha) was the best herbicide; atrazine (2 kg/ha) can be used when humid conditions are not very high. Prometryne and diphenamid (2.0 and 3.0 kg/ha, respectively) did not give good control. (*Summary by A.J. Trans. by I.B.Z.*) D02 D03

0099-7567 BENVENUTI, G. *et al.* **Ensayo de variedades y distancias de siembra en el cultivo de la yuca (Chone-Manabi - Marzo 1974/Junio 1975). Documento de trabajo no. 3 y anexos.** (*Evaluation of cassava varieties and planting distances in the province of Manabí, work document no. 3 and annexes*). Ecuador. Ministerio de Agricultura y Ganadería Proyecto FAO ECU/71/522. Serie Cultivos Tropicales - Didáctica. 1976. v 1. 49p., v.2., 85p., Cuad. Span., Sum. Span.

Cassava. Field experiments. Cuttings. Spacing. Planting. Cultivars. Tuber productivity. Plant development. Harvesting. Timing. Tubers. Starch content. Protein content. Dry matter. Productivity. Ecuador.

An experiment was conducted in Garrapata, Province of Manabí (Ecuador) to study the development of 3 local cassava varieties at 3 different densities and to compare their production at the same density, as well as that of each variety at all densities The varieties were Taureña (A), Chola (B) and Canela (C); planting distances were 1 x 1 m (10,000 plants/ha), 1.50 x 1 m (6,600 plants/ha) and 2 x 1 m (5,000 plants/ha). There were 3 replications for a total of 27 plots and 80 plants/plot. Planting was done in March 1974; the 1st crop was harvested in Aug. and the last in June 1975, for a total of 11 monthly harvests. Results were as follows. (1) Height development (descending order) of the 3 varieties was A, C, B. Varieties A and C are erect with some vertical or slightly lateral branching, whereas C is shorter and has a larger canopy with many lateral branches. (2) Regardless of variety, cassava planted at 1 x 1 m covered the alleys before the other 2 treatments; therefore, fewer weeds developed. (3) Up to the 11th mo, variety A had most vegetative growth; afterwards, it was B. (4) All varieties yielded most at the 1 x 1 m planting distance. Variety C yielded most roots, DM, starch and protein content at 13 mo. (*Summary by T.M.*) D02 D03

0100-7452 CASTRO M., A., COCK, J. H. and TORO, J. C. **Efecto de la densidad de siembra en el rendimiento de la yuca.** (*The effect of planting density on cassava yields*) *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976 pp.233-239. Span., 5 Refs., Illus.

Cassava. Cultivation. Spacing. Cultivars. Tuber productivity. Colombia.

The effect of planting density on cassava yield is discussed briefly, citing some experiments carried out at the Centro Internacional de Agricultura Tropical since 1970. Under CIAT conditions, optimal density was 10,000 plants/ha for varieties of a short type and tall types with erect growing habits and 5,000 plants/ha for those tall types with branching growing habits. It is concluded that for each cultivar there is an optimal planting density and that as the population increases, yield increases, but the no. of roots/plant, root size and harvest index decrease. On the other hand, the greater the density, the lesser the weed competition. Tables giving data on dry matter yields for 5 varieties (M Mex 11 and M Col 22, 1080, 1438 and 1467) at 4 different planting densities. (*Summary by S.S. de S. Trans. by T.M.*) D02 D03

0101-7450 CASTRO M., A., TORO M., J.C. and CELIS A., E **Métodos de siembra y cuidado inicial de la yuca.** (*Planting methods and initial care of cassava*). *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 217-224 Span., Illus .

Cassava. Planting. Cuttings. Cultivation. Colombia.

The following aspects of planting cassava and its initial care are dealt with briefly: planting methods (on the flat, on ridges, in beds, hills), cutting of stems for propagation material, position

of cuttings (vertical, slanted, horizontal), germination of cuttings under field conditions, planting depth and initial care (pathogens, insects, weed control, water supply). *(Summary by S.S. de S Trans. by T M.)* D02

0102-8414 COCK, J.H., WHOLEY, D. and GUTIERREZ DE LAS CASAS, O. Effects of spacing on cassava (*Manihot esculenta*). Experimental Agriculture 13 289-299 1977. Engl., Sum. Engl, 14 Refs., Illus.

Cassava. *Manihot esculenta*. Field experiments. Spacing. Tuber productivity. Dry matter. Tubers. Cultivars. Plant development. Colombia.

Three varieties in one cassava trial and 5 in another were planted in a sytematic density experiment, which showed that optimum plant density for root yield changes with plant age. Some varieties showed a pronounced optimum plant population whereas others showed a flat-topped response curve. Reduction in yield above the optimum is due to a reduced harvest index. Yields of over 50 tons/ha were obtained with varieties that responded to close spacing (*Author's summary*) D02 D03 C01

0103-3633 CONCEIÇAO, A J. DA and SAMPAIO, C V. Competição de espaçamentos na cultura da mandioca. (*Effect of spacing on cassava productivity*). Cruz das Almas, Brasil. Universidade Federal da Bahia Escola de Agronomia - Brascan Nordeste Série Pesquisa 1(1) 80-85. 1973. Port, Sum. Port, Engl., 10 Refs., Illus.

Cassava. Spacing. Cuttings. Productivity. Soil analysis. Field experiments. Brazil.

The effect of different spacings on cassava yield was studied at the Universidade Federal da Bahia, Cruz Das Almas (Brazil) from 1969-72. No statistical differences were found among treatments, but best results were obtained when planting at 1 x 0.50 m and 1 x 0.60 m. (*Author's summary*) D02

0104-8019 DHARMAPUTRA, T.S. and BRUIJN, G.H. DE The Mukibat system of cassava production. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.94-98. Engl., Sum. Engl., 1 Ref., Illus

Cassava. Field experiments. Propagation. Cuttings. Spacing. Tuber productivity. Timing. Cultivars. Grafting. Indonesia.

The Mukibat system of cassava production may outyield normal systems The system is based on the grafting of *Manihot glaziovii* on a stock of *M esculenta* Individual varieties react differently to the system; therefore, it may be possible to select for high-yielding varieties that have good eating quality but that produce only moderately under the normal system The highest accumulation of root DM of the Mukibat cassava occurred from 12-15 mo in all 3 varieties tested. Nitrogen was the limiting plant nutrient at one location. Scion material taken from Mukibat plants was found to be as good as that taken from the original *M. glaziovii* tree. Two types of scion were tested. the so-called "black" type was superior to the "white" at one location but not at the other. (*Author's summary*) D02 D03

0105-8204 DOLL, J., PINSTRUP-ANDERSEN, P and DIAZ, R.O. **An agro-economic survey of the weeds and weeding practices in cassava (*Manihot esculenta* Crantz) in Colombia.** Weed Research 17:153-160. 1977. Engl., Sum. Engl., Fr., Germ., 7 Refs., Illus.

Cassava. *Manihot esculenta.* Weeds. Weeding. Labour. Costs. Cassava programs. Colombia.

A survey of weeds and weeding practices was carried out by a team of agricultural economists and agronomists on 283 farms in 5 cassava-growing regions of Colombia at 3 times during a cropping season From 71-78% of the weed species present were broad-leaved species. As cassava grew older, grass species were present to a greater extent and sedge species to a lesser relative frequency. Surprisingly, *Pteridium aquilinum* was the most frequently listed species, in addition to *Bidens pilosa* and *Cyperus rotundus.* Regional variations in the most frequently encountered species were found, but several of the weeds were common to many zones. The most frequently encountered species did not usually have the highest plant populations. Most of the annual grasses, sedges and broad-leaved weeds found can be controlled by currently recommended herbicides for cassava, but further research is needed on *Imperata cylindrica, Melinis minutiflora, P. aquilinum* and *Sida* spp The av no of manual weedings was 3.3/crop, occupying 48 man-days/ha. which represents 50% of the total labor requirements for cassava production and more than 1/3 of the total costs. Reasons for not using herbicides were (1) relative costs of herbicides and labor, (2) lack of information, (3) lack of capital, (4) right herbicides were not available in small packages. This survey has identified new field problems and has suggested further research programs to solve them (*Author's summary*) D02 J00

0106-5749 ENE, L.S.O. **Preliminary results on field methods for multiplication and distribution of certified planting materials of recommended cassava varieties.** *In* Okpala, E.U. and Glaser, H.J., eds. Workshop on Cassava Bacterial Blight in Nigeria, 1st., Umudike, Nigeria, 1974. Proceedings. Umudike, Federal Agricultural Research and Training Station, 1974. pp.61-69. Engl., 4 Refs., Illus.

Cassava. Field experiments. Propagation. Cuttings. Shoots. Germination. Plant-growth substances. Rooting. Timing. Nigeria.

To determine the most efficient method for producing cassava shoots for rapid multiplication of varieties, 4 treatments were studied: (A) 1-node cuttings, (B) 2-node cuttings, (C) 10-cm long cuttings and (D) 20-cm long cuttings. The cuttings were planted horizontally in boxes containing sandy loam. When the shoots reached 8 cm in height, they were cut and rooted in different types of polyethylene propagation chambers. In another experiment, the cut ends of shoots were dipped in 5 and 10 ppm naphthaleneacetic acid (NAA) for 5, 10 and 15 min. Treatment C gave the most shoots (115), followed by D (100), as compared to A and B (71 and 73, respectively). Multiplication of material from the initial 20 cuttings ranged from 3 6 times (A) to 5.8 times (C). Rooting of excised new shoots occurred at 7-10 days, but only in the wholly sealed polyethylene chamber NAA shortened rooting time to 2 days, and total no. of rooted shoots, av no. of roots and av length of longer shoots were higher in the NAA treatment than in the control (water). There were no significant differences between the 2 concentrations; however, the foregoing parameters decreased with increased NAA contact. Using 10-cm cuttings, 6600 cuttings/yr can be obtained from 1 mature plant This method may be combined with cultural control methods (i e., crop rotation) to check for and eliminate bacterial blight. (*Summary by A.J. Trans. by I.B Z.*) D02 C01

0107-2260 FRITZ, J. and RAMAHADIMBY, G. **Essais comparatives varietaux sur manioc; région du lac Alaotra et de Moramanga; campagne 1955-1957.** (*Comparative trials with*

cassava varieties; Lake Alaotra and Moramanga regions). Station Agronomique du Lac Alaotra, n.d. Fr.

Cassava. Field experiments. Cultivars. Tuber productivity. Clones. Germination. Cassava mosaic virus. Resistance. HCN content. Timing. Spacing. Cuttings. Malagasy Republic.

In the region of Lake Alaotra, 49 hybrids were evaluated for yield, resistance to mosaic, percentage of plant stand and HCN content at harvesting. Clone no. 28559 gave excellent yields, germination percentages and resistance to root rot, but was susceptible to mosaic. Thirteen regional trials were conducted with 6 varieties to compare yields, root density, resistance to root rotting, percentages of germination and final stand. Var. 43 had the best characteristics, particularly on old alluvial soils; but percentages of germination and root density were low. It was also susceptible to root rot. (*Summary by I.B.Z.*) D02 D03

0108-4980 HADI, J.W and GOZALLIE, D M. **Effect of spacing and NK fertilizer on the yield of Gading cassava variety.** Bogor, Indonesia, Central Research Institute for Agriculture, 1975. 10p. Engl., Sum. Engl., 6 Refs., Illus

Cassava. Field experiments. Spacing. N. K. Fertilizers. Tuber productivity. Soil fertility. Indonesia.

Field experiments were conducted at Citayam, Jakenan and Muneng (Indonesia) during the 1973-74 rainy season to determine the optimum planting density and fertilizer applications for the cassava variety Gading. In general, closer spacing did not increase yield since no. and wt of roots/plant decreased On the poor soils at Jakenan, however, yields increased significantly (10% level) at 16,700 plants/ha (1 x 0.60m). Recommended NPK applications are 90-30-0 for Citayam and 90-30-50 for Jakenan and Muneng. Estimated profits per hectare are given (*Author's summary*) D02 D03

0109-7352 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Manioc.** (*Cassava*). *In*—. Rapport analytique 1972; cultures diverses. Abidjan, Cote d'Ivoire, 1973. pp.59-70. Fr., Illus.

Cassava. Cassava programs. Cultivars. Tuber productivity. Timing. Field experiments. Ivory Coast.

Information is given on the Bouaké cassava collection (85 varieties). Two experiments were conducted to compare yields, starch content and resistance to cassava mosaic. Kataoli is a high-yielding variety; Llanera is not well suited to the ecological conditions. (*Summary by I.B.Z.*) D02 D03

0110-8412 KAMALAM, P., RAJENDRAN, P.G. and HRISHI, N. **A new technique for the rapid propagation of cassava** (*Manihot esculenta* Crantz). Tropical Agriculture 54(3).213-217. 1977. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. *Manihot esculenta* **Propagation. Cuttings. Germination. Timing. India.**

A rapid propagation technique was developed by inducing sprouting of 2-node, single-node and half-node cuttings of cassava. Of the different treatments, the use of half-node cuttings was found to be the most efficient. In one yr, 647 plants and 3235 stem cuttings (20 cm long) could be developed from a single plant with 2 stems. (*Author's summary*) D02

0111-3801 KIERSNOWSKI, S Conservación de los tallos de mandioca. *(Conserving cassava stem cuttings).* Chacra 20(233) 60-61. 1950. Span., Illus.

Cassava. Cuttings. Stems. Storage. Germination. Timing. Argentina.

The results are given of diverse on-the-farm methods for conserving cassava stems for propagation material. The varieties Negra, Concepción and Carape were used to study the following methods. (1) straw piles, (2) straw clamps, (3) damp conditions-straw huts, (4) dry conditions-straw huts and (5) dry (completely protected in a shed). Nos. 3 and 4 gave best results with a percentage of sprouting in one experiment of 56, 61 and 41% at 25 days and 76, 80 and 55% at 47 days for the 3 varieties, respectively; in a 2nd trial results were 46, 26 and 38% and 67, 24 and 61% at 25 and 47 days, respectively. Sprouting was slow, low and irregular because of climatic conditions; the previous year, up to 99% germination was obtained. It is concluded that (1) the response to the storage method varies according to variety, moisture and method of placing under the straw; (2) the storage area must be well ventilated, (3) the branches with the most moisture sprout more easily than dry ones in low-moisture soils; and (4) dry stems maintain their germinating capacity for more time. *(Summary by A J. Trans. by T M)* D02

0112-4773 KOCH, L. Uitkomsten van een snoeiproff en een grondbewerkingsproef met cassave. *(Effects of pruning and tilling cassava)* Korte Berichten uitgaande van den Landbouwvoorlichtingsdienst. Selectie — en zaadtiun te Buitenzorg no 23 1-18 1920 Dutch

Cassava. Cultivation. Pruning. Timing. Land preparation. Productivity.

Young plants were pruned twice, at heights of >1½ and 4 ft. Pruning probably had an adverse effect on productivity although the results did not difinitely show this. In the tillage experiment, 2 methods were compared: (1) planting on the flat, followed by hilling and (2) planting on beds, followed by hilling and tilling the soil in the furrows In the last 6 mo of the 1st year of growth, stem development was better with method 2, however, this had no effect on yield. For this reason the simpler, cheaper method (1) is preferred. When harvesting earlier (at 13-14 mo instead of 20), method 2 is more advantageous *(Summary by R. van G)* D02

0113-8208 LIN, Y.P. and TSAI, C.I. [Tests of cassava planting methods]. *In* Taiwan Department of Agriculture and Forestry Annual Report of Dryland Food Crops Improvement Series no. 16, 1974. Taipei, 1975. pp.55-57. Chin., Sum. Engl.

Cassava. Field experiments. Planting. Cuttings. Spacing. Taiwan.

Field experiments evaluating different planting methods indicated that highest yields were obtained when cassava cuttings were planted at an angle, 20 cm deep, registering a 5% gain over the conventional upright method, 10 cm deep. Next was the treatment planting cuttings at an angle, 15 cm deep, yielding 2.5% more than the conventional method The other 7 methods were inferior to the check. In conclusion, cuttings should be planted at an angle, 15-20 cm deep or 10 cm deep when planting upright. *(Author's summary)* D02

0114-8177 NEW SYSTEM insures clean cassava seed. Cali, Colombia Centro Internacional de Agricultura Tropical. Noti-CIAT Series AE no. 1-3, 6-7. 1976 Engl., Illus.

Cassava. Propagation. Cuttings. Shoots. Propagation materials. Colombia.

With this simple method it was possible to obtain some 30,000 commercial cassava cuttings per plant, free of cassava bacterial blight. Two-noded cuttings are placed in a propagation chamber All sprouts of these cuttings are cut and placed in rooting flasks in sterile water before final planting. (*Summary by Abstracts on Tropical Agriculture*) D02

0115-0170 OPSOMER, J.E. **Etudes de plantes vivrières a Yangambi. II. Note sur le mode de plantation de boutures de manioc.** (*Study of food plants in Yangambi. II. Methods of planting cassava cuttings*). Bulletin Agricole du Congo Belge 28(1):131-135. 1937. Fr., 3 Refs

Cassava. Field experiments. Cuttings. Planting. Tuber productivity. Zaire.

Cassava cuttings were planted vertically horizontally or at a slant to compare yields. Planting followed a classical design (abcabc, etc.)with 4 replications; spacing was 1 m x 1 m (1 cutting each time) on the flat. Differences in root yields were not significant. Av no. of stems was higher in cuttings planted horizontally. (*Summary by I.B.Z.*) D02

0116-7540 ROGERS, D.J. Tuber and root crops: cassava (*Manihot esculenta*). FAO Agricultural Studies 93 26-29. 1974 Engl., 6 Refs.

Cassava. Propagation. Cuttings. Stems. Seed. Storage.

Several instructions are given for selecting cassava cuttings effectively Some methods for storing vegetative material, as well as for collecting seeds, are given. Data to be included when shipping cassava material are general information on collection (site, collector, data, origin) and on the plant (stem, branching, habit, foliage and roots). (*Summary by A.J. Trans. by T.M.*) D02

0117-7547 SHANMUGAM, A. **Influence of spacing on the growth and yield of six tapioca varieties.** Agricultural Research Journal of Kerala 12(1):74-75. 1974. Engl., Sum. Hindi., 1 Ref.

Cassava. *Manihot esculenta.* **Spacing. Growth. Plant height. Tuber productivity. Field experiments. Cultivars. India.**

The effect of 3 spacing treatments (75 x 60 cm, 75 x 75 cm and 75 x 90 cm) was studied in 6 cassava varieties in Kerala (India). M.E. 4, 15 and 1 responded to the widest spacing whereas the other 3 yielded more with the intermediate planting distance. Close spacing reduced yields in all the varieties studied. Optimum planting density for economic yields may vary from 14 to 17 thousand plants/ha. (*Summary by I.B.Z.*) D02 C01 D03

0118-7980 **SISTEMAS DE produção para mandioca.** (*Cassava production systems*). Ceará, Brasil. EMBRAPA - EMBRATER. Série Sistemas de Produção. Boletim no.15. 1976. 36p. Port., Illus.

Cassava. Cultivation. Land preparation. Planting. Harvesting. Inter-cropping. Insect control. Insecticides. Cassava programs. Maps. Soil analysis. Brazil.

Conclusions are presented on the analysis of infrastructure in cassava-producing zones, on the farmers' technical know-how, their interests and attitudes towards technical assistance. Three

cassava production methods were developed for the state of Ceará (Brazil) for the following physiographic regions: Litoral, Sierra de Baturité, Bajo Jaguaribe, Ibiapaba and Araripe. Sanitary aspects of cassava growing are included, together with soil characteristics of these regions. (*Summary by I.B.Z.*) D02 J00

0119-4942 STOK, J.E. VAN DER. **Bibitproef bij cassave** (*Manihot utilissima* Pohl). (*Selection of cassava stem cuttings*). Teysmannia no.20:730-734. 1909. Dutch.

Cassava. Cultivars. Field experiments. Cuttings. Selection. Planting. Tuber productivity.

The older stem parts of the cassava plant were traditionally considered by the Javanese to be the best planting material. An experiment was conducted with 10 varieties from an 8-mo-old stand to see which part was best; 25-cm cuttings were taken from basal, middle and upper stem parts. Cuttings were planted in alternating rows at 2 x 2 ft spacing and harvested after 7 mo. An analysis was made of av fresh root yield/plant, av fresh wt of the aerial part, no. of roots/plant, and av size and no. of branches. Cuttings from the upper stem parts produced lower yields. There was no substantial difference in yield between the middle and basal parts, but the latter was better. Results, however, may differ if the cuttings are taken from older stands. The germinating rate of the buds from the upper stem parts was slightly higher than for the other two. After 1 mo, however, the stands were almost uniform, and those from the middle and basal stem parts were somewhat better. There were also more and thicker branches on plants from older stem cuttings. Root no. depended on varietal difference, not on stem age. Varietal selection should be carried out to improve yields. (*Summary by M.T.*) D02

0120-7686 TINEO, J. **Selección de estacas y la siembra de yuca.** (*Selection of cassava stem cuttings and their planting*). Agro Información 1(8).29-31. 1976. Span., Illus.

Cassava. Stems. Cuttings. Planting. Venezuela.

Recommendations are given for selecting cuttings and preparing the land for planting cassava Cuttings should be healthy; 8-12 mo old; 2 cm in diameter x 20-25 cm long, selected from the middle part of the stem; and with 3-5 buds/cutting Cuttings should be disinfected with a pesticide before planting. The land should be plowed 25 cm deep In heavy, poorly drained soils, cuttings should be planted on ridges (15-20 cm) with 1-1.2 and 0.8-1 m between rows and plants, respectively, for the local climatic conditions. Cuttings planted at a slant produce more than those planted either vertically or horizontally, but this method requires more labor. (*Summary by A.J. Trans. by T.M.*) D02

0121-7451 TORO, J.C , CELIS, E. and JARAMILLO, G. **Métodos de cosecha de la yuca.** (*Methods for harvesting cassava*). *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 225-232. Span , 6 Refs.

Cassava. Cultivation. Harvesting. Mechanization. Agricultural equipment. Colombia.

Various methods—both manual and mechanical—for harvesting cassava are discussed. Since harvesting represents about 30% of the production costs, it is necessary to develop methods to increase the efficiency of the operation. Two factors should be kept in mind: vibration and traction. The following methods are described: (1) manual. By hand, picks, straps, lifting poles; (2) manual-mechanical. Ditching plow, moldboard plow; and (3) mechanical. The possibility of using modified beet and potato harvesters and a tractor implement designed by Briceño and Larson to pull out roots is also discussed. Whatever the method used, planting methods, soil type and moisture content must be taken into account. (*Summary by S.S. de S. Trans. by T.M.*) D02

0122-8215 TSAI, C.I. **[Test of planting methods of cassava]**. *In* Taiwan Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 17, 1975. Taipei, 1976. pp.51-52. Chin , Sum. Engl

Cassava. Field experiments. Planting. Cuttings. Tuber productivity. Taiwan.

Nine different planting methods were studied Highest yields were obtained when planting cassava cuttings at an angle, 20 cm deep, which gave a 7.1% gain over the conventional upright planting at a 10-cm depth. Next were the treatments of planting at an angle at 10 and 15 cm, giving 4.8 and 3.7% higher yields than the conventional practice. In conclusion, depths of 15-20 cm for angle planting and 10 cm for upright planting are recommended (*Author's summary*) D02 D03

See also *0135* *0200* *0302* *0377*

D03 Energy Productivity and Yields

0123-7360 ARRAUDEAU, M., CRATEL, M. and RAMANOELINA, M. **Bilan de l'experimentation pluriannuelle multilocale sur manioc à Madagascar.** *(Twelve-year report on cassava trials in several regions of the Malagasy Republic).* Tananarive, Institut de Recherches Agronomiques à Madagascar. Document no. 393. 1974 pp. 127-138 Fr., Illus.

Cassava. Field experiments. Cultivars. Productivity. Selection. Identification. Uses. Cultivation. Rotational crops. Malagasy Republic.

The results are given of 12 years of research carried out at the Institut de Recherches Agronomiques in the Malagasy Republic as regards improving clones to replace local, low-yielding varieties or those susceptible to mosaic and rots. Characteristics, av yields (3-yr period) and uses are given for 12 varieties grown in the provinces of Diego-Suárez, Fianarantsoa, Tomatave, Tananarive and Tuléar. Types of fertilization, rotation and planting systems used in the southern part of the country are described briefly. It is concluded that the no. of varieties/region should be limited to 2, in order to avoid problems of multiplication, specific varietal recommendations are made for the different regions. *(Summary by S.S. de S Trans. by T.M.)* D03

0124-8211 CHEN, W.T. **[District yield trials of new cassava strains].** *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 17, 1974. Taipei, 1975. pp.50-52. Chin., Sum. Engl

Cassava. Field experiments. Cultivars. Tuber productivity. Taiwan.

Field experiments evaluating new cassava strains were conducted at Shuishang, Kuantien and Yuching. Lines Nan-Kai-Si nos. 3, 5, 6 and 7 were better than the check variety in all aspects. Nan-Kai-Si no. 5 ranked 1st in root yield, no. 6 was 2nd, followed by nos. 3 and 7, yielding 22.5, 16.9, 16.8, and 7.8% higher than the check, respectively. As for dry chip yield, these 4 lines ranked the same, yielding 26.6, 22 3, 21.9 and 9.5% higher than the check, respectively. *(Author's summary)* D03

0125-8213 CHEN, W.T. **[District yield trials of new cassava strains].** *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 17, 1975. Taipei, 1976 pp.45-48. Chin., Sum Engl

Cassava. Field experiments. Cultivars. Tuber productivity. Taiwan.

Field experiments with new cassava varieties were conducted in 1974-75 at Shuishang, Kuantien and Yuching. Results were as follows: Lines Nan-Kai-Si nos 6, 5 and 7 were better than the check

variety in all aspects. As regards root yield, Nan-Kai-Si no. 6 was the highest, outyielding the check by 17.6%. Nan-Kai-Si no 5 and no. 7 were 2nd and 3rd, yielding 15.7 and 12.0% higher than the check, respectively. As for yield of dry chips, the same ranking occurred, the 3 lines yielding 23.4, 20.4 and 14.2% higher than the check, respectively. (*Author's summary*) D03

0126-8209 CHEN, T.L. **[Observational yield trials of introduced cassava varieties]**. *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 16, 1974. Taipei, 1975. pp.47-49 Chin., Sum. Engl.

Cassava. Field experiments. Cultivars. Tuber productivity. HCN content. Starch content. Plant height. Taiwan.

Trials were conducted with introduced cassava varieties in 1974 to select one with high yielding ability and low HCN content, adapted to the Hsichu area Results were as follows. Ivory no. 1 was the highest yielder with 31,850 kg/ha, outyielding the native variety by 27.4%. Ivory nos 3 and 2 yielded 30,594 and 27,813 kg/ha of roots, showing an increase of 22 4 and 11.3% over the native variety, respectively. However, differences were not statistically significant. The introduced varieties also had a higher percentage of dried chips (48-45%) and starch content (20-18%) than the native one (39% for dried chips and 16% for starch content). In other words, the former contain less cellulose and give more edible parts than the latter. As for plant height, Ivory no. 3 was the tallest (165 cm), no. 2 measured 162 cm and no. 1, 156.8 cm. All were shorter than the native variety (169 4 cm). All 3 introduced varieties had less toxic (HCN) constituents than the native variety Taking 100% as the base for the latter, the former had 23, 15 and 21% HCN for Ivory nos. 1, 2 and 3, respectively. (*Author's summary*) D03 C03

0127-8210 CHEN, T.L. **[Yield trials of introduced cassava varieties]**. *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Crops Improvement Series no. 16, 1974. Taipei, 1975 pp.53-54. Chin., Sum. Engl.

Cassava. Cultivars. Adaptation. Tuber productivity. Field experiments. Taiwan.

In order to select a cassava variety best adapted to the Hsinchu area, experiments were carried out with introduced varieties at Houlong and Hsinpu. Results were as follows: As regards plant height, entries ranged from 200-220 cm tall at Hsinchu and from 70-115 cm at Houlong (sandy loam soil) After 8 mo of growth, Jurai produced 45,546 kg/ha at Hsinchu and 41,329 kg at Houlong, showing a significant increase of 127.7 and 7.5% over the local cassava variety, respectively. The highest yielder of dried chips at both sites was Ubiputeh. (*Author's summary*) D03

0128-8207 CHIU, F.H., LIU, Y.S. and CHEN, T.L. **[Observational yield trials of introduced cassava varieties]**. *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 15, 1973. Taipei, 1974. pp.46-47. Chin., Sum. Engl.

Cassava. Cultivars. Tuber productivity. Field experiments. Taiwan.

Experiments were conducted to study the characteristics of newly introduced cassava varieties and to select the variety best adapted to the Hsinchu area As regards av yield/plant, Cosmopolis ranked 1st (1,710 kg), Ubimlaka, 2nd (1,490 kg) and Jurai, 3rd (1,400 kg). All 15 introduced varieties outyielded the check variety (Native-Green). (*Author's summary*) D03

0129-8212 CHIU, F.S. and CHEN, T.L [Yield trials of introduced cassava varieties]. *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 17, 1975. Taipei, 1976. pp.42-44. Chin., Sum. Engl.

Cassava. Cultivars. Adaptation. Tuber productivity. Field experiments. Taiwan.

Experiments were conducted on hilly tablelands at Toufen and Tunghsiao to select superior cassava varieties adaptable to the Hsinchu area. Crops were harvested at 314 and 294 days after planting. It was found that neither growth nor yield were better than those in previous years because of the shortage of rainfall during the growing season. The check (a local variety) had the highest yield (32,875 and 23,906 kg/ha) and Hsinnung Yu 3 was 2nd. Among the new varieties, Hsinnung Yu 3 (low HCN content) had a 7.2% higher percentage of dry chips than the check in the Tunghsiao experimental field. (*Author's summary*) D03

0130-4998 COELHO, C. **Observações sôbre o cultivo da mandioca no município da Vitória.** *(Cassava cultivation in the municipality of Vitória).* Boletim da Secretaria de Agricultura Industria e Comercio. 10 (3/4):14-27. 1944. Port.

Cassava. Cultivars. Identification. Field experiments. Experiment design. Productivity. Brazil.

A report is made of 4 experiments with 4 cassava varieties in the state of Pernambuco (Brazil). The physical characteristics of the varieties Pacarú Preta, Vira Barco, Cordão de Ouro and Pau de Xexéu are given. Growing conditions (soils, planting densities), cultural practices and planting dates are explained. The results of 2 harvests showed that Vira Barco was the best yielder. Analysis, however, showed that there was often a reduction in starch yield, probably in favor of cellulose content, making it necessary to carry out a study on harvesting and planting dates An experiment is being conducted to study qualitative and quantitative yields as a product of 2 factors: productivity and resistance. Results obtained in Vitória coincide with those obtained by another researcher in Dois Irmãos. *(Summary by S.S. de S. Trans. by T.M.)* D03

0131-7917 INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. **Agronomy systems.** *In*__. Annual Report 1975. Ibadan, Nigeria, 1976. pp.37-40. Engl., Illus.

Cassava. Cultivation. Inter-cropping. Tuber productivity. Field experiments. Cassava programs. Nigeria.

Experiments on intercropping cassava with maize, melons and vegetables were conducted at Ibadan, Nigeria. Results show that it is essential to plant cassava 1-2 mo before maize to ensure a relay crop prior to the harvesting of cassava. When intercropped with maize and melons, cassava yielded 34 tons fresh wt/ha, as compared to 28 tons when planted alone. When cassava was intercropped with a sequence of vegetables (tomatoes, okra, french beans), 20 tons/ha were obtained. Cassava showed a marked response to black plastic mulch; av fresh root wt was 21 tons/ha, as compared to 14 tons in the absence of mulch. (*Summary by A.J. Trans. by I.B.Z.*) D03 K01

0132-6954 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. Manioc. (*Cassava*). *In*__. Compte rendu 1964. Libreville, Gabon, 1965. pp.13-14. Fr.

Cassava. Cultivars. Tuber productivity. Cassava mosaic virus. Resistance. Productivity. Chickwangue. Gabon.

Results are given of 2 yield trials conducted at Lebamba (Gabon) on 15 clones from Madagascar and 4 local ones. Plant yields, resistance to cassava mosaic virus, and yields for making chickwangue (cassava paste) are presented. Local varieties had the highest gross yields but their high starch content made them unsuitable for chickwangue. (*Summary by S.S. de S. Trans. by I.B.Z.*) D03

0133-6953 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. Manioc. (*Cassava*) *In* Compte rendu 1965 Libreville, Gabon, 1966. p.28. Fr.

Cassava. Cultivars. Tuber productivity. Casssva mosaic virus. Resistance. Chickwangue. Productivity. Gabon.

The results are given for yield/plant, resistance to mosaic and yield in making chickwangue (cassava paste), obtained in Gabon during 1964-65 with 15 clones from Malagasy Republic, 1 from the Ivory Coast and 4 local varieties. The best was from the Ivory Coast (B 33), followed by a local variety (L 3). (*Summary by S.S. de S. Trans. by T.M.*) D03

0134-7356 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. Manioc. (*Cassava*). *In*—. Rapport, analytique 1973; cultures diverses. Abidjan, Côte d'Ivoire, 1974. pp.36-47. Fr.

Cassava. Field experiments. Cultivars. Tuber productivity. Starch productivity. Dry matter. Cassava mosaic virus. Resistance. Ivory Coast.

Information is given on 45 cassava varieties available at the Bouaké Station and on 2 trials carried out with 10 varieties to evaluate yield, DM content, starch content and resistance to mosaic disease. (*Summary by I.B.Z.*) D03

0135-4769 KOCH, L. Uitkomsten van 3 vergelijkende proeven met cassave. (*Results of three comparative yield trials with cassava*). Korte berichten uitgaande van den Landbouwvoorlichtingsdienst. Selectie - en Zaadtwin te Buitenzorg no. 15:1-8. 1919. Dutch.

Cassava. Field experiments. Cultivars. Productivity. Planting.

Experiments were conducted with several Brazilian varieties to evaluate yield. Lower yielding Aipin Valenca and higher yielding Aipin Mangi were planted in association and alone Aipin Valenca yielded more when planted in association, probably because it is a taller plant type, shading Aipin Mangi Several different planting methods (on the flat, on ridges, with and without hilling) were compared using Aipin Valenca and Mandioca Criolinha; there was no significant difference in yields (*Summary by R. van G*) D03 D02

0136-8031 MONTALDO, A. and MONTILLA, J.J. Production of cassava foliage. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.142-143. Engl., Sum Engl.

Cassava. Foliage. Production. Productivity. Proteins. Venezuela.

Studies were carried out on the production of foliage from cassava for use as protein in animal feed. Best results were obtained with successive cuttings of foliage at 3- to 4-mo intervals with plant densities of 31,250 and 15,625 plants/ha. Production rates obtained were 14.5 tons/ha dry foliage in 12 mo during the dry season, 19.6 tons in 12 mo during the rainy season and 35.2 tons in 17 mo during the rainy season. The protein content of the material (stems, branches and leaves) varied from 13.8-22.3%, with a maximum protein yield of 2.7 tons/ha/yr. (*Author's summary*) D03

0137-7541 SHANMUGAN, A. and THAMBURAJ, S. Effect of planting systems on the yield of four tapioca clones (*Manihot esculenta* Crantz). South Indian Horticulture 23(1) 62-63 1975. Engl., 4 Refs.

Cassava. Field experiments. Cultivars. Productivity. Cultivation. Planting. India.

In order to determine the best planting system (measured in terms of yield) for cassava under the conditions at Tamil Nadu, replicated trials were conducted using 4 clones: M E. 3. 4. 7 and 14 Methods studied were hilling, planting on the flat and ridges. Significantly greater yields were obtained when planting on ridges: 6.2-13 6% higher than for hilling and 7.2-44 4% higher than for on the flat. The same tendency was noted for the averages of the 4 clones. The beneficial effect was attributed to efficient drainage during the rainy season, which was advantageous for swollen root development. (*Summary by A.J. Trans. by T.M.*) D03

0138-8214 TSAI, C.I. [District yield trials of new cassava strains]. *In* Taiwan. Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 17, 1975. Taipei, 1976. pp.49-50. Chin., Sum. Engl.

Cassava. Field experiments. Cultivars. Tuber productivity. Taiwan.

Experiments were conducted with 7 new cassava varieties. All except Ubiputeh were generally higher in root yield than the check. N58-30 produced 31,792 kg/ha, which was 25.1~28.2% higher than the check. N58-24 was next with 30,500 kg; and N58-27 was 3rd with 29,833 kg/ha. (*Author's summary*) D03

0139-8206 TSAI, C.I. and LIN, Y P. [Yield trials of introduced cassava varieties]. *In* Taiwan Department of Agriculture and Forestry. Annual Report of Dryland Food Crops Improvement Series no. 15, 1973 Taipei, 1974. pp.48-49. Chin., Sum. Engl.

Cassava. Field experiments. Cultivars. Tuber productivity. Plant height. Taiwan.

In yield trials evaluating introduced cassava varieties, plant height varied greatly. Spiragununga was the tallest (292.3 cm), Turoi-V the 2nd, (286.8 cm), Chirqui the 3rd (286.1 cm) and Native-Red (check) the shortest (265.5 cm). Statistical analysis indicated no significant differences in root yield among the 4 introduced varieties and the check varieties (both ck_1 and ck_2); however, Chiriqui produced 29.4 and 10.2% more roots and Blacktwig, 20.0 and 2 4% more than Native-Red (ck_1) and Native-Green (ck_2), respectively. As regards dried chips, Blacktwig and Chinqui were 21.5 and 36 3% higher than ck_1 and 2.1 and 14.5% higher than ck_2, respectively. (*Author's summary*) D03 C01

0140-8028 WAHAB, A H. **Characteristics of indigenous and introduced cultivars of cassava in Guyana.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.131-136. Engl, Sum. Engl., 3 Refs.

Cassava. Cultivars. Tuber productivity. Field experiments. Experiment design. Soil analysis. Germination. Plant height. Timing. Guyana.

A 12-mo yield trial was conducted to assess the performance of 12 cassava varieties on Guyana's poor peats and peaty soils. On the peats, the high-yielding varieties (M Mex 59, M Mex 23, Del Pais and M Col 673) gave fresh yields of 30.5, 19.3, 19.3 and 18.2 tons/ha, respectively. On the peaty clays, high-yielding varieties were M Mex 59, Uncle Mack, Del Pais and M Mex 23, with 23.1, 22.1, 20.0 and 17.6 tons/ha, respectively. Plant height and shoot and branching patterns were not related to yield, but harvest index was correlated with yield on both soils. Useful matter (ratio of peeled/unpeeled root) was not significantly different among varieties on either soil. (*Author's summary*) D03 C01

0141-6423 WILSON, G.L. **Cassava (*Manihot esculenta*).** Tropical Grassland 10(3):232-233. 1976. Engl.

Cassava. Cultivars. Tuber productivity. Productivity. Australia.

In response to the increasing demand for inexpensive and reliable sources of carbohydrates, the University of Queensland is studying agronomic and nutritional factors of cassava production. Results are given for trials evaluating the yield of several accessions at Redland Bay and Wipa. (*Summary by T.M.*) D03

See also 0010 0045 0074 0077 0078 0083 0085 0086 0089 0094 0095 0097 0098 0099 0100 0102 0104 0107 0108 0109 0117 0122 0430

E01 General Descriptive Studies

0142-8035 LOZANO, J.C and TERRY, E R. **Cassava diseases and their control.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.156-160. Engl., Sum. Engl , 26 Refs

Cassava. Disease control. Cuttings. Foliage. Stems. Roots.

For purposes of control, cassava pathogens are classified as (a) those that attack vegetative propagating material, (b) those that attack foliage and green stem portions, and (c) root rot pathogens that can induce pre- and postharvest deterioration Control measures for each of these categories are discussed; these measures should, however, be applied as part of an integrated system for any cassava cultivation program. (*Author's summary*) E01

0143-5300 LOZANO, J.C. and SCHOONHOVEN, A. VAN **Danger of dissemination of diseases and pests through the introduction of material for propagation of cassava.** *In* Nestel, B. and MacIntyre, R , eds. The international exchange and testing of cassava germ plasm; proceedings of an interdisciplinary workshop Palmira, Colombia, 1975. Ottawa, Canada, International Development Research Centre, 1975. pp 41-44. Engl

Cassava. Disease control. Viroses. Mycoplasmoses. Bacterioses. Insect control. Cuttings.

This article presents general considerations on the danger of disseminating cassava diseases and pests through the introduction of planting material (cuttings and seeds). It was concluded that (1) severe quarantine restrictions should be established; (2) the potential damage that pests and diseases can cause to the crop is unknown, and (3) cassava cuttings require careful selection and treatment for experimental or commercial use. Quarantine measures that should be taken for cassava are specified. All cassava growers and scientists should make a careful selection of the fields and individual plants from which cuttings or true seed will be obtained. They should disinfect and sterilize all tools and packings and treat all the material chemically or physically before planting; and finally, they should handle cuttings with extreme care. (*Summary by A.J. Trans. by S.S. de S.*) E01 F01

0144-7448 LOZANO, J. C. and TERRY, E. R. Enfermedades de la yuca y su control. *(Diseases of cassava and their control). In* . Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp.16-30. Span., 27 Refs.

Cassava. *Manihot esculenta*. Bacterioses. Mycoses. Viroses. Mycoplasmosis. Disease control. Tubers. Deterioration. Colombia.

Cassava is attacked by more than 30 bacterial, fungal, viral, viruslike and mycoplasmal agents. In this manual the diseases are classified in 3 categories. (1) Pathogens attacking vegetative propagation material are principally fungi that are concentrated in the epidermal, cortical and lignified tissues (*Sphaceloma manihoticola, Gloeosporium* sp.) and saprophytes or facultative parasites commonly found in the soil (*Rosellinia necatrix, Fusarium* spp., *Sclerotinia* sp, *Aspergillus* spp., etc.). Some bacteria (*Xanthomonas manihotis*), mycoplasma and viral or virusilke agents also attack planting material. Preventive measures include the careful selection of propagation material, avoiding damage to said material and adequate selection and preparation of the soil. (2) Among those pathogens attacking the leaves and green parts of the stem are found many fungi (*Cercospora* spp, *Phoma* sp., *Oidium* sp, etc.) bacteria, mycoplasma and viral or viruslike agents. Many are endemic and the severity of the attack is related to susceptibility of the cultivar and climatic conditions. Control measures include the use of resistant varieties and disease-free planting material, roguing of diseased plants, suitable cultural practices (planting dates and density, leaf area index). (3) As regards root rots, preharvest deterioration is the result of soil pathogens and postharvest rot is a combination of pathological and/or physiological factors. Roots should be left in the ground until used, resistant cultivars should be used, only sound roots showed be stored; surface sterilants, fungicides, refrigeration and paraffin or storage clamps using moist sawdust or straw and soil can be used to retard deterioration *(Summary by S S. de S. Trans. by T.M.)* E01

0145-7447 LOZANO, J. C. Enfermedades importantes de la yuca. *(Important diseases of cassava). In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 1-15. Span.

Cassava. Disease control. *Xanthomonas manihotis.* Cassava common mosaic virus. Cassava vein mosaic virus. Cassava superelongation. *Sphaceloma manihoticola. Cercospora henningsii Cercospora caribaea* Mycoses. *Oidium.* Identification. Colombia.

A description is given of some diseases that attack cassava, and some control measures are given. Diseases dealt with are bacterial blight, bacterial stem rot, African mosaic, common mosaic, leaf vein mosaic, witches'-broom, brown leaf spot, blight leaf spot, white leaf spot, concentric-ring leaf spot, superelongation, cassava ash, anthracnose, rust, infected propagating material, pre- and postharvest root rots. A key for identifying said diseases is included. *(Summary by S S. de S Trans. by T.M.)* E01

See also 0067 0068

E02 Bacterioses

0146-2477 ARAGAO, H. DE B. **Pesquizas sobre** *Phytomonas français.* [*Research on Xanthomonas manihotis (Phytomonas français)*]. Memorias do Instituto Oswaldo Cruz 25)4):299-302 1931. Port.

Cassava. *Xanthomonas manihotis.* **Disease transmission.** *Manihot esculenta*

Different culture media were tested for *Xanthomonas manihotis* (*Phytomonas français*), a flagellate found in the latex of *Manihot esculenta* (*M. palmata*) Novy and MacNeal's, Noeller's and the classical N.N.N. media were evaluated, all of which are based on horse blood. Human blood gave the best results. Plant-to-plant inoculation procedures were tried, using latex or grafts from infected plants. This last method gave positive results. (*Summary by A L. Trans. by I.B.Z.*) E02

0147-8041 LEU, L. S. **Cassava bacterial blight in Taiwan.** *In* Symposium of the International Society for Tropical Root Crops, 4th, Cali, Colombia, 1976 Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.175-179. Engl., Sum. Engl., 10 Refs, Illus.

Cassava. *Xanthomonas manihotis.* **Laboratory experiments. Cultivars. Resistance. Field experiments. Disease control. Taiwan.**

Bacterial blight, the most important cassava disease in Taiwan, was probably present before 1945. The disease is systemic in nature and transmitted primarily by cuttings and secondarily by wind-borne water. Angular leaf spots, wilting, defoliation, gum exudates on leaf lobes, stipules and stems, and death of plants are caused by the vascular-invading bacterium *Xanthomonas manihotis* which confines itself to the genus *Manihotis* and shows poor survival ability in the soil. The disease was induced by using bacterial suspension, dipping of healthy cuttings, injecting into young stems, spraying of whole plants, cutting leaves of young plants with contaminated scissors, and pouring into injured roots of young plants (*Author's summary*) E02

0148-8043 OBIGBESAN, G. O. and MATULUKU, E. O. **Effect of potassium and bacterial blight on the yield and chemical composition of cassava cultivars.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.185-188. Engl, Sum. Engl., 15 Refs.

Cassava. Cultivars. Resistance. *Xanthomonas manihotis.* **Tuber productivity. Field experiments. Fertilizers. K. Tubers. Starch content. Leaves. Mineral content. Analysis. Nigeria.**

Studies on cassava cultivars having different levels of susceptibility to bacterial blight caused by *Xanthomonas manihotis* revealed that the infection exerted differential influence on the mineral nutrient and starch contents of the cultivars The disease caused a reduction in macronutrient content, led to a higher accumulation of micronutrients in the diseased leaves, and affected root quality adversely by lowering the percentage of starch content. Despite the relatively greater tolerance of cv. 60506, CBB reduced its root and starch yields significantly. (*Author's summary*) E02

0149-7527 TAKATSU, A and LOZANO, J.C. **Translocación del agente causal del añublo bacterial de la yuca** (*Manihot esculenta* Crantz) **en los tejidos del hospedero.** (*Translocation of the causal agent of cassava bacterial blight in host tissues*). Fitopatología (Peru) 10(1).13-22 1975. Span., Sum Engl. Span, 14 Refs, Illus.

Cassava. *Manihot esculenta. Xanthomonas manihotis.* **Plant physiology. Plant tissues. Colombia.**

Studies on the translocation of the causal agent of cassava bacterial blight (considered to be a biotype of *Xanthomonas manihotis*) within the host tissues showed that this pathogen moves mainly through the xylem tissue The primary stem symptoms appear on the green portion of the stem, but their appearance depends on varietal susceptibility and the water content of the soil Spray inoculations gave even infection; this method appears to be useful for screening for resistant varieties A new shoot-rooting method, which shortens the rooting period as compared with other reported methods, was devised; and no failures to root occur (*Author's summary*) E02

0150-8042 TERRY, E. R Factors affecting the incidence of cassava bacterial blight in Africa. *In* Symposium of the International Society of Tropical Root Crops. 4th, Cali, Colombia. 1976 Proceedings. Ottawa, Canada, International Development Research Centre. 1977 pp.179-184. Engl., Sum Engl, 13 Refs., Illus.

Cassava. *Xanthomonas manihotis.* **Field experiments. Laboratory experiments. Africa.**

Cassava bacterial blight (*Xanthomonas manihotis*) is a widespread and damaging disease in Africa Its severity varies with locality and climatic conditions Factors that may affect its severity are soil type, climate, cultural practices and varietal susceptibility. The distribution and economic importance of CBB in Africa and the results of epidemiological studies are included (*Author's summary*) E02

0151-4340 TERRY, E.R **Fear of cassava bacterial blight in Africa makes control imperative.** World Crops and Livestock 29(3):107-108. 1977. Engl, Sum. Engl., 8 Refs., Illus.

Cassava. *Manihot esculenta. Xanthomonas manihotis.* **Etiology. Epidemiology. Disease control. Maps. Cameroon. Nigeria. Zaire.**

The present state of knowledge on cassava bacterial blight is reviewed. Attention is paid to etiology and symptomatology, geographic distribution, epidemiology and control. (*Summary by Abstracts on Tropical Agriculture*) E02

See also 0156 0211

E03 Mycoses

0152-8175 CHEN, C T and CHANG, H S. **Cassava, a new natural host of** *Periconia manihoticola* Plant Disease Reporter 60(12) 1083-1084 1976 Engl., 4 Refs., Illus

Cassava. *Manihot esculenta*. **Mycoses.** *Periconia manihoticola*. **Leaves. Taiwan.**

A disease of cassava, characterized by severe leaf spotting and caused by *Periconia manihoticola*, was found in Taiwan in Oct 1975. (*Summary by Abstracts on Tropical Agriculture*) E03

0153-3042 CHEVAUGEON, J **Les maladies cryptogamiques du manioc en Afrique Occidentale.** (*Fungal diseases of cassava in Western Africa*). Encyclopédie Mycologique. Paris, Paul Lechevalier, 1956. v.27, 205p. Fr., 143 Refs., Illus.

Cassava. Mycoses. *Cercospora caribaea Cercospora henningsii. Glomerilla cingulata* **Cultivars. Resistance. Africa.**

Because of the importance of cassava as a food and the lack of detailed information on fungi that attack cassava, an inventory was made of fungi in western Africa, they were described, and conditions favoring their development were studied Sixteen new species were found Morphological, biometric and biological data are included for all species Pathogenic studies made it possible to observe the damage caused by parasites in association and separately The role of oxalic acid produced by *Cercospora caribaea* was shown, as well as the disease symptoms caused by fungi, such as necrosis of leaf tips, leaf spots and various types of root rot The most important ecological factors in pathogenic development were determined, as well as the influence of host susceptibility. In the cassava varieties tested, differences in susceptibility were found, but none was immune The effect of physical factors on the development and polymorphisim of certain fungi was also studied The organic and mineral nutrition of 3 important parasites of cassava was compared to that of saprophytes *Glomerella cingulata* is one of the most harmful fungi and the most adaptable one; it requires only abundant oxygen at the moment of spore germination. Temperature determines the areas of distribution of *C. henningsii* and *C caribaea;* and if the moisture requirements of *C henningsii* are satisfied, it can invade all cassava plantations in western Africa. The influence of climate, soil, light and nutrition (oxygen, nitrogen, mineral) is discussed at length A detailed analysis is made of the form and conditions of germination, spore production and transmission of infection of the aforementioned fungi, as well as their distribution in western Africa and the Ivory Coast. (*Summary by S.S de S. Trans. by T.M.*) E03

0154-7467 CHEVAUGEON, J **Sur la repartition de deux Cercospora parasites des feuilles du manioc dans la région d'Abidjan.** (*The distribution of two Cercospora fungi attacking*

cassava leaves in the Abidjan region). *In* Conference Internationale d'Africanistes de l'Ouest, 5, Abidjan, Ivory Coast, 1953. Compte Rendu. p.47. Fr.

Cassava. *Cercospora henningsii. Cercospora caribaea* **Ivory Coast.**

During the dry season, temperature is not a limiting factor on the index of infection of *Cercospora henningsii* and *C. caribaea* in Abidjan There is, however, a close relationship between this index and the av RH *C. caribaea* appears above 60% RH, becoming abundant at 70%. *C. henningsii* is active up to 78% RH. (*Summary by I.B.Z.*) E03

0155-3856 COURSEY, D.G. and BOOTH, R. H. **The post-harvest phytopathology of perishable tropical produce.** Review of Plant Pathology 51:751-765. 1972. Engl , 121 Refs.

Cassava. Fresh products. Deterioration. Mycoses. Bacterioses.

Factors reducing the quantity and quality of tropical perishable products (tubers, vegetables and fruits) are discussed, with emphasis on postharvest phytopathological problems and possible solutions. Although there are physiological, mechanical and pathological factors, the heaviest postharvest losses are caused by microorganisms (fungi, bacteria and, to a lesser extent, viruses) Most progress in postharvest pathology has been made in the fruit export industry; little information is available on postharvest deterioration of tropical tubers and vegetables. The use of chemical products has not been studied to any extent, research to develop varietal resistance and on product handling is recommended. A list is given of postharvest diseases; pathogens attacking cassava include *Rhizopus* sp., *Bacillus* spp. and *Fomes* sp. *(Summary by A.J. Trans by T.M.)* E03

0156-8355 DIAZ, R O. and LOZANO, J.C. **Enfermedades presentes en el cultivo de la yuca en Colombia.** (*Diseases found on cassava in Colombia*). *In* Díaz, R O. and Pinstrup-Andersen, P., eds. Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977 14p. Span., Sum Engl., Span., 5 Refs

Cassava. *Cercospora henningsii. Cercospora caribaea. Uromyces manihotis. Sphaceloma manihoticola. Xanthomonas manihotis. Phoma. Oidium.* **Colombia.**

The diseases caused by *Cercospora* spp. and *Oidium manihotis* were found widely distributed in all the samples. Rust (*Uromyces manihotis*), frog skin root disease and stem cankers (unknown causal agents) were restricted to certain areas of Colombia. Superelongation (*Sphaceloma manihoticola*) and bacterial blight (*Xanthomonas manihotis*) were found in several zones; Phoma leaf spot [*Phoma (Phyllosticta)* sp.] was restricted to crops located at 1200 m above sea level, where temperatures are below 20°C during the rainy season. Actual losses caused by bacterial blight, Phoma leaf spot and frog skin root disease were estimated. (*Author's summary*) E03 E02

0157-8413 LARIOS, J. and MORENO, R. A. **Algunas características del hongo que causa la roña de yuca** (*Manihot esculenta* **Crantz) en Costa Rica.** (*Some characteristics of the fungus causing superelongation of cassava*). Fitopatologia 12(1).1-5. 1977. Span., Sum. Engl., Span., 14 Refs , Illus.

Cassava. *Manihot esculenta. Sphaceloma manihoticola.* **Laboratory experiments. Isolation. Culture media. Cultivars. Resistance. Costa Rica.**

The morphological characteristics of the fungus causing superelongation of cassava in Costa Rica (*Sphaceloma* sp.) were similar to those described elsewhere. Culture media prepared with cassava leaves-dextrose, potato dextrose, and Czapeck supported good growth. Colonies had a specific color according to the medium on which they developed. Optimum growth temperature was between 25-29°C, and highest dry wt accumulation occurred at a pH of 5. Under artificial illumination, adequate colony development was obtained at 475-700 nm. Under natural conditions, 80% of the cassava cultivars in the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) collection, all of local origin, were resistant. (*Author's summary*) E03

0158-8176 LARIOS, J.F. and MORENO M., R.A. **Epidemiología de algunas enfermedades foliares de la yuca en diferentes sistemas de cultivo. I. Mildiu polvoso y roña.** (*Epidemiology of some foliar diseases of cassava in different cropping systems. I. Cassava ash and superelongation*). Turrialba 26(4):389-398. 1976. Span., Sum. Engl., 22 Refs., Illus.

Cassava. *Oidium manihotis. Sphaceloma.* Cassava superelongation. Inter-cropping. Leaves. Epidemiology. Field experiments. Sweet-potatoes. Maize. Beans. Costa Rica.

Results are given of field experiments in Costa Rica studying the epidemiology of cassava ash (*Oidium manihotis*) and superelongation (*Sphaceloma sp.*), as affected by planting system (cassava alone; associated with sweet potatoes, beans or maize; associated with maize and beans). Data were correlated with 18 agroclimatic variables, and 6 mathematical functions were studied through regression analysis Maximum incidence and severity of each disease were also compared There were differences in progress curves among treatments, indicating that cropping systems affected disease development. Rainfall, RH, temperature and crop age were closely related to the development of cassava ash; superelongation, however, was not significantly correlated. (*Summary by T.M.*) E03

0159-7005 SCHMIDT, H.L. **Uber Vorkommen und Haufigkeit von hohen Pilzkeimgehalten sowie einzelner Pilzarten in Futtermitteln.** (*Occurrence and frequency of high fungal numbers and single species of fungi in feedstuffs*). Landwirtschaftliche Forschung 28(3). 224-234. 1975. Germ , Sum Germ., Engl., Fr., 8 Refs., Illus.

Cassava. Processed products. Mycosis.

The occurrence of high plate counts of fungi from feedstuffs of southwestern Germany was examined in a large no. of samples to obtain detailed information about the regularity of fungal infection and for better quality control. Of 1278 samples, the portion of specimens with high no. of bacteria (>10 Mill/g) and fungi (>100 T/g) was larger in cereals and maize products (37.6 and 47.8%) than in mixed feeds for pigs and poultry (28.6 and 33.6%). In this microbiological significant group of samples the portion of specimens with high fungal numbers reached 70 to 91%. The seasonal distribution of samples with fungal numbers in cereals and in maize showed marked peaks in fall and in spring. In the samples of cereal containing mixed feed this distribution was so similar, that of a close relationship between the germ counts of cereal products and those of mixed feed must be spoken. This relationship is confirmed by common microfloristic features. A comparison between the occurrence of some species of storage fungi (*Aspergillus flavus, Aspergillus niger, Aspergillus candidus, Penicillium rubrum*) within cereal and cassava samples allowed more subtle demarcation of the spoilage fungi characteristical of each sort of feed. It was found, that simultaneous occurrence of *A. candidus* and *P. rubrum* is only frequent in moldy cereals. This association is of interest too, when cereals containing mixed feeds are microbiologically examined, because it indicates the quality of the added grain. (*Author's summary*) E03

See also 0211

E04 Viroses

0160-7663 ALAGIANAGALINGAM, M N and RAMAKRISHNAN, K **Studies on a virus disease of cassava (*Manihot esculenta*) Crantz). III. Respiration and enzyme activity.** Auara 4/5. 95-100. 1972-73 Engl. Sum Engl. 11 Refs.

Cassava. Cassava mosaic virus. Plant respiration. Enzymes. Analysis. Timing. India.

Cassava mosaic virus-infected cassava leaves respired at a faster rate throughout the day as compared to healthy leaves. There were also significant differences in activity of catalase, peroxidase and ascorbic acid oxidase between healthy and diseased leaves *(Author's summary)* E04 C00

0161-8036 BOCK, K. R., GUTHRIE, E. J. and SEIF, A A. **Field control of cassava mosaic in Coast Province, Kenya.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Ottawa, Canada, International Development Research Centre, 1977. pp.160-163. Engl, Sum Engl., 1 Ref.

Cassava. Cassava mosaic virus. Field experiments. Disease control. Productivity. Kenya.

A series of observational trials to study the epidemiology of cassava mosaic in the field were undertaken at the Coast Agricultural Station, Mtwapa from 1973-76, using a moderately tolerant cultivar (46106/27) and a highly susceptible one (F279). Results indicate that control of mosaic in the field in coastal districts of Kenya is possible by using mosaic-free planting material, roguing infected plants, and allowing a reasonable degree of isolation of clean plots from infected ones Under the prevailing climatic conditions, the use of infected cuttings causes more damage than the whitefly vector. Yield losses due to mosaic in cv. 46106/27 and cv F279 were 70 and 86%, respectively (*Author's summary*) E04

0162-7926 BOCK, K R. and GUTHRIE, E.J. **Recent advances in research on cassava viruses in East Africa.** *In* African Cassava Mosaic, Muguga, Kenya, 1976. Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.11-16. Engl., Sum. Engl., 1 Ref., Illus.

Cassava. Cassava African mosaic virus. Cassava brown streak virus. Cassava mosaic virus. Epidemiology. Identification. Kenya.

Two serologically related but distinct viruses were isolated from cassava infected with brown streak and with mosaic. The preliminary working hypothesis is that one is cassava brown streak and the other mosaic virus; this must be verified by reinoculation to cassava. (*Author's summary*) E04

0163-8283 BOCK, K. R., GUTHRIE, E. J. and MEREDITH, G. **RNA and protein components of maize streak and cassava latent viruses.** Annals of Applied Biology 85(2):305-308. 1977. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Viroses. Laboratory experiments.

Polyacrylamide gel electrophoresis indicated that maize streak (MSV) and cassava latent (CLV) viruses each contain one species of protein and 2 of RNA. The estimated protein mol wt is 28000 for MSV and 34000 for CLV. The mol wt obtained for the 2 RNA species using formamide-containing gels were the same for the 2 viruses: 1.7×10^6 and 1.3×10^6. It is suggested that the viruses have a 2-part genome and that the tendency of their nucleoprotein particles to form pairs favors the delivery of complete genomes to infection sites. (*Author's summary*) E04

0164-8074 GAMBORG, O.L. and KARTHA, K.K. **In vitro techniques in the control of cassava mosaic disease.** *In* African Cassava Mosaic, Muguga, Kenya, 1976. Report of an Interdisciplinary Workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.30-35. Engl., 21 Refs., Illus.

Cassava. Cassava African mosaic virus. Cassava mosaic virus. Mosaic disease. Disease control. Tissue culture. Propagation. Laboratory experiments. Plant breeding.

Cassava mosaic disease causes substantial losses in yields of cassava, particularly in Africa. In vitro techniques can be employed to supplement conventional procedures for combating disease problems. An efficient meristem culture method has been developed for obtaining plants free from cassava mosaic disease symptoms and can be utilized in the production of disease-free planting stock. (*Author's summary*) E04

0165-8101 LUISONI, E. *et al.* **Screening and quarantine of cassava from East Africa.** *In* African Cassava Mosaic, Muguga, Kenya, 1976. Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.27-29. Engl., 8 Refs., Illus.

Cassava. Cassava African mosaic virus. Disease control. Laboratory experiments.

This paper describes work carried out in Guinea and Italy on the control of African cassava mosaic. A total of 248 cuttings from 10 Kenyan and 4 Tanzanian varieties, as well as several cuttings from Guinea were screened. Plants were kept in insect-proof, temperature-controlled glass and screenhouses. Healthy cassava plants were screened against naturally ocurring local viruses in 3 locations. Ground leaves were checked for the presence of sap-transmissible viruses in either a suspension of alumina and Celite or 0.02 *M* phosphate buffer at pH 7 containing 0.005 *M* DIECA and Nathioglycollate and 0.001 *M* EDTA. The extracts were inoculated in test plants and tested by electron microscopy of thin sections using standard techniques and by negative staining. Plants grown in screenhouses grew better than those in glasshouses and in the field. Tobacco mosaic virus was present in cassava but did not induce symptoms. No definite results were obtained on natural transmission of viruses or causes of cassava mosaic. As a result of this work, a no. of cassava varieties introduced from East Africa by the Institute Nazionale Piante da Legno were found virus free, multiplied and sent to Guinea. (*Summary by I.B.Z.*) E04

0166-7818 NARASIMHAN, V. and ARJUNAN, G. Effect of mosaic disease on cassava. Salem, Tamil Nadu, India, Tapioca Research Station, 1974. 10p. Engl., Sum. Engl., 10 Refs.

Cassava. Cassava mosaic virus. Field experiments. Plant development. Leaves. Stems. Tubers. India.

Cassava mosaic virus is very serious in Tamil Nadu State (India), with 2.6-78.2% infection in the area The 2 local varieties Burma and Malabar showed typical mosaic symptoms, however, many roots had longitudinal, discontinuous splits with deep horizontal constrictions and starch content was low This is the 1st time this symptom has been observed It was found that when planting mosaic-infected cuttings, maximum yield reduction (80 8%) and root splitting occurred, however, when using healthy cuttings, yield reduction was less (19.3%) and no root splitting was observed. This shows the importance of using disease-free planting material (*Author's summary*) E04 C01

0167-7465 PETERSON, J.F. **Cassava mosaic study; progress reports Nos. 3 and 4, Jan.-Nov., 1974.** Ste. Anne de Bellevue, Canada, Macdonald Campus of McGill University, 1974. 17p. Engl., Illus.

Cassava. Cassava programs. Cassava mosaic virus. Disease transmission. Vectors. Laboratory experiments.

Results are given of transmission studies, characterization and control measures for cassava mosaic virus. Mechanical, dodder, graft and insect transmissions were studied. Most promising preliminary results for an indicator host were obtained with *Nicotiana clevelandi*, which showed symptoms after manual inoculation with a crude extract of infected cassava leaves. Characterization studies were based on purification, nucleic acid extraction and electron microscopy. Growing infected plants at high temperatures (39°C day, 35° night) for 5 wk failed to eliminate the virus. Further purification trials are being conducted with *N. clevelandii*. (*Summary by T.M.*) E04

0168-8102 PETERSON, J.F. and YANG, A. F. **Characterization studies of cassava mosaic agents.** *In* African Cassava Mosaic, Muguga, Kenya, 1976. Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.17-26. Engl., Sum. Engl., 15 Refs , Illus.

Cassava. Cassava African mosaic virus. Cassava mosaic virus. Identification. Laboratory experiments.

Attempts to identify the agent(s) involved in the infection of Nigerian cassava clones have not been successful. Since signs of infectivity were obtained on *Nicotiana clevelandii*, further studies will be conducted with methods used by Bock and Guthrie. Electron microscope investigations will also be continued as some of the particles encountered occasionally, which may or may not be the virus, have not been observed in cassava by other investigators. Although the symptoms are typical of those associated with cassava mosaic, it is possible that there are a mixture of agents, some of which are latent. (*Author's summary*) E04

0169-6964 ROGER, L. and MALLAMAIRE, A. Notes de phytopathologie africaine: mosaïque du manioc. *(Notes on African phytopathology: cassava mosaic disease).* Annales Agricoles de L'Afrique Occidentale Française et Etrangère 1:203-207. 1937. Fr., 8 Refs., Illus

Cassava. *Manihot esculenta Manihot glaziovii.* Cassava mosaic virus. Vectors. Virus transmission. *Bemisia.* Cultivars. Resistance. Africa.

A brief report is given on African mosaic and its effects on yields of cassava and Ceará rubber (*Manihot glaziovii*). It spread from the Ivory Coast to other parts of Africa through the use of infected cuttings The insect vector in the Congo has been identified as *Bemisia gossypiperda*, in Nigeria as *B. nigeriensis* and in the Ivory Coast as *Bemisia* sp. The varieties Calabar II and Sareso are resistant to the disease in the Ivory Coast. The disease can be transmitted directly from plant to plant and through cuttings, and indirectly by inoculation in the laboratory. (*Summary by S.S. de S. Trans. by T.M.*) E04 F01

0170-6811 TERRY, E. R. **Description and evaluation of cassava mosaic disease in Africa.** *In* Terry, E.R. and Mac Intyre, R., eds. The International Exchange and Testing of Cassava Germ Plasm in Africa; proceedings of an interdisciplinary workshop, Ibadan, Nigeria, 1975. Ottawa, Canada, International Development Research Centre, 1976. pp. 53-54 Engl., Illus.

Cassava. Mosaic diseases. Identification. Africa.

A description is given of the symptoms of cassava mosaic on the basis of a tentative rating scale used to evaluate the severity of the disease and plant reaction. The scale consists of 5 classes: class 1 shows no symptoms and is considered as representative of field resistance, whereas class 5 exhibits the most severe mosaic symptoms These 5 degrees are illustrated by means of photographs. (*Summary by A.J. Trans. by S S. de S.*) E04

0171-8068 TERRY, E.R. and JENNINGS, D.L. **Symptomatology of cassava mosaic disease and a proposal for further study to categorize the variants.** *In* African Cassava Mosaic, Muguga, Kenya, 1976 Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre 1976. pp.36-38. Engl., 3 Refs , Illus.

Cassava. Mosaic diseases. Disease transmission. Viroses. Identification. Cassava African mosaic virus.

Differences in the symptomatology of the cassava mosaic disease complex have been observed. The occurrence of symptoms such as bushy dwarfism and veinal chlorosis on plants where typical cassava mosaic symptoms were absent or mild has raised questions as to their causal agent. Since there are no techniques for differentiating the causal agent(s), the following methodology is proposed: visual identification and categorization of variants, transmission of agents by grafting to 2 or more cassava varieties, sap transmission to noncassava indicators, and serial transfer by *Bemisia tabaci* to hosts of differing resistance. Symptomatology would then be studied under controlled environmental conditions in a 2nd location. (*Summary by T.M.*) E04

See also 0016 0203 0211 0212

E05 Nematodes

0172-8264 BRATHWAITE, C.W.D. **Preliminary studies on plant parasitic nematodes associated with selected root crops at the University of West Indies.** Plant Disease Reporter 56(12): 1077-1079. 1972. Engl., Sum. Engl., 8 Refs.

Cassava. Nematodes. Trinidad and Tobago.

A preliminary survey of nematodes associated with taro (*Colocasia esculenta*), cassava (*Manihot esculenta*), yautia (*Xanthosoma sagittifolium*), sweet potatoes (*Ipomoea batatas*) and yampee (*Dioscorea trifida*), grown at the University of the West Indies, revealed that 9 genera of plant parasitic nematodes were associated with these crops. The root knot nematode *Meloidogyne* sp. and the spiral nematode *Helicotylenchus* sp. were found on all crops. *Tylenchus* sp., *Aphelenchus* sp *Criconemoides* sp. and *Pratylenchus* sp. were also found on cassava, the last one associated with the roots. Their effect on yield has not been determined. (*Summary by T.M.*) E05

F00 PEST CONTROL AND ENTOMOLOGY

0173-8103 BERNAYS, E.A. *et al.* **Food plants in the survival and development of *Zonocerus variegatus* (L.).** Acrida 4(1):33-45. 1974. Engl., Sum. Engl., Fr., 16 Refs., Illus

Cassava. Injurious insects. Entomology. Nigeria.

Vegetation analyses showed that during the period of nymphal development of *Zonocerus variegatus*, the amounts of green vegetation were reduced; and herbs, which initially contributed about 50% of the total vegetation, disappeared almost entirely. Survival of the 1st and 2nd instars was studied on 102 different plant species occurring in the habitat near Ibadan, Nigeria. On only 11 of these, as well as on a mixture of the 5 commonest plants, did more than 50% of the insects survive to the 3rd instar. Nine of the 11 were herbaceous, the others being *Citrus* and *Manihot*. Survival value of 30 plants was tested for the late instars; only 5 herbs and *Manihot* permitted 50% of the insects to survive to adult. Although *Zonocerus* eats a wide range of plants, the woody species are not generally suitable for survival. However, the herbaceous plants which provide suitable food tend to disappear as the dry season and development progress, and the population is forced into the *Manihot* plots by the shortage of food in the adjacent thicket areas (*Author's summary*) F00

0174-3156 HALL, C.J.J. VAN Ziekten en Plagen der Cultuurgewassen in Nederlandsch-Indie in 1918. *(Diseases and pests of crops in the Dutch East Indies in 1918).* Mededelingen van het Laboratorium voor Plantenziekten no. 36:1-49. 1919 Dutch

Cassava. Injurious mites. Injurious insects. Indonesia.

As regards cassava, losses in different regions of the Dutch East Indies were caused by lack of water, waterlogging, mites, rats and white grubs. *(Summary by R. van G.)* F00

0175-8396 KAUFMANN, T. **Observations on aggregation, migration, and feeding habits of *Zonocerus variegatus* in Ghana (Orthoptera: Acrididae).** Annals of the Entomological Society of America 58(4):426-436. 1965. Sum. Engl., 24 Refs., Illus.

Cassava. *Zonocerus variegatus*. Injurious insects. Entomology. Ghana.

Zonocerus variegatus has only one generation/yr in Ghana. Nymphal period and adulthood cover approx. 7 mo. Females mated about 40 days after emergence; spermatozoa were found in males 20 days after emergence. Females produced 2-4 egg pods, averaging 37 eggs/pod. Nymphs roost from evening to next morning, preferably on shrubs with thick, broad leaves. Population density, types of vegetation and microclimatic conditions are important factors for nymphal migration. Nymphs were attracted by moving objects within a very short distance, reacting by

following them. Once migration began, mechanical body contact stimulated the whole migrating crowd; speed of migration was directly proportional to no. of individuals involved. Within a cassava field, no. of individuals/plant depended on density of nymphal population on the ground, which in turn was determined by various microclimatic factors. Pattern of upward movement on tall cassava stems was like that of migration on the ground. Adults were solitary and never migrated in masses. The grasshoppers are polyphagous on various forbs, but certain plants are preferred to others. Maximum feeding activity took place between 25-30°C, during daylight hours only. In dietary experiments cassava, alone or in combination with false rubber (*Funtumia elastica*), gave best results as to body wt, developmental period and adult fecundity and longevity; poorest results were obtained with *Justicia flava*. A diet of Gramineae alone produced sterile females but fertile males. Adults of both sexes reared on such a diet were shorter lived than those reared on forbs. (*Author's summary*) F00

0176-8205 MA, W.C. **Experimental observations of food-adversive responses in larvae of** *Spodoptera exempta* (Wlk.) **(Lepidoptera, Noctuidae).** Bulletin of Entomological Research 66: 87-96. 1976 Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Entomology.

The oligophagy of the African armyworm *Spodoptera exempta* was investigated. Resistance to feeding on cassava, a nonhost plant, declined at a faster rate if the larvae had been reared on an artificial diet. If diet-reared larvae were allowed to feed on maize for increasing periods of time, the subsequent rejection of cassava increased accordingly. This effect could still be induced after removing the labral or palpal sensilla but not after removing both pairs of styloconic sensilla. The left and right pair of styloconic sensilla are supplementary to each other. Insofar as aversive responses to nonhost plants are concerned, the rearing on an artificial diet can be considered as a case of pseudomaxillectomy. It is suggested that during feeding on maize the larva receives a specific input pattern that influences central acceptance-rejection decisions in a time-dependent manner. This specific information is absent from an artificial diet and can no longer be perceived by larvae without styloconic sensilla. (*Author's summary*) F00

0177-8318 MODDER, W.W.D. and SINGH, S.R. **Utilization of cassava,** *Manihot esculenta*, **in the laboratory by the later instars of the African grasshopper,** *Zonocerus variegatus* **(L.) (Acridoidea: Pyrgomorphidae).** Revue de Zoologie et de Botanique Africaines 90(2):417-430. 1976. Engl., Sum. Engl., 20 Refs., Illus.

Cassava. *Manihot esculenta. Zonocerus variegatus.* **Laboratory experiments. Injurious insects. Entomology.**

Solitary *Zonocerus variegatus* were fed on cassava leaves under controlled laboratory conditions that permitted separation of feces and maintenance of leaves in fresh condition for 24 h at a time. Feeding, defecation and wt changes were followed in 5th instars (males) and 6th instars and adults (both sexes) and values calculated for consumption index (CI), approx. digestibility, assimilation and growth rates, as well as efficiencies of conversion of ingested and digested food. Nymphal stages included a variable feeding period and a premolt nonfeeding period of 5-6 days. The similarity in growth rates in the nymphal feeding periods and in the 1st 10 days after adult emergence suggest that the latter is a somatic growth phase. In male adults there was no growth following this phase; in female adults, however, a lower growth rate ensued for about 50 days, and it is possible that this phase includes ovarian development and fat deposition. Plots of CI against liveweight were used to predict maximum attainable wt for males and females. A plot of wt change against CI was used to fix approx. (1) the CI value above which growth rate is constant, (2) the CI value that would just maintain the life of adults, and (3) the rate of adult wt decrease at starvation. The CI values obtained for *Z. variegatus* were lower than for *Schistocerca gregaria* although they were comparable with those for 2 other acridids. (*Author's summary*). F00

0178-5704 PEÑA R., J.E. **Ciclo biológico y crianza masal de la mosca, *Silba pendula* (Bezzi) del cogollo de la yuca, (*Manihot esculenta*).** (*Life cycle and mass rearing of the cassava shoot fly, Silba pendula*). Tesis Ing. Agr. Palmira, Universidad Nacional de Colombia. Facultad de Ciencias Agropecuarias, 1973. 39p. Span., Sum Span , Engl., 8 Refs., Illus

Cassava. *Manihot esculenta. Silba pendula* Entomology. Colombia.

Research was conducted on the cassava shoot fly (*Silba pendula* Bezzi) to define the insect's life cycle, its adaptability to semisynthetic media, and how feeding conversion was affected by different basal diet substrates. The trials were conducted in the laboratories and fields at CIAT and at the Facultad de CienciasAgropecuariasin Palmira, Colombia. The life cycle was completed in an av period of 51.4 days; the incubation period, 4 2 days, the larval period, 20 days; the pupal period, 24.5 days; and the adult period lasted 2 4 days, on the av. A similar correlation was found in the av wt of the pupa maintained on a natural diet (4 64 mg) and on a cassava meal diet with 200 ml of water (4 49 mg). (*Author's summary*) F00

0179-7674 SCHOONHOVEN, A. VAN., PEREZ A., A.M. and PEÑA, J.E. **Influencia de la defoliación artificial en la producción de raíces de yuca y su correlación con el daño causado por *Erinnyis ello* (L).** (*The effect of artificial defoliation on cassava yields and its correlation with damage caused by Erinnyis ello (L.). In* Congreso de la Sociedad de Entomología Colombiana, 2º, Cali, 1974. Memorias. Bogotá, Colciencias, 1974. pp.145-163. Span., 6 Refs.

Cassava Field experiments. *Erinnyis ello.* Cultivars. Leaf area. Timing. Resistance. Tuber productivity. Experiment design. Statistical analysis. Colombia.

In order to measure the effect of artificial defoliation on yields of cassava (*Manihot esculenta* var Llanera and CMC 84) at different ages and to correlate this with damage caused by *Erinnyis ello,* plants were pruned monthly from the 2nd-5th mo and from the 5th-9th mo, with 3 levels of defoliation in plots with plants at a distance of 1 x 1 m. The treatments were (1) no defoliation (t_0), 40% defoliation (t_1), and 80% (t_2). In the 2nd planting (at a distance of 1 x 1 5 m), plants were pruned monthly from the 2nd-9th mo and from the 6th-9th month, with 0, 20 and 40% defoliation (T_0, T_1 and T_2, respectively). The leaf area consumed by the larvae was determined in the laboratory and the greenhouse. CMC 84 underwent no alterations in the total no of leaves produced even at highest levels of defoliation, whereas Llanera had a reduction in no. of leaves at level t_2 during the lst 6 mo, resulting in yield reductions. In the 2nd planting, Llanera had reductions in no. at leaves in T_2 during the lst months, as compared with the control, T_1 and T_2 from the 6th-9th mo. Both trials indicate that Llanera is more susceptible to defoliation than CMC 84, especially with treatment t_2 from 2-6 mo. Based on field data for leaf area consumption/larva (1107 cm^2), CMC 84 required 9.9 and 16 3 larvae/plant for 40 and 80% defoliation, respectively, at 6 mo; whereas in an 8-mo-old crop, it was 13.5 and 25.4 larvae/plant, respectively. For Llanera, 40 and 80% defoliation at 6 mo (pruning from 2nd-6th mo) corresponded to 9.3 and 11.5 larvae/plant, with 13 and 21.4 larvae/plant at 7 and 6 mo (pruning from 5th-9th mo). It was concluded that defoliation did not vary the total no. of leaves produced, which shows that cassava recovers rapidly from the lost leaf area. An 80% defoliation caused yield reductions in Llanera. From 10-20 larvae/plant/mo (20-40% defoliation) will not affect cassava under the conditions of this experiment (highly fertile soils) *(Summary by A.J. Trans. by T.M)* F00 C01

0180-8265 TOYE, S. A. **Notes on the biology of *Zonocerus variegatus* (L.) (Orthoptera, Acridoidea) in the western State of Nigeria.** Revue de Zoologie et de Botanique Africaines 84(3/4):384-392. 1971. Engl., Sum. Engl , 14 Refs., Illus.

Cassava. *Zonocerus variegatus.* Injurious insects. Entomology.

An account is given of field observations on the occurrence, distribution and life history of the 2 distinct generations of *Zonocerus variegatus* that occur annually in the Western State of Nigeria. Laboratory observations show that the species is parasitized by mermithid worms and the dipteran *Blaesoxipha filipjevi* Emphasis is placed on the urgent need for a detailed study of the general biology of the species, including populations dynamics and control, in view of its ever-increasing status in Nigeria as a pest of food and cash crops, including cassava (*Author's summary*) F00

F01 Injurious Insects and their Control

0181-7324 ALBUQUERQUE, M. DE Cochonilha em mandioca na Amazônia. (*Mealybugs on cassava in the Amazon region).* Belém, Empresa Brasileira de Pesquisa Agropecuária, 1976. 10p. Port , Sum. Port., Engl., 2 Refs.

Cassava. Injurious insects. Insect control. *Phenacoccus.* **Brazil.**

A serious attack of mealybugs on cassava occurred at the Centro de Pesquisa Agropecuária do Tropico Umido in Belém (Brazil) in 1975. It was necessary to burn all existing material, including those wild species that were not resistant. The causal agent was *Phenacoccus* sp. (Homoptera: Pseudococcidae), reported for the 1st time in the Amazon region. None of the insecticides used gave 100% control. (*Author's summary. Trans. by T.M.*) F01

0182-8049 ALBUQUERQUE, M. DE. **Mealy bug attack on cassava in Amazonia.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings. Ottawa, Canada, International Development Research Centre, 1977. p.207. Engl., Sum. Engl

Cassava. Injurious insects. *Phenacoccus.* **Insect control. Brazil.**

A severe attack on cassava by a mealybug (*Phenacoccus* sp) occurred in the Amapa Territory (Brazil) for the 1st time in 1975. The insect is described and control measures are recommended (*Author's summary*) F01

0183-8415 BELLOTI, A. and SCHOONHOVEN, A. VAN. **Mite and insect pests of cassava.** Annual Review of Entomology 23:39-67. 1978. Engl., 116 Refs.

Cassava. *Manihot esculenta.* **Injurious mites.** *Mononychellus tanajoa. Tetranychus urticae. Tetranychus cinnabarinus.* **Mite control.** *Erinnyis ello. Bemisia. Eudiplosis brasiliensis. Vatiga manihotae. Anastrepha pickeli. Silba pendula. Lonchaea chalybea. Aonidomytilus albus. Coelosternus granicollis. Coelosternus notaticeps. Coelosternus manihoti. Coelosternus rugicollis. Phenacoccus.* **Injurious insects. Insect control. Pest damage. Entomology.**

Based on a review of all the literature available on mite and insect pests of cassava, the following aspects are discussed amply: host plant, distribution of cassava pests, economic damage due to insects and mites, mites and insects attacking foliage, insects attacking stems and those attacking roots, cuttings and seedlings, dried cassava storage pests. Considerations for a cassava pest management program, as well as the status of cassava entomological research, are dealt with as well (*Summary by T.M.*) F01

0184-8044 BELLOTI, A.C. and SCHOONHOVEN, A. VAN **World distribution, identification, and control of cassava pests.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.188-193. Engl., Sum. Engl.

Cassava. Injurious insects. Injurious mites. Insect control. Pest control. Entomology.

Numerous insect and mite pests have been identified attacking cassava These pests represent a wide range of insect fauna; more than 100 species have been recorded. Although many of these are minor pests and cause little or no economic loss, recent research has shown that several pests can cause crop losses and must be classified as major pests. These include mites, thrips, stemborers, whiteflies, hornworms, scale insects and white grubs. Mites, whiteflies, scales, white grubs, stemborers, ants and termites are distributed worldwide; others are local pests or limited to 1 or 2 continents. Chemical control is uneconomical in many areas where cassava is a low value crop Pesticides are expensive and their continual use is impractical for a long-season crop such as cassava Emphasis should be directed toward the use of resistant varieties, biological control and improved cultural practices. Strict quarantine practices should be enforced to prevent the spread of cassava pests into areas where they are not present. (*Author's summary*) F01

0185-3630 BREUNING, S . and TEOCCHI, P. **Note sur *Hecyra obscurator* F. Coléoptère Cerambycidae Lamunae vivant sur le manioc en Afrique Centrale.** Bulletin de l'Institut Française d'Afrique Noire (Serie A). 36(2):394-402. 1974. Fr., 22 Refs., Illus.

Cassava. *Hecyra obscurator.* Injurious insects. Entomology. Africa.

A brief recount is given of the origins, species and synonymy of the genus *Hecyra*, which has been reported in Africa only. A detailed description is included of the adult insect, the larva and the nymph, geographical distribution and host plants The larva lives in the dead stems of cassava and other euphorbiaceous as well as gramineous plants. (*Summary by I.B.Z.*) F01

0186-5465 CHAZEAU, J. and GUTIERREZ, J. **Evolution des populations de *Tetranychus neocaledonicus* André (Acariens, Tetranychidae) et de trois de ses prédateurs sur manioc dans le sud-ouest de Madagascar.** (*Evolution of Tetranychus neocaledonicus populations and three of its predators on cassava in southwestern Madagascar*). Cahiers O.R S.T.O M Série Biologie no. 25:3-11. 1974. Fr., Sum Fr., Engl , 6 Refs , Illus.

Cassava. *Tetranychus neocaledonicus.* Injurious mites. Biological control. Insect agents. Leaves. Entomology. Malagasy Republic.

A field study was conducted on unsprayed cassava in southwestern Madagascar to study the biological control of the mite *Tetranychus neocaledonicus* by 3 predators *Stethorus madecassus, Amblyseius rotundus* and *A. bibens* Although mites are susceptible to heavy rains, they are always present in the field; and populations increase as soon as conditions are favorable High mite populations, however, do not coincide with those of *S madecassus* and *A. bibens*. On the other hand, *A. rotundus* is found at different heights and times so it exerts little control over the mites in the field, as opposed to laboratory conditions. In any case, the cassava plants were not affected by the mite population levels. (*Author's summary*) F01

0187-8356 DIAZ, R O., BELLOTI, A.C. and SCHOONHOVEN, A. VAN **Descripción de los insectos presentes en el cultivo de la yuca en Colombia.** (*Insects found on cassava in Colombia*). *In* Diaz, R.O. and Pinstrup-Andersen, P., eds. Descripción agroeconómica

del proceso de producción de yuca en Colombia Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 17p. Span., Sum. Engl., Span., 3 Refs., Illus

Cassava. Injurious insects. Injurious mites. Productivity. Colombia.

Approx 20 insect and mite pests were found attacking cassava in several regions of Colombia at different growth stages and seasons of the year. Thrips, gall midges and whiteflies were found in more than 50% of the plantations visited. Pests found at all stages of growth were *Anastrepha* sp. (the cassava fruit fly), *Empoasca* sp., *Vatiga manihotae* (cassava lace bug) and *Oligonychus peruvianus* (mite). High parasitism of cassava hornworm (*Erinnyis ello*) eggs was found. Pests were also restricted to different zones: cutworms were found in the states of Valle del Cauca and Quindío and stemborers in Cauca. Potential yield losses due to thrips were estimated. (*Author's summary*) F01

0188-1708 GALLEGO M., L. **Estudios entomológicos: el gusano de las hojas de la yuca (*Erinnyis ello*).** (*Entomological study on the cassava hornworm*). Revista de la Facultad Nacional de Agronomía (Colombia) 11:84-110. 1950. Span., 22 Refs., Illus.

Cassava. *Erinnyis ello*. Insect control. Biological control. Insect agents. Entomology. Colombia.

The following aspects of the cassava hornworm (*Erinnyis ello*) are dealt with: habits, life cycle, description and control. *E. ello* is specific to cassava, but it also attacks other species such as *Aleurites triloba, Hevea* spp., *Euphorbia heterophyla, Carica papaya, Urtica horrida* and *Gossypium* spp. The frequency of the attack in Colombia varies from one region to another; on the Atlantic Coast outbreaks occur: Dec.-Feb. and June-Aug.; in Tolima and Valle, June-Aug; and in Antioquia and Caldas at any time. A description is given of the 5 larval stages (12-15 days), prepupal (2 days), pupal (10-13 days), adult and egg. The pest can be controlled by chemical, cultural and biological means. Concerning biological control, the following are mentioned; (1) egg parasites (*Telenomus dilophonata* y *Trichogramma minutum*), (2) larva parasites (*Apanteles americanus*), (3) egg predators (*Dolichoderus* sp.) and (4) larva predators (*Polistes canadiensis, P. carnifex* and *P. versicolor*). Other parasites and predators included are *Zenillia* sp., *Zigozenillia* sp and *Betvosia becinta* (parasites) and *Crotophaga* sp., *Turdus ignobiles, Polibonus echerıway, Otus* sp., *Speotyo cunicularia* and *Estrix* sp. (bird predators). (*Summary by A.J. Trans. by I.B.Z.*) F01

0189-8171 GONZALEZ, R.H. **Crop protection in Latin América, with special reference to integrated pest control.** FAO Plant Protection Bulletin 24(3):65-75. 1976. Engl., 25 Refs.

Cassava. Pest control. Latin America.

Agricultural production in Latin America is severely affected by plant pests and diseases, particularly in the tropical and subtropical zones. Several pest and disease problems are discussed, as well as pesticide inputs in agricultural production. Integrated pest control measures are recommended to avoid complete dependence on synthetic pesticides Examples are given of integrated control programs for cotton, citrus, pears and apples; integrated control methods for sorghum, maize, rice, beans, cassava and lucerne are discussed briefly. (*Summary by Abstracts on Tropical Agriculture*) F01

0190-8321 JERATH, M.L. **Note on the biology of *Zonocerus variegatus* (Linnaeus) from eastern Nigeria.** Revue de Zoologie et de Botanique Africaines 72(3/4) 243-251. 1965 Engl., Sum. Engl., 13 Refs

Cassava. Injurious insects. Entomology. Africa.

The biology of *Zonocerus variegatus* was studied both in the field and laboratory at Umudike, eastern Nigeria from 1961-63. In this area, *Z. variegatus* has one generation with 2 broods/yr. Eggs begin to hatch about Aug and continue to do so until Feb. Nymphs are abundant from Nov.-July. Newly emerged adults appear in Jan.-Feb and are common until Oct. One of the hosts is cassava. (*Author's summary*) F01

0191-8045 NYIIRA, Z.M. **Population dynamics of the green cassava mite and its predator** *Oligota*. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.193-197. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. *Mononychellus tanajoa*. Insect agents. Ecology. Entomology. Uganda.

The green cassava mite *Mononychellus tanajoa* Bondar (Acarina: Tetranychidae), also known as the cassava leaf mite, is a fairly new pest in Africa Because of its potential threat to cassava production, studies have been made of its biology, ecology and possible control. Initial infestations of this mite occur in sheltered places along the midribs and veins of cassava leaves. Denser populations are recorded during dry spells The ratio of active mites, eggs, males and females on the apical and basal halves of the leaf are discussed. Cassava plants 3-10 mo old were more heavily infested than the younger and older plants. Some varieties of cassava supported fewer mites, suggesting a degree of resistance. Reduction in no. of mites was associated more with absence of leaves than weather conditions although rain and possibly RH had negative effects on population buildup. The Staphylinidae *Oligota* was the dominant predator, appearing in sufficient no. and at the same time as the green cassava mite. The population fell sharply when the host population started diminishing. The results point out the potential of varietal resistance and biological control as possible effective considerations in the integrated control of *M. tanajoa*. (*Author's summary*) F01

0192-8124 PEÑA, J. *comp.* **Lista de insectos dañinos y benéficos recolectados en cultivo de yuca 1973-1976.** (*List of beneficial and harmful insects found on cassava from 1973-1976*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 5p. Span.

Cassava. Injurious insects. Insect agents. Colombia.

A list is given of harmful and beneficial insects found on cassava in several localities of the states of Valle del Cauca, Huila and Santander and the Llanos Orientales (Colombia) from 1973-1976. Data include the insect order, family and species, as well as the type of damage caused. (*Summary by I.B.Z.*) F01

0193-8047 PILLAI, K. S. **Susceptibility of cassava chips to** *Araeceras fasciculatus*. *In* Symposium of the International Society for Tropical Root Crops, 4th , Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.202-203. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava chips. Resistance. Injurious insects. India.

Studies were made to ascertain the relative susceptibility of cassava chips made from different varieties to *Araeceras fasciculatus*. The test insect was collected from the storage house and cultured in the laboratory on cassava chips. Of the 10 varieties tested, H-226 and H-2304 were the least susceptible. (*Author's summary*) F01

0194-7544 SARADAMMA, K., DALE, D. and DAS, N. M. **Chemical control of the red spider mite, *Tetranychus telarius L. (Tetranychidae).*** Agricultural Research Journal of Kerala 10(2):136-140. 1972. Engl., Sum. Engl., 3 Refs.

Cassava. Injurious mites. Mite control. Acaricides. Laboratory experiments. Field experiments. *Tetranychus telarius.* India.

Eleven newer pesticides were evaluated in the laboratory for their toxicity to red spider mite adult *(Tetranychus telarius)* on cassava. Their performance in the field was also assessed. Carbophenothion, monocrotophos, dimethoate and formothion were very effective against the pest whereas dicofol, elsan, chinomethionate, thiometon, phosphamidon and fenitrothion were ineffective under laboratory and field conditions Parathion was not good in controlling the pest in the field though in laboratory evaluation it ranked high *(Author's summary)* F01

0195-7548 SARADAMMA, K. and DAS, N.M. **Resistance of tapioca varieties to the red spider mite *Tetranychus telarius* Linn.** Agricultural Research Journal of Kerala 12(1):108-110. 1974. Engl., Sum. Hindi, 2 Refs.

Cassava. Cultivars. *Tetranychus urticae.* Resistance. Entomology. Field experiments. India.

The effect of 20 varieties of cassava on the biology and development of the red spider mite *Tetranychus urticae* (= *T. telarius*) was studied. The developmental period was observed; longevity and fecundity of newly emerged adult pairs was ascertained as well. Elavan, H 97, H 226, Kalikalan, Kayyalachady and H 165 were resistant to *T. urticae* (longer development period, shorter longevity and fecundity). Nymphal mortality ranged from 0-75%. Size of adults did not differ significantly. (*Summary by A.J. Trans. by I.B Z.*) F01

0196-8282 TERRY, E.R., SCHAEFERS, G.A. and GARBER, M J. **Preferential feeding and damage to cultivars of Nigerian cassava by the variegated grasshoper (*Zonocerus variegatus*).** Annals of Applied Biology 85(2) 167-173. 1977. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Injurious insects. Pest damage. Defoliation. Cultivars. Field experiments. Nigeria.

Large populations of *Zonocerus variegatus* invaded a cassava crop established during the dry season. Resulting damage was severe, certain cultivars being totally destroyed. The grasshoppers exhibited a statistically significant preference for certain cultivars, the defoliation of which shifted attacks to less preferred ones. On the variety Isunikankiyan, populations increased and persisted even after defoliation, probably due to acceptability of the bark by the grasshoppers. (*Author's summary*) F01

0197-8174 WINDER, J.A. **Ecology and control of *Erinnyis ello* and *E. alope*, important insect pests in the New World.** Pans 22(4):449-466. 1976. Engl., Sum. Engl., 106 Refs. Illus.

Cassava. *Erinnyis ello. Erinnyis alope.* Ecology. Insect control. Insect agents. Insecticides. Entomology.

The sphingid moth *Erinnyis ello* L. is an important pest of cassava and the most serious pest of the rubber tree in the New World; *E alope* Drury is sometimes a serious pest of papaya. Information on known host plants, life cycle, behavior, natural enemies, seasonal abundance and present methods of control is reviewed. Perspectives for improved control of *E ello* (with special reference to rubber plantations in Brazil) through the manipulation of natural enemies, a more

rational use of insecticides and the adoption of certain cultural methods, are discussed (*Author's summary*) F01

0198-8046 YASEEN, M and BENNETT, F.D. Distribution, biology and population dynamics of the green cassava mite in the Neotropics. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp 197-202 Engl., Sum. Engl., 12 Refs.

Cassava. *Mononychellus tanajoa*. Entomology. Insect agents. Insect control. Ecology. Caribbean. Central America. South America.

Investigation on the biology and ecology of the green cassava mite *Mononychellus tanajoa* and its natural enemies, as well as those of other cassava mites, have been conducted in the Neotropics since April 1974 by the Commonwealth Institute of Biological Control, Trinidad. In Trinidad, densities of *M. tanajoa* are closely related to rainfall; dry periods are conducive to the development of high mite populations The age and physiological condition of the host plant also greatly influence mite densities. Mite dispersal is influenced by wind Regular observations on several cassava varieties during 1975 did not indicate any of these to be resistant to mite attack. Predators play a significant role in regulating population densities of the mite. Of the several predators recorded, *Oligota minuta*, the dominant predator, and *Typhlodromalus limonicus* and *T. repax*, 2 important predaceous mites, merit introduction against *M. tanajoa* in Africa. (*Author's summary*) F01

See also *0067* *0068* *0143* *0169*

G00 GENETICS AND PLANT BREEDING

0199-7391 MOH, C.C. **The application of nuclear energy to agriculture; triennial report.** Turrialba, Costa Rica, Tropical Agricultural Research and Training Center, 1975. 68p. Engl., 24 Refs., Illus.

Cassava. *Manihot esculenta.* Plant breeding Mutation. Selection. HCN content. Plant physiology. Metabolism. Biochemistry. Enzymes. Plant physiological processes. Plant development Cultivars. Costa Rica

This report deals with induced mutations in *Manihot esculenta* and *Phaseolus vulgaris.* Emphasis is placed on the development of a plant ideotype that would be successful in a multiple cropping system. The Instituto Interamericano de Ciencias Agrícolas (IICA) has been working with different methods of inducing mutations in cassava The following aspects are discussed in detail: methods of inducing mutations in cassava (irradiation of seeds, cuttings and pollen), selection of early maturity mutant, induction of vigorous erect mutant and breeding for low cyanogenic glucoside content As regards the biochemical and physiological properties of cassava, the photosynthetic metabolism of the cassava leaf, translocations of radioactive carbon after assimilation of $^{14}CO_2$, and the metabolic fate of translocated photosynthetic carbon are dealt with. Based on results obtained to date, future plans for induced mutations and plant improvement are discussed (*Summary by T.M.*) G00

G01 Breeding, Germplasm, Varieties and Clones, Selection

0200-7295 EMPRESA BRASILEIRA DE PESQUISAS AGRONÔMICAS. **Projeto mandioca; roteiro de visitas e informações sôbre os trabalhos experimentais desenvolvidos em Cruz das Almas e outros municipios do Estado da Bahia.** *(Cassava project: reports on experimental work done in Cruz das Almas and elsewhere in the state of Bahia)* Cruz das Almas, Bahia, Brasil, 1975. 14p. Port.

Cassava. Cassava programs. Field experiments. Plant breeding. Germplasm. Clones. Resistance. Productivity. Harvesting. Timing. Fertilizers. Minerals. Experiment design. Brazil.

A report is given of experimental work on cassava done by EMBRAPA in Cruz das Almas and other municipalities in the state of Bahia. Emphasis is placed on plant breeding (open and controlled pollination) Several trials using a randomized block design were also conducted to select high-yielding varieties high in protein and starch content and resistant to pests and diseases A list is given of 238 varieties in the germplasm collection. Other experiments were conducted to determine optimal harvesting dates for 293 clones and the effect of applying NPK, micronutrients and liming (*Summary by S.S de S. Trans. by T M.*) G01 D01 D02

0201-6813 EZUMAH, H. C., KABONYI, S and BEYA, K. **Guidelines for the establishment of a cassava improvement project: the Zaire model.** *In* Terry, E R. and Mac Intyre, R., eds The International Exchange and Testing of Cassava Germ Plasm in Africa; proceedings of an interdisciplinary workshop, Ibadan, Nigeria, 1975. Ottawa, Canada, International Development Research Centre, 1976. pp.45-48 Engl.

Cassava. Cassava programs. Plant breeding. Zaire.

A series of recommendations are presented for the establishment of a joint-cassava breeding program between Zaire and the International Institute of Tropical Agriculture, as a response to the wide range of phytosanitary and environmental problems affecting cassava in this country. The steps recommended are (1) to establish a germplasm bank comprising improved materials from IITA and other organizations and agencies, (2) to identify areas of maximum impact and concentrate efforts in such regions, (3) to establish nurseries at various locations to screen for desirable characters and distribute these materials to nearby areas, (4) to recruit local personnel for the program, and (5) to define responsibilities of local and foreign staff. (*Summary by A J Trans. by S S de S.*) G01

0202-0799 GOMEZ C., P.L. **Mejoramiento de la yuca (*Manihot esculenta*) en Colombia.** *(Cassava breeding in Colombia)* Cali, Colombia, Universidad del Valle-Instituto Colombiano Agropecuario, 1971. 4p Span, 1 Ref.

Cassava. Cassava programs. Plant breeding. Field experiments. Cultivars. Crossbreeding. Mutation. Propagation material. Colombia.

A brief report is made of ongoing cassava research at the Instituto Colombiano Agropecuario. Twelve varieties are being evaluated for their protein and starch content, cooking qualities, and weight of roots and foliage at different harvest dates. Genetic variability of these same varieties is being studied by means of diallel crosses and self-fertilization. Sexual and asexual seeds were irradiated to study possible mutations. (*Summary by T.M.*) G01

0203-3648 HAHN, S.K. and HOWLAND, A.K. Breeding for resistance to cassava mosaic. *In* Cassava Mosaic Workshop, Ibadan, Nigeria, 1972. Proceedings. Ibadan, International Institute of Tropical Agriculture, 1972. pp 37-39. Engl.

Cassava. Plant breeding. Resistance. Cassava mosaic virus. Brackcrossing. Selection. Nigeria.

A report is given of activities carried out by IITA in their breeding for resistance to cassava mosaic in Africa. Initially crosses were made between interspecific hybrids (*Manihot glaziovii* x *M. esculenta* whose progeny were backcrossed to *M. glaziovii*) and local cultivars of *M. esculenta* with other desirable agronomic characteristics On the basis of field resistance (rated on a scale of 1-5; 1 = least degree of chlorosis, deformation and reduction in leaf size), some resistant material (grades 1-2) was found but not among Latin American populations. It is concluded that (1) there is resistance to cassava African mosaic; (2) there is apparently no resistant material among *M. esculenta* cultivars in Africa; (3) resistance is apparently controlled genetically by quantitative genes; and (4) it is possible to obtain higher levels of resistance and incorporate them in high-yielding varieties. (*Summary by A.J. Trans. by T.M.*) G01 E04

0204-6952 INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR. Manioc. (*Cassava*). *In*__. Rapport Annuel 1967. Tananarive, 1968. pp.184-192. Fr.

Cassava. Cassava programs. Plant breeding. Hybridizing. Cultivars. Tuber productivity. Hybrids. Selection. Malagasy Republic.

Research work is focused on natural and controlled hybridizations, with the purpose of producing clones better than H. 57 and 58, with higher yields and starch content, and a degree of bitterness suited to intended use. There are 3 cassava collections (a) 193 mosaic-free clones, (b) 21 clones collected for their different morphological characteristics in the leaves, flowers and roots, and (c) 121 hybrids from *Manihot* spp. Results are given of several comparative yield trials at Lake Alaotra and other regions. The best clones were H. 58 at Diego Suárez and Tamatave and H. 73, 63, 58 and 226 at Fianarantsoa. (*Summary by I.B.Z.*) G01

0205-6827 INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR. Manioc. (*Cassava*) *In*__. Rapport Annuel 1969. Tananarive, 1970. pp.176-178. Fr.

Cassava. Cassava programs. Plant breeding. Crosbreeding. Hybrids. Selection. Malagasy Republic.

A report is given of work carried out at the experimental station of Lake Alaotra (Madagascar) and the hybrids used for experiments in several regions of the country. The promising new hybrids that have not been distributed yet are Vira Barco, 55254, 55107, 55019, 55351 and 55324. The results of crosses made in 1969 are given in a table, which indicates the male and female

parents and the no. of seeds obtained. Self-pollination will be practiced with several clones in order to increase knowledge on the hereditability of certain characters. It is recommended that selection trials be conducted simultaneously in the upland and coastal zones since clones selected in one region do not give good results in the other. (*Summary by S.S. de S. Trans. by I.B.Z.*) G01

0206-7370 INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR **Manioc.** (*Cassava*). *In*_____. Rapport Annuel 1973. Tananarive, Madagascar. 1974. pp.18-21. Fr.

Cassava. Cassava programs. Field experiments. Plant breeding. Hybridizing. Cultivars. Selection. Resistance. Starch content. Productivity. Germplasm. Malagasy Republic.

A description is given of varietal trials conducted at the Lake Alaotra experiment station during 1973 to select hybrids superior to H. 5, 58 and 60 The methods of hybridization and selection of clones are explained. Evaluation was based on agronomic characteristics (yield and index of recovery), as well as physiological (resistance to mosaic and rot) and technological characteristics (starch content and flavor). Outstanding clones are listed, and the no of varieties in the germplasm bank at the Institut de Recherches Agronomiques in Malagasy Republic is given (*Summary by S S de S. Trans. by T.M.*) G01

0207-6955 INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR. **Manioc; amélioration variétale.** (*Cassava; varietal improvement*). *In*__ Rapport Annuel 1964. Tananarive, 1965. pp.174-177. Fr.

Cassava. Cassava programs. Plant breeding. Malagasy Republic.

This paper describes the work on varietal improvement being carried out at the Lake Alaotra Agricultural Station, the program objectives, their 3 collections of hybrids and clones, and the results of local and multilocal hybridization studies. (*Summary by I.B.Z.*) G01

0208-6951 INSTITUT DE RECHERCHES AGRONOMIQUES DE MADAGASCAR. **Manioc; objetifs poursuivis.** (*Cassava; research goals*). *In*_Rapport Annuel 1968. Tananarive, 1969. pp.200-204. Fr.

Cassava. Cassava programs. Plant breeding. Selection. Hybrids. Malagasy Republic.

The hybridization program at Lake Alaotra is working on the development of varieties that are high yielding, resistant to mosaic and rots; cuttings with high percentages of germination; and roots with low fiber content. To date, the best hybrids are H. 43, 54, 35, 45, 53 and 58. Fertilization trials will be continued since unfertile soils are one of the main limitations. (*Summary by I.B.Z.*) G01

0209-7371 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Le manioc.** (*Cassava*). *In*__ Rapport 1971. Nogent-sur-Marne, France, 1973. pp.140-143. Fr.

Also in Agronomie Tropicale 28(1) 437-438. 1973.

Cassava. Cultivars. Selection. Plant breeding. Cassava programs. Ivory Coast. Malagasy Republic. Togo.

A brief description is given of several varietal studies carried out in the Ivory Coast, Lake Alaotra and Togo The crops studied include cassava, yams, yautia (*Xanthosoma* sp.), taro (*Colocasia* sp.) and sweet potatoes. Yields, starch content and varietal improvement are among the aspects studied. (*Summary by I.B.Z.*) G01

0210-0185 INSTITUT NATIONAL POUR L'ETUDE AGRONOMIQUE DU CONGO BELGE. DIVISION DES PLANTES VIVRIERES. **La sélection des plantes vivrières à Yagambi: le riz et le manioc.** *(Breeding of rice and cassava in Yangambi)* Bulletin D'Information de L'Institut National pour l'Etude Agronomique du Conge Belge. 1(1/2):37-54. 1952 Fr.

Cassava. Plant breeding. Hybridizing. Selection. Cultivars. Productivity. Congo.

Principal foods in the Congo are bananas, maize, cassava, peanuts and rice. As regards cassava, a study is made of requirements for industrial and human consumption (rich in carbohydrates, low in lipids, protids, cellulose and HCN), as well as agronomic aspects (plant growing habit, vegetative cycle, resistance to mosaic), as a basis for breeding. A report is given of techniques and selection criteria used during 8 yr of hybridization Yields obtained in trials from 1939-50 are given in table form. *(Summary by S.S. de S. Trans. by T.M.)* G01

0211-7918 INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. **Root and tuber improvement program; cassava.** *In*___. Annual Report 1975. Ibadan, Nigeria, 1976. pp.127-151. Engl., Illus.

Cassava. Cassava programs. Plant breeding. Germplasm. Field experiments. Tuber productivity. Clones. Selection. Cassava mosaic virus. *Xanthomonas manihotis.* **Resistance.** *Cercospora henningsii.* **Cultivation. Nigeria.**

A report is made of the program's 1975 research activities on cassava, sweet potatoes and yams. With regard to cassava, improved clones outyielded local varieties because of their resistance to several diseases, especially cassava bacterial blight (CBB). Clones with resistance to cassava mosaic and CBB proved to be stable in Zaire Through continuous selection, av HCN content of populations was reduced. Promising material resistant to mosaic, CBB and anthracnose was distributed to African and Asian countries. *Xanthomonas manihotis*, causal agent of CBB, remained infective after 22 mo of dry storage at room temperature. (*Summary by A.J. Trans. by I.B.Z.*) G01 E02 E03 E04

0212-8034 JENNINGS, D.L. **Breeding for resistance to African cassava mosaic disease: progress and prospects.** *In* African Cassava Mosaic, Muguga, Kenya, 1976 Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.39-44. Engl., 7 Refs , Illus

Cassava. Plant breeding. Crossbreeding. *Manihot esculenta. Manihot glaziovii. Manihot dichotoma Manihot melanobasis* **Cassava African mosaic virus. Resistance. Hybrids. Genetics. Cassava programs. Africa.**

Germplasm from the breeding program at Amani (Tanzania) is the main source of material resistant to African cassava mosaic. It includes *Manihot esculenta* cultivars and backcross hybrids of *M. glaziovii, M. dichotoma* and *M melanobasis.* Improved techniques for obtaining higher resistance, as well as 5 genotypes selected for distribution to farmers in East Africa, are explained In West Africa high-yielding breeding material from Latin America is being used;

however, resistance must be incorporated. Recommendations are made for exploiting IITA's germplasm throughout Africa and for studying the genetics of mosaic resistance including sources not yet studied genetically and the association between resistance to cassava bacterial blight and mosaic. (*Summary by T.M.*) G01 E04

0213-7470 KAWANO, K *et al.* **Hibridación en la yuca.** (*Cassava hybridization*). *In*__. *Curso sobre producción de yuca Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976 pp 144-145. Span.*

Cassava. Hybridizing. Plant breeding.

The following aspects of cassava hybridization are discussed briefly. heterozygosity, yields of populations derived from cross-, self- and controlled pollinations Controlled pollination is recommended, if a breeder decides to use open pollination, the use of masculine sterility is recommended. (*Summary by T.M.*) G01

0214-8112 KAWANO, K. **Mejoramiento genético de yuca para productividad.** (*Genetic improvement of cassava for productivity*). Cali, Colombia. Centro Internacional de Agricultura Tropical. Seminarios Internos. Serie SE-06-77. 1977. 20p. Span., Illus.

Cassava. Cassava programs. Plant breeding. Tuber productivity. Colombia.

When developing breeding programs, it is necessary to take into account certain characteristics of the crop such as method of propagation (vegetative or sexual) and physiological factors affecting yield (i.e., the roots in cassava). Genetic improvement, as well as the specific breeding objectives for cassava, is defined. The biological characteristics of cassava, factors of genetic variation and selection and different methods for evaluating material are discussed. After 4 years' work the cassava breeding program at CIAT has developed hybrid lines yielding more than 50 tons/ha/yr (fresh wt) and more than 30 tons on oxisols in the Llanos Orientales of Colombia, which represents a 50% increase over local varieties. (*Summary by T.M.*) G01

0215-7449 KAWANO, K., AMAYA, A. and DAZA, P. **Selección para la productividad en yuca** (*Manihot esculenta* Crantz). *(Selecting for productivity in cassava). In* Curso sobre producción de yuca. Ed prelim Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 146-149. Span., Sum. Span., 26 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Selection. Plant breeding.**

Variations in yield and harvest index (HI) were studied in plants derived from cross-pollinations. Varietal variation was sufficiently great to be able to make efficient visual selection 7 mo after transplanting the seedlings. Correlations were found for yield and harvest index between hybrids and the same genotype when planted from cuttings. There was no correlation between root yield data in the single-row and population trials, but there was a highly significant correlation for HI When HI was highly correlated with root yield in the population trial, the correlation between HI in the single-row trial and root yield in the population trial was significant It is thus concluded that in selecting for root yield in single-row trials, HI is a better character for selection than root yield. *(Author's summary Trans. by T.M.)* G01

0216-7822 NASSAR, N.M.A. Conservation and evaluation genetic resoruces of cassava (mandioca), *Manihot esculenta* Crantz. 2. Promising wild species native of Central Brazil.Goiânia, Brasil, Universidade Federal de Goiás. Instituto de Ciências Biológicas, 1977. 8p. Engl., Sum. Engl., 13 Refs.

Manihot. Cultivars. Selection. HCN content. Tuber development. Tubers. Leaves. Plant geography. Brazil.

Seven wild *Manihot* species native to Central Brazil were collected, screened for root formation, HCN content, growth habit and nature of natural habitat. *M. oligantha* Pax emend. Nassar subsp. *nesteli* is highly promising for use as a parent in breeding programs (short, limited vegetative parts, abundant root formation, high starch content, little HCN, adapted to dry, coarse sand habitats). The desirable characters of *M. anomala, M zehntneri, M. tripartita, M. gracilis* and *M. tomentosa* are given as well. (*Summary by T.M.*) G01

0217-7564 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. Food crops. *In* ____. Annual report for the year 1956-57. Lagos, Federal Government Printer. 1958. pp 15-17. Engl.

Cassava. Cassava programs. Field experiments. Cultivars. Germplasm. Selection. Productivity. Resistance. Hybridizing. Branching. Weeds. Propagation material. Tuber development. Composition. Timing. Cassava mosaic virus. Nigeria.

Research activities on cassava during 1956-57 concentrated on (1) the continued collection and classification of varieties, (2) introduction of new material, (3) evaluation of resistance to mosaic, (4) yield trials, (5) influence of type of planting material on yield, (6) influence of growing period on yield, and (7) hybridizations. Once again, selection 53101 yielded best at Moor Plantation Cuttings taken from the base of the stem yielded better than those from the upper part or lateral branches. Sel 55123 was apt for harvesting at 24 mo whereas 53101 and 37065 were not New hybrid materials (1000 clones) were all susceptible to mosaic; primary infection reduces yields significantly The carbohydrate :N ratio in leaves of injected plants was higher than in healthy plants although the actual percentages of carbohydrate and N were less, possibly indicating a greater rate of breakdown. (*Summary by A.J. Trans. by T.M.*) G01 C01

0218-7566 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. Food crops. *In*____. Annual report 1957-58. Lagos, 1959? pp. 17-19. Engl.

Cassava. Field experiments. Cassava programs. Cultivars. Germplasm. Productivity. Resistance. Plant development. Hybridizing. Selection. Spacing. Cassava mosaic virus. Nigeria.

Research activities on cassava during 1957-58 concentrated on (1) the continued collection and classification of varieties in Nigeria, (2) introduction of new material, (3) varietal yield trials, (4) hybridizations, and (5) evaluation of resistance to mosaic Introductions of *Manihot melanobasis* from Surinam and *M. glaziovii* from Puerto Rico were highly susceptible to cassava mosaic in Ibadan. Introductions from Ghana and Nigeria gave promising yields (>10 tons/acre). In varietal yield trials conducted in 8 locations in western Nigeria, the best selections from Moor Plantation were compared to the best local variety. On the whole, Sel. 53101 was the best yielder. Controlled pollinations (20,000) were made; 36% of those between *M. glaziovii* x 53101 were successful whereas only 2-8% of the other interspecific hybridizations were successful. Backcrossing of hybrids from Amani with *M. esculenta* were 36% successful; interspecific crosses with *M. esculenta*, 23%. Introductions of *M. esculenta* x *M. glaziovii* gave the greatest percentage of types resistant to mosaic. On the basis of leaf symptoms, the possible existence of another strain of mosaic virus was determined. (*Summary by A.J.*) G01 C01

0219-7565 NIGERIA. DEPARTMENT OF AGRICULTURAL RESEARCH. **Report on the root crops research unit.** *In* _____. Annual report for the year 1963-64. Lagos, Federal Ministry of Information Printing Division. 1968 pp.47-59. Engl.

Cassava. Cassava programs. Field experiments. Cultivars. Germplasm. Pollination. Hybridizing. Selection. Productivity. Resistance. Cassava mosaic virus. Propagation material. Fertilizers. Nigeria.

A report is given of research carried out on yams, cassava and sweet potatoes in Nigeria. As regards cassava, the breeding program has concentrated on selecting for high-yielding varieties, resistance to mosaic and high protein content under diverse climatic conditions. Varietal trials were conducted in various locations of eastern, western and northern Nigeria. Significant yield differences were found in varieties coming from cuttings of healthy plants and from mosaic-infected plants In trials to determine optimal planting material, it was found that cuttings from the main stem were best. On the other hand, no significant yield differences were found for cuttings from plants with different growing habits. In fertilization trials (300 lb/acre of 10·10:20), a 50% increase in yield was obtained over plots of the same variety on which no fertilizer was applied. This increase was more noticeable with hybrids. *(Summary by A.J. Trans. by T M.)* G01 D00

0220-1766 SILVA, W J. DA **Plano de melhoramento da mandioca** (*Manihot esculenta* Crantz). *(Cassava:a breeding program)* Agronômico 23:100-116. 1971. Port.. 7 Refs. Illus

Cassava. *Manihot esculenta. Manihot melanobasis. Manihot saxicola.* Cassava programs. Plant breeding. Brazil.

Work done on cassava breeding in Madagascar, Tanzania. Indonesia. India and Brazil is discussed in order to establish a parallel to the following program, which should be carried out in chronological order: (1) collection of material to form a germplasm bank. Progeny of *Manihot melanobasis* and *M. saxicola* should be included because of the favorable characters they can contribute toward improving *M esculenta*; (2) screening of promising material in yield trials; and (3) crossing of selected clones. Steps taken to incorporate genetic variability through hybridization include diallel crosses, self-pollination and individual crosses of self-pollinated plants. *(Summary by S.S de S. Trans by T.M.)* G01

0221-1632 STATION AGRONOMIQUE DU LAC ALAOTRA. **Synthese et conclusion des essais varietaux manioc en repoblika Malagasy.** *(Results of cassava varietal trials in the Malagasy Republic).* Lac Alaotra, 1967. 11p. Fr.

Cassava. Cassava programs. Field experiments. Plant breeding. Cultivars. Resistance. Cassava mosaic virus. Productivity. Malagasy Republic.

Results are given of research carried out by the Institut de Recherches Agronomiques in the Malagasy Republic from 1961-67 on the breeding of cassava varieties that can, in a short term, replace the local, low-yielding varieties, susceptible to mosaic and rots. Varieties grown in the provinces of Diego-Suarez, Fianarantsoa, Tamatave, Tananarive and Tulear were screened for resistance to mosaic and rots and for palatability, and very marked differences were found. Highest yields were obtained with H. 57 and 58 (50 tons/ha) in the region of Lake Alaotra. These 2 varieties cover a wide range of desirable characteristics and meet the needs of both human consumption and industrial uses. It appears that with the new hybrids being studied, it will be possible to obtain higher yields and plant cassava under different environmental conditions. The

principal objective is to develop just one variety for human and animal consumption, as well as starch manufacture. *(Summary by S.S. de S. Trans. by T.M.)* G01

See also *0026* *0383* *0396*

G02 Cytogenetics

0222-4586 GIOELLI, F. **Embriologia del "*Manihot esculenta*" Crantz.** (*Embryology of Manihot esculenta Crantz*). Lavori 4:256-261. 1933. Ital.

Cassava. *Manihot esculenta.* **Morphogenesis. Cytogenetics.**

Because of the scarcity of data concerning the embryology of the genus *Manihot*, a study was carried out. It was found that (1) the male gametophyte is very precocious; it has been possible to observe only the mother cells from the pollen in karyokinesis, with nuclei in spireme and fully formed pollen. (2) The female gametophyte presents a typically unicellular archesporium. (3) The megaspore mother cell is elongated in shape; synapsis can be observed during its 1st division. (4) During microsporogenesis a protuberance is formed from which 4 overlapping megaspores are successively originated. (5) Germination always occurs in the megaspores. (6) The gametogenic divisions occur regularly, giving rise to a binuclear phase, a tetra-nuclear phase and last to an 8-nuclei adult megatophyte, which is normally monosporous. (7) The synergidae are elongated in shape. (8) The antipodal cells are overlapped and disappear very early, leaving no traces. (9) The development of the endosperm is of the nuclear type. (*Summary by C.M. Trans. by I.B Z.*). G02 C01

H00 NUTRITION

0223-5281 LUETZELBURG, P. VON. **Die Ernährung der Indianer in Amazonien.** *(The natives' diet in the Amazon region).* Zeitschrift der Gesellschaft für Erkunde zu Berlin 1940 216-218. 1940. Germ.

Cassava. Uses. Human nutrition. Processing. South America.

A study was made of the Amazon region including the diets of the natives. Cassava is one of the most important staples in the lower Amazon, where it is easily grown. The Indians make farinha using very rudimentary instruments (tipiti) . They also make a fermented beverage known as cachiri. The natives use cassava and cassava products for bartering as well. *(Summary by H.P. Trans. by T M)* H00

0224-7404 WYLLIE, D. and HUXLEY, P.A **Cassava research at the Faculty of Agriculture Forestry and Veterinary Science, Morogoro, Tanzania.** Dar es Salaam, Tanzania, University of Dar es Salaam, 1976. 11p. Engl , 6 Refs.

Cassava. Cassava programs. Research. Cassava leaves (vegetable). Feeds and feeding. Forage. Germplasm. Tanzania.

The School of Agriculture, Forestry and Veterinary Science at Morogoro (Tanzania) has placed emphasis on improving cassava production. The program, which began in 1975, now has a collection of 50 disease-free varieties. Research has concentrated on maximizing production of plant protein since cassava leaves are highly appreciated for both human and animal consumption. Two other important uses are starch and dried chips for exportation. Mention is made of trials being carried out on cassava uses. (*Summary by S.S de S Trans. by T.M.*) H00

See also 0412

H01 Cassava Foods and Nutritive Value

0225-4983 ALBUQUERQUE, M. DE. **Alguns aspectos da influência econômico-social da mandioca na Amazônia.** (*The socioeconomic impact of cassava in the Amazonian region*) Norte Agronômico 3(3):13-20. 1957. Port.

Cassava. Nutritive value. Cassava products. Socioeconomic aspects. Brazil.

An analysis is made of the socioeconomic significance of cassava in Brazil. The importance of cassava as a food is studied, including 20 ways of preparing the roots and leaves It is concluded that since the colonial period, cassava has maintained the hegemony among the subsistence crops, especially in the Amazonian region. It is considered a negative social factor because it is responsible for unbalanced diets (it constitutes 2/3 of the diet) and wears out the soil. A few solutions are proposed. (*Summary by S.S. de S. Trans. by T.M.*) H01

0226-1694 BERNABAI, A. **Piante alimentari, l'utilissima manioca.** (*Food crops: cassava*). Annali della Sanita Pubblica 23(5):1313-1352. 1969. Ital., Sum. Ital., 33 Refs., Illus.

Cassava. Nutritive value. Water content. Carbohydrate content. Protein content. Fat content. Ash content. Mineral content. Vitamin content. Tubers. Leaves. Cassava meal. Gari. Gaplek. Tapiocas. Kwashiorkor. Maps. Uses.

A description is given of the origins of cassava, its geographical distributions, morphology, industrial applications (paper, textiles, fuel, adhesives) and its uses as a foodstuff in America, Africa and Asia. The chemical composition of cassava (fresh roots, leaves, gaplek, gari, meal and tapioca) is given, and its protein content is compared to that of other foods. The high incidence of kwashiorkor in Africa is due to a cassava-based diet. (*Summary by I.B.Z.*) H01

0227-8325 BRUNS, P., HOOD, L F. and SEELEY JUNIOR, H.W. **Effect of modified starch on the microflora of the small intestine and caecum of rats.** Nutrition Reports International 15(2).131-138 1977 Engl , Sum. Engl., 20 Refs , Illus.

Cassava. Cassava starch. Modified starches. Dietary value. Laboratory animals. Laboratory experiments.

The effects of hydroxypropyl distarch phosphate cassava (HDP) on the microflora of the cecum and small intestine of rats were studied. Diets containing either 35% unprocessed HDP or unmodified cassava starch (UMS) were fed to rats for 30,60 and 180 days. Animals were sacrificed and samples of cecum and small intestine contents were obtained aseptically for enumeration of specific bacterial populations Pooled samples were plated in duplicate, using both selective and

nonselective media. Rats fed diets containing HDP exhibited a complete loss of streptococci from their small intestines and ceca during the 180-day trial Populations of cecal lactobacilli increased during this period in rats consuming UMS, whereas those on HDP retained constant cecal lactobacilli counts Cecal coliforms declined over 3 logs in rats on HDP for 180 days. Results indicate that HDP has a marked influence on the intestinal microflora of both growing and mature rats. (*Author's summary*) H01

0228-7551 CAMPOS, F.A. DE M. **O complexo da mandioca como traço da influencia Amerindia na alimentação brasileira.** (*Cassava as evidence of the Amerindian influence in Brazilian foodstuffs*). Hospital 39(6):13-33. 1951. Port., 47 Refs., Illus.

Cassava. Human nutrition. Cassava products. Uses. Brazil.

Based on a literature review, a brief recount is made of the historical role of cassava in human and animal nutrition. The physicochemical characteristics of both fresh and cooked roots, as well as cassava flour, are analyzed. Different local preparations of cassava are given. (*Summary by I.B.Z.*) H01

0229-7552 CHAVES, J.M. and RIBEIRO, O. **Dosagem da riboflavina em alimentos.** (*Determining the riboflavin content of foodstuffs*). Anais do Associação Brasileira de Química 2:91-96. 1943. Port., 7 Refs, Illus.

Cassava. Riboflavin. Cassava starch.

A comparison was made of microbiological (Snell-Strong) and physicochemical (fluorometric) methods for determining the riboflavin content of foods, including cassava starch. The fluorometric method was found to be simpler and more accurate, and results were in agreement with the literature on the subject. (*Summary by I.B.Z.*) H01

0230-2070 DER EINSATZ von Quellmehlen und Stärkequellmehlen in der Dauerbackwaren- und Susswarenindustrie. (*The use of starch and pregelatinized starch in the bakery and confectionery industries*) Gordian 71(6):190-191. 1971. Germ

Cassava. Cassava starch. Industrial starches. Confectioneries. Bakery products. Analysis. Composition. Nutritive value.

Starch and pregelatinized starch are important in the bakery and confectionery industries. The composition of 5 different raw materials (wheat, maize, rice, cassava and potatoes) is given in a table. The characteristics of these starches, their pasting properties, etc. are determined by the type of drying, temperature, properties of the raw materials, molecular structure of the starch grains, amylase and amylopectin content. The size of the starch particles should be less than 5 μ. Because of their protein content and mineral substances, these starches are more nutritive. The advantages of using these starches in the aforementioned industries are given. (*Summary by H.P. Trans. by T.M.*) H01 101

0231-8323 FAFUNSO, M A. and OKE, O.L. **Leaf protein from different cassava varieties.** Nutrition Reports International 14(6).629-632. 1976. Engl., Sum. Engl., 13 Refs.

Cassava. Cultivars. Leaves. Proteins. Analysis. Laboratory experiments.

Protein was extracted from 15 cassava varieties to determine which would give the highest yield; digestibility was also tested All varieties gave an even extractability of total N (55.8-60.9%); in all cases over 75% of the N was protein in nature, ranging from 43.6-46 0% Digestibility followed the same pattern (52.8-60.9), indicating that varietal differences do not occur For leaf protein work it appears that any cassava variety can be used without loss in efficiency of nutritive value. (*Author's summary*) H01

0232-8364 HOOD, L.F. *et al.* **Effect of modified and unmodified tapioca starches on ^{59}Fe retention in rats. Journal of Nutrition 106(12):1768-1772. 1976. Engl., Sum. Engl., 10 Refs.**

Cassava. Cassava starch. Modified starches. Nutritive value. Laboratory animals. Laboratory experiments. Animal physiology.

The effects of a chemically modified cassava starch, hydroxypropyl distarch phosphate (HDP), and unmodified cassava starch (UMS) on ^{59}Fe retention by rats were compared. An evaluation was made of 3 variables: the type of starch in the diet, the cooking of either the starch alone or the entire diet, and the iron status of the rats. There were no significant differences in ^{59}Fe retention between iron-adequate rats fed either UMS or HDP. ^{59}Fe retention by iron-deficient rats was not affected by the type of starch in the diet when uncooked starch was used; if cooked, however, the substitution of HDP for UMS resulted in a significant depression in iron retention. Cooking the entire diet produced a similar but less marked effect. The results suggest that the inclusion of one particular type of modified cassava starch in the diet may affect iron utilization. (*Author's summary*) H01

0233-7385 KETIKU, A.O. and OYENUGA, V.A. **Dehydrated yam (*Dioscorea rotundata*, Poir) and cassava (*Manihot utilissima*, Pohl) as sources of energy to the laboratory rat.** West African Journal of Biological and Applied Chemistry 16(2).9-13. 1973. Engl., 9 Refs.

Cassava. Tubers. Gari. Dietary value. Food energy. Cassava flour. Feeds and feeding. Laboratory animals. Yams. Diets. Nigeria.

Studies were undertaken to determine the gross energy (GE) of yam tubers, cassava roots (including peels) and their processed products (elubo and gari), as well as the proportions of GE metabolized by rats. The metabolizable energy (ME) values of these foodstuffs and the composition of the diets are given in table form. It was found that the processing of cassava roots into gari was accompanied by a slight decrease in GE from 4.5 to 4.4 kcal/g. There was also a decrease in ME from 4.25 kcal/g for cassava to 3 69 kcal/g for gari. The ME of unpeeled cassava flour was the highest of the different foodstuffs Although gari can be stored for longer periods of time, the process is costly and the resulting product has less GE and ME for rats. (*Summary by T.M.*) H01

0234-7531 LANGWORTHY, C.F. and DEVEL, H J. **Digestibility of raw rice, arrowroot, canna, cassava, taro, tree-fern, and potato starches.** Journal of Biological Chemistry 52(1):251-261. 1922. Engl., 4 Refs.

Cassava. Cassava starch. Nutritive value. Digestibility. Analysis. Composition.

In order to determine the digestibility of different uncooked starches including that of cassava, puddings containing 20% starch were prepared and given to different groups of people for 3 days

(9 meals). The food and feces were analyzed. In the case of cassava starch, the diet administered supplied 18 g protein, 48 g fat and 246 g carbohydrates/man/day, with a food energy value of 1,490 calories. Av daily consumption of cassava starch/day was 140 g. The individuals remained healthy. Analysis of the feces showed that uncooked cassava starch has 100% digestibility. (*Summary by A.J. Trans. by T.M.*) H01

0235-7562 LELONG, M., PAUPE, J. and DALLOZ, J.C. **Le tapioca en diététique infantile.** (*Tapioca in diets for children*). *In* Journée National de Dietetique, 3th, Marseille. 1962. pp.5-8. Fr., Sum. Fr.

Cassava. Tapiocas. Digestibility. Dietary value. Human nutrition.

The processing of tapioca and its characteristics are discussed briefly. Tapioca compares favorably to wheat, rice, maize and potato starches. Its digestive qualities make it a satisfactory food for children, combined with milk (human or cow's milk). Several formulas for babies are given. Tapioca is especially recommended for premature babies and pathological cases. (*Summary by I.B.Z.*) H01

0236-4330 MARTINO, G. and CHENU-BORDON, J.G. **Sul valore alimentare della mandioca.** (*The nutritive value of cassava*). Archivio di Scienze Biologiche 17:305-319. 1932. Ital., 6 Refs., Illus.

Cassava. Nutritive value. Laboratory animals. Animal physiology. Diets.

A 100% cassava diet for rats resulted in injury to the osseous system and retarded bone growth and total body weight. In cassava, the P/Ca ratio is low (2,5) and there is also a vitamin A deficiency. When 25% wheat was added to the rations, there were no alterations. When cod liver oil was added, bone processes became normal. Adding 15% casein to the diets resulted in normal growth and weight recovery. (*Summary by C.M. Trans. by I.B.Z.*) H01

0237-2715 MIYA, E.E. *et al.* **Avaliação químico-sensorial de novos cultivares de mandioca.** (*Organoleptic and chemical evaluation of new cassava cultivars*). Coletanêa do Instituto de Tecnologia de Alimentos 6:257-275. 1975. Port., Sum. Port., Engl., 12 Refs., Illus.

Cassava. Cultivars. Sweet cassava. Bitter cassava. Organoleptic examination. Palatability. HCN content. Tubers. Starch content. Protein content. Brazil.

On the basis of organoleptic tests and chemical analysis, an evaluation was made of 16 new high-yielding cassava cultivars, dividing them into 2 main groups: bitter and sweet. The organoleptic characteristics of the 4 most promising cultivars from the Pederneiras selection field in the state of São Paulo (Brazil), were studied as well. There was a high correlation between the bitter flavor of raw roots and their HCN content although some roots with a low HCN content may still have a slightly bitter taste. It is suggested that there may be another factor besides HCN that is responsible for the bitterness. The cultivar with the best organoleptic properties was 521-Carapé, which is sweet. Bitter cultivars IAC 5-1 and 48-243 were the worst; IAC-X-319 was the sweetest. (*Author's summary*) H01

0238-8169 NARTEY, F. and MOLLER, B.L. **Amino acid profiles of cassava seeds** (*Manihot esculenta*). Economic Botany 30:419-423. 1976. Engl., 20 Refs.

Cassava. *Manihot esculenta.* Seeds. Protein content. Amino acids. Analysis. Tubers. Leaves. Nutritive value.

The amino acid contents of cassava seed protein are reported The nutritive value of the seeds is compared with that of the roots and leaves Free amino acids constituted 2% of the total N in cassava seed kernels. (*Summary by Abstracts on Tropical Agriculture*) H01 C03

0239-8170 NICOL, B.M. and PHILLIPS, P.G. **The utilizations of dietary protein by Nigerian men.** British Journal of Nutrition 36:337-351. 1976. Engl., Sum. Engl , 34 Refs.

Cassava. Proteins. Dietary value. Human nutrition. Diets. Human physiology. Nigeria.

The excretion of urinary and fecal nitrogen by young Nigerian men of a low-income group varied significantly among subjects but not significantly in the same subject when they were given a mixed diet of rice, cassava flour, vegetables and fish. At the levels of energy and protein supplied by this diet, they gained or lost small amounts of weight, mean values indicating N equilibrium, the variation around the mean being high. The correlation between urinary and fecal N was significantly negative at and below the level of N equilibrium, becoming positive 2-3 wk after they had consumed the above diet supplemented by 400 g lean beef/day and had already established considerable gain in body wt and N retention. Diets were made isoenergetic by adding the beef at the expense of cassava flour and palm oil. The physiological processes involved in their adaptation to a highly efficient use of low-protein diets are discussed in relation to the biological value and true digestibility of those diets and to the "safe level of protein intake" and protein/energy ratios proposed by FAO/WHO (1973, 1975). It is concluded that the protein requirements of apparently healthy men can only be established in the context of their ecological, socioeconomic and nutritional backgrounds. (*Author's summary*) H01

0240-6942 ORTIZ, D.O. **L'eliminazione urinaria di fosfati inorganici nei ratti alimentati con mandioca o con patata.** (*The urinary elimination of inorganic phosphates in rats fed with Manihot or potatoes*). Bolletino della Societá Italiana di Biologia Sperimentale 7:759-761. 1932. Ital. 4 Refs.

Cassava. Nutritive value. Animal nutrition. Animal physiology. Laboratory experiments.

Cassava is considered to be an incomplete food because of its low protein and vitamin A contents. As compared to potatoes, it has a lower P/Ca rate, which impairs bone formation for growing rats. Urinary elimination of 2 adult male rats fed exclusively on cassava or potatoes was studied. After 2 mo, the cassava-fed rat showed 29% loss of body wt, as compared with 22% for the one on potatoes. Food consumption was 4095 g of potatoes and 2318 g of cassava. The amount of urine eliminated was 1877.1 cc for the potato-fed rat and only 283.7 cc for the cassava-fed rat. There was 44.5 mg of P/100 cc urine for the cassava-fed rat and 217 mg P/100 cc urine for the one on potatoes. (*Summary by I.B.Z.*) H01 H03

0241-7915 OYEFESO, J.A. **Cassava indicted ailments—a lack of technological know-how or mere cassava consumption?** Indian Journal of Nutrition and Dietetics 13(3) 77-83. 1976 Engl., Sum. Engl., 29 Refs.

Cassava. Nutritive value. Human nutrition. Toxicity. HCN. Detoxification processes.

The nutritional value of cassava and its potential as a cheap energy source are highlighted The HCN content of the roots, as well as of some African food products based on cassava, is given Methods of detoxification are discussed. Only circumstantial evidence links human diseases with

chronic cyanide consumption; neuropathic ataxia, which occurs in West Africa, may have a multifactorial etiology. A better understanding of cyanogenic glucosides is necessary. (*Summary by T.M.*) H01 H04

0242-3279 VIGNOLI, L. and CRISTAU, B. **Le gari, produit alimentaire préparé a partir du manioc; analogies et différences avec le tapioca.** *(Gari, a cassava product; comparison to tapioca).* Cahiers Coloniaux 8:303-308. 1950. Fr.

Cassava. Gari. Tapiocas. Analysis. Africa.

Results are given of tests comparing samples of gari from different parts of Afriga (Togo, Cameroon and Dahomey) to tapioca. Tapioca is derived from cassava starch and gari from cassava flour. Analysis was made of moisture, ashes, iron and cellulose contents, the fraction soluble in cold water, a qualitative characteristic of amylodextrins; free sugar content, reducing sugars after hydrolyzation, and HCN content. The gari was poorer in amylodextrins and had larger starch granules. Gari is similar to cassava flour in its rich cellulose and ash contents and the weak relationship between sugars resulting from hydrolysis and dry extraction *(Summary by S.S de S. Trans. by T.M.)* H01

See also 0032 0033 0036 0046 0274

H02 Nutritive Disorders in Humans

0243-7543 ANGULO, J.J. and SPIES, T D. **The determination of the folic acid content of foods usually consumed by patients with tropical sprue.** American Journal of Tropical Medicine and Hygiene 27(3):317-321 1947. Engl., 10 Refs

Cassava. Deficiency diseases. Human health. Anaemia. Vitamin deficiencies. Cuba.

The folic acid content in foods forming part of the regular diet of a group of patients presenting symptoms of tropical sprue was determined in order to determine a possible cause for the incidence of this condition. The samples (cassava, coffee, yellow maize, yams, plantains, rice, sweet potatoes and taro) were submitted initially to digestion with Taka-diastase and then pancreatic enzymes from hens. Cassava contained only 0.0004µg folic acid/g. The very low level of folic acid in the patients' diets may be one of the causes of tropical sprue since they recuperated notably when folic acid was administered. (*Summary by A J. Trans by T.M*) H02

0244-8056 DELANGE, F. *et al.* **The toxic effect of cassava on human thyroid.** *In* Symposium of the International Society for Tropical Root Crops. 4th., Cali, Colombia. 1976. Proceedings. Ottawa, Canada, International Development Research Centre. 1977. pp.237-242. Engl., Sum. Engl., 20 Refs., Illus.

Cassava. Endemic goitre. Iodine. Thiocyanates. Human physiology. Analysis. Zaire.

Previous investigations on the goiter endemia of Idjwi Island (Eastern Zaire) suggested that cassava could play a role in the etiology of endemic goiter. The suggested mechanism was a loss of iodide in the urine due to the antithyroid action of thiocyanate resulting from the endogenous conversion of linamarin contained in cassava. This hypothesis was further tested in 677 inhabitants of another extremely severe goiter endemia situated in the Ubangi area (Northwestern Zaire), where cassava is also a staple food Very low renal excretion of iodide (11 3 µg/day) and high thiocyanate content in serum (0.83 mg/100 ml) and urine (11.3 mg/day) indicate that this population is subjected to an extremely severe iodine deficiency and to the consumption of a goitrogenic foodstuff. Cassava consumption is followed by a sharp increase in urinary excretion of stable iodine and in the level of serum and urinary thiocyanate. The highest urinary concentrations of thiocyanate were observed in the subjects with the largest goiters The data confirm the hypothesis that cassava consumption increases serum thiocyanate concentration, which has an antithyroid action and causes a loss of iodide in the urine. In view of the iodine deficiency already prevailing in the diet, this mechanism could play a critical role in goiter development. (*Author's summary*) H02 H04

0245-7405 RIVERA L , P H. and WASSERMAN L , M. **Influencia de la ingestión de yuca en una zona con bocio endémico.** *(The influence of cassava consumption in a zone with*

endemic goiter). Tesis Quím. Bogotá, Universidad Nacional de Colombia, Facultad de Ciencias, 1969. 98, 15p. Span., Sum. Span., 52 Refs., Illus

Cassava. Endemic goitre. Etiology. Laboratory experiments. Laboratory animals. Diets. Iodine. Composition. Analysis. Absorption. Animal health. Colombia.

Goiter has been endemic in Colombia for a long time. The simple intake of iodized salt has failed to eradicate it in certain regions. The purpose of this work was to study the hypothesis that the combined action of iodine deficiency and the presence of a goitrogen element in the diet cause goiter. Cassava was selected as the most probable cause of goiter; the study was conducted in Villeta, a large cassava-producing region with a high incidence of endemic goiter. The group of guinea pigs selected for the trial were fed a nongoitrogen diet, deficient in iodine but with satisfactory nutritional value, which consisted of wheat flour and maize gluten enriched with vitamins, minerals and fats. To prove that the diet met these 3 requirements, these tests were made: daily iodine analysis (by activation) of the urine of 20 guinea pigs fed with this diet for 1 mo; the percentage of uptake of a dosis of I^{131} injected 24 h before slaughter; preparation of growth curves; chromatographic determination of iodide, monoiodotyrosine, diiodotyrosine and thyroxine taken from thyroid extracts of these animals. The 2nd step was to verify the effects of cassava on the following parameters of the thyroid function body weight, I^{131} uptake, and content of I^-, monoiodotyrosine, diiodotyrosine and $T_3 + T_4$ in the thyroid gland. Guinea pigs were fed a ration composed of 50% of this diet + 50% cassava. The effects were observed at 7, 21 and 28 days and compared to the rations received by 3 different groups of animals. (1) diet without iodine; (2) diet without iodine + a known goitrogen element (thyourea); and (3) diet with iodine The results show that cassava has an inhibiting effect on thyroid metabolism, apparently in the process of the synthesis of diiodotyrosine from monoiodotyrosine. *(Author's summary. Trans. by S.S. de S.)* H02

See also 0284

H03 Animal Feeding

0246-7927 ATHANASSOF, N. **Bibliographia agricola: I. Alimentação das vaccas leiteiras. II. As raspas de mandioca.** (*Agricultural bibliography. I. Feedstuffs for dairy cows. II. Cassava chips*). Boletim de Agricultura 40:622-630. 1939. Port.

Cassava. Cassava chips. Feeds and feeding. Cassava tubers (vegetable). Dairy cattle. Diets. Animal nutrition. Brazil.

Cassava has a favorable effect on the milk production of dairy cows, provided that their feed rations are supplemented with protein-rich forages (i.e., copra). Fodder from cassava contains mostly carbohydrates (80.23%); water content must not exceed 10-12.5% for good storage. Peeled chips are preferred. Some cassava-based rations are given for dairy cows, together with a cost analysis. (*Summary by I.B.Z.*) H03

0247-1983 ATHANASSOF, N. **Contribução para o estudo do "Mandioca", "Canna" e "Campin fino"; utilizados como forragem na alimentação do gado leiteiro.** (*Cassava, sugar cane and Panicum spp.as forage for dairy cattle*). Piracicaba, Brazil, n.i., 1917. 89p. Port., Illus.

Cassava. Feeds and feeding. Forage. Dairy cattle. Milk. Production. Nutritive value. Costs. Animal nutrition. Brazil.

A comparison is made of the nutritional qualities of cassava, a variety of sugar cane (*Saccharus officinarum*) and Angola grass (*Panicum spectabile*), as forage for dairy cattle. Cassava is also compared to alfalfa hay, maize, wheat and cotton brans. Factors that affect the quantity and quality of milk are analyzed. It is concluded that cassava is superior to the other forages since it increases lactic secretion (8.5% more than sugar cane), maintains liveweight gain and improves the quality of milk. It is especially recommended for good milk cows, preferably during the 1st half of the lactation period. Production costs were lowest for cassava. (*Summary by I.B.Z.*) H03

0248-2695 [CASSAVA AND cassava leaf as meal for broilers and growers]. *In* National Conference on Agricultural and Biological Sciences, 13th., Bangkok, Thailand, 1974. Proceedings. Bangkok, Kasetsart University, 1974. pp.451-463. Thai., Sum.,Engl., 8 Refs.

Cassava. Cassava meal. Leaves. Chicks. Dietary value. Animal nutrition. Feeds and feeding. Animal physiology. Thailand.

Two experiments were designed to study the effect of various levels of cassava and Na_2SO_4 supplementation in diets for broilers (0-8 wk) and growers (10-16 wk) of mixed sex; a 3rd

experiment studied the effects of various levels of cassava leaf meal on broilers. **Experiment 1.** Diets with 0, 15, 30 and 45% cassava and 15 or 45% cassava + 0.3% Na_2SO_4 were fed to 3 replicate groups of 10 Cobbs chicks. After 4 wk there was no significant difference in wt gain, feed intake, feed conversion efficiency or mortality. At the end of the experiment; however, the groups fed 15 and 45% cassava significantly outgained the 0 and 30% groups; there was a cubic response ($P<0.10$) in wt gain. In the Na_2SO_4 supplemented groups, there was a linear decrease ($P<0.01$) in gain with each increase in cassava. The mortality rate was significantly higher ($P<0.01$) for the 45% and 15% cassava + 0.3% Na_2SO_4 groups than the others. **Experiment 2.** Similar diets (adjusted to nutrient levels for growers) were fed to 3 replicate groups of 11 Hy-Line chicks. Mortality, feed intake and feed conversion efficiency were not statistically different There was a quadratic response ($P<0.01$) in wt gain for the 0, 15, 30 and 45% cassava-fed groups In the Na_2SO_4-supplemented groups there was a linear decrease ($P<0.05$) in wt gain for each increase in cassava. Trends for feed efficiency were similar. **Experiment 3.** After 4 wk there were no significant differences in feed intake, wt gain, feed conversion efficiency and mortality. Similar results were obtained at 8 wk except for a linear decrease ($P<0.05$) in wt gain each time cassava leaf meal was increased. Results are not conclusive. Although 15% cassava yielded comparable results, symptoms of toxicity were noted in some chicks. Cassava leaf meal, even at the 5% level, cannot be used under the experiment conditions. Further research is required to identify a growth-depressing factor in cassava leaf meal. (*Author's summary*) H03

0249-3813 CAVALLI, R. **L'ingrassamento economico dei maiali; prove pratiche eseguite con l'impiego di mangimi meno usati.** (*Economical feeding of pigs*). Rivista di Zootecnia 8:277-293. 1931. Ital.

Cassava. Cassava meal. Swine. Fattening. Feed contituents. Diets. Animal health. Animal nutrition. Prices.

Traditionally, swine fodder has been made of milk products, Turkish or Indian wheat flour and cereal brans. It is often difficult for farmers to obtain dairy products such as whey; for this reason an experiment was conducted to evaluate other feeds in an effort to obtain the most weight in the shortest time. Three groups of Yorkshire pigs, weaned at 70 days, were given the following diets: (1) control, (2) cassava meal, dried barley bran and 2 commercial feed supplements, "lactaris" and "zotamina," and (3) a diet of cassava meal, wheat meal, rice meal, barley bran and meat meal. The new rations were well accepted by the pigs and their health was excellent. Desired weight was reached in week 8 by Group 3, week 12 by Group 2 and week 9 by the control. Av daily wt gain was 0.952 kg for Group 3, 0.839 kg for Group 2 and 0.750 kg for the control. The 3rd diet was the most inexpensive. (*Summary by I.B Z.*) H03

0250-8167 CHOU, K.C., MULLER, Z. and NAH, K.C. **High levels of tapioca-meal in poultry rations.** Indian Journal of Animal Science 44(9):697-702. 1976. Engl., Sum. Engl., 9 Refs.

Cassava. Cassava meal. Poultry. Diets. Feed constituents. Animal physiology. Dietary value. Animal nutrition. Singapore.

Broilers were fed balanced pelleted diets containing 20, 30, 40, 50 and 58% cassava meal as a substitute for maize, fortified with essential fatty acids, niacin, lysine, methionine and malt. Only supplemental amino acids improved growth and feed efficiency significantly. It was concluded that cassava meal can be used even above 50% in broiler rations when balanced. Further experiments were conducted with pullets during their developing period (12-22 wk) and 168 days of the laying period. The 50% cassava meal diets were slightly higher in crude fiber and lower in energy than in maize diets. There were no significant differences in liveweight gain, feed efficiency or mortality; however, egg production and size were significantly reduced in comparison to the

maize diet. The cassava developing diets also produced adverse effects during the 1st 12 wk of the laying period. (*Author's summary*) H03

0251-7904 DEVENDRA, C. **Feedings pigs in the tropics: the value of the Lehmann method.** World Review of Animal Production 12(2):39-42. 1976. Engl., 14 Refs., Illus.

Cassava. Feeds and feeding. Swine. Animal nutrition.

Traditional diets for pigs comprise approx. 75% cereals, 15% vegetable protein sources, 8% animal protein sources, 2% feed additives and supplements. Since feed costs have increased considerably, efforts are being made to maintain profit margins by cheaper ingredients and increased efficiency of utilization. The Lehmann method for feeding pigs consists of normal feeding of weaner pigs until they reach 22.7 kg liveweight. From this weight up to slaughter, each pig receives 1.1 kg of meal daily, which supplies most of the protein requirements. The main advantage of the Lehmann method is that the amount of the concentrate meal given can be limited, maximizing the utilization of local high-energy substitutes such as cassava, sweet potatoes, yautia, taro, yams, bananas, plantains, water hyacinths, breadfruit, sago, coconut meal, cashew scrap kernel meal, molasses, vines, citrus by-products and garbage. (*Summary by I.B.Z.*) H03

0252-7677 GALLO C., J. T. Producción de carne de cerdo en América Latina. *(Swine production in Latin America)* Bogotá, Instituto Colombiano Agropecuario, 1970?. 14p. Span., Sum. Span., 14 Refs., Illus.

Cassava. Animal nutrition. Swine. Feed constituents. Nutritive value. Food energy. Statistical data. Tuber composition. Protein content. Colombia.

The possibilities are discussed of improving swine production in Latin America, based on energetic sources available in the tropics, especially bananas, sugar cane, cassava and opaque maize. Cassava is one of the products with more potential because of its high dry matter yield; nevertheless, there are 2 problems: its storage and low protein content. The 1st problem can be solved by silage, which does not affect its palatability for pigs. Because of cassava's low protein content, it is necessary to use high levels of protein supplement, which could be a limiting factor. Breeding for higher protein content is indicated as a partial solution. (*Summary by A.J. Trans. by T.M.*) H03

0253-8061 GOMEZ, G.G., CAMACHO, C. and MANER, J.H. **Utilization of cassava-based diets in swine feeding.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.262-266. Engl., Sum. Engl., 9 Refs

Cassava. Cassava meal. Dietary value. Swine. Diets. Animal nutrition. Colombia.

A swine feeding program based on diets with high levels (60-70%) of sweet cassava meal plus soybean meal as the protein source, without methionine supplementation but adequately supplemented with vitamins and minerals, was used experimentally throughout the animals' lifetime. The experimental results were compared with those obtained in a control diet based on common maize and soybean meal. The gilts fed cassava meal gained weight more slowly during the growing-finishing periods and gained less weight during pregestation and gestation. Nevertheless, they gained weight subsequently in lactation, whereas the gilts in the control group

lost weight during this period. The results indicate that the experimental diets with high levels of sweet cassava meal, without methionine supplementation, produced a smaller no. of pigs/litter, resulting in lower total weights/litter than normally expected. The quantity of feed required to produce one weaned pig was greater for the cassava group than for the control. The quantities of soybean meal required to balance the total protein were significantly greater in the cassava meal-based diets than in the comon maize diets. (*Author's summary*) H03

0254-7511 GOMEZ G., G.G. **Progresos en la investigación sobre la utilización de yuca como alimento para porcinos.** (*Research developments in the use of cassava in swine feeding*). Cali, Colombia. Centro Internacional de Agricultura Tropical. Seminarios Internos. Serie SE-04-77. 1977. 27p. Span., Sum. Span., 28 Refs., Illus.

Cassava. Toxicity. Linamarin. Linamarase. Detoxification. HCN absorption. Detoxification processes. Feeds and feeding. Tubers. Cassava meal. Swine. Animal nutrition. Protein enrichment.

The use of cassava-based feedstuffs seems promising, especially for swine; however, toxic factors must be taken into account when diets are formulated. In Africa, cassava consumption is indicated as one of the factors responsible for the tropical ataxic neuropathy syndrome observed in Nigeria: it is also reported causing goiter in areas where I-deficient diets predominate (Nigeria and Zaire). A hypothetical model of the cassava goiter-causing mechanism has been formulated. Most of the information on the utilization of cassava in swine feeding has been produced by CIAT and the Instituto Colombiano Agropecuario (Colombia). An increase of 65-70% in protein supplement is required in cassava-based feeds, as compared to cereals, because of its low protein content. The Swine Protection Unit and the Cassava Program at CIAT, together with the University of Guelph (Canada), are cooperating on a project to produce microbial protein, using cassava roots as the substrate for the fungus *Aspergillus fumigatus* 1-21A, an asporogenous mutant that grows under very limited temperature (45°C) and pH (3.5). conditions. Currently, another mutant (*A. fumigatus* ON5), sensitive to temperatures of 37-40°C,is being tested; its spores are not able to grow at animal body temperatures. Results to date suggest good potential perspectives. (*Author's summary. Trans. by I.B.Z.*) H03

0255-7433 HENKE, L.A. **Feeding test with hogs.** Hawaii University Quarterly Bulletin 2:29-40. 1923. Engl.

Cassava. Cassava meal. Fattening. Feeds and feeding. Swine. Animal nutrition. Feed constituents.

An experiment was conducted to determine the kinds and amounts of feeds taken ad libitum by pigs. Pigs 14-19 wk old consumed 29% green alfalfa, 34% roots (cassava and sweet potatoes) and 37% concentrates. At the age of 20-25 wk, the pigs selected 22% green alfalfa, 27% roots and 51% concentrates. In another experiment, 3 lots of 7 seven pigs each (approx. 12 wk old) were fed ad libitum with rations that consisted of (1) cassava meal, (2) cassava meal + molasses and (3) dried pineapple waste. Best wt gains were obtained during the last 3 wk of the test. Better and more economical gains were made by the lot selecting 21% cassava meal than by the lot selecting 22% cassava meal + molasses. (*Summary by A.J. Trans. by I.B.Z.*) H03

0256-8057 HEW, V.F. and HUTAGALUNG, R. I. **Utilization of cassava as a carbohydrate source for pigs.** *In* Symposium of the International Society for Tropical Root Crops,

4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.242-246. Engl., Sum. Engl , 11 Refs.

Cassava. Cassava meal. Swine. Food energy. Dietary value. Diets. Animal nutrition. Malaysia.

Cassava is an inexpensive source of valuable energy for pigs. Cassava with a low cyanogenic glucoside content, used with high-quality proteins to make up for nutrient deficiencies in amino acids and vitamins, can replace grains, reducing the cost of feed substantially When 30 Landrace pigs were given diets containing 0, 15, 30, 45 and 60% cassava as the energy source, no significant difference in performance or carcass characteristics was observed. The increase in cassava levels was accompanied by an increase in fish meal, a high-quality protein source available locally. The inclusion of fish meal rather than other proteins of plant origin in high cassava diets is comparable to the supplementation of methionine or other synthetic amino acids in cassava diets. (*Author's summary*) H03

0257-4453 HUTAGALUNG, R.I. *et al.* **Potential of palm oil mill effluent as feed for growing-finishing pigs.** Planter 53:2-9. 1977 Engl., Sum. Engl., 27 Refs.

Cassava. Cassava meal. Feed mixtures. Swine. Fattening. Finishing. Diets. Costs. Statistical analysis. Dietary value. Malaysia.

Two types of processed palm oil mill effluent, referred to as censor tk8 (35% palm oil sludge, 32.5% cassava meal, 32.5% palm kernel cake) and tkg (32% palm oil sludge, 34% cassava meal, 17% palm kernel cake, 17% grass meal), were evaluated in pigs. Both meals replaced 50 or 100% of the maize fraction in a conventional maize/ soybean ration. The rate of gain of pigs fed 50% censor tk8 or tkg was relatively the same, but their feed intake and feed per gain ratio were significantly higher than those of the control. At 100% replacement of maize by either censor tk8 or tkg, performance was significantly poorer than that of the 0 (control) and 50% censor diets. There were no substantial differences in carcass characteristics. An analysis of cost showed that it is economical to replace 50% maize with censor tk8 or tkg. *(Author's summary)* H03

0258-8060 HUTAGALUNG, R.I. and TAN, P.H. **Utilization of nutritionally improved cassava in poultry and pig diets.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.255-262. Engl., Sum Engl., 21 Refs.

Cassava. Poultry. Swine. Cassava chips. Fermentation. Industrial microbiology. Diets. Animal physiology. Dietary value. Composition. Feed constituents. Malaysia.

Studies related to the improvement of cassava through nutrient supplementation and fermentation are discussed. An experiment was carried out to investigate the effect of substituting maize with different levels of fermented cassava on the performance of broiler chicks. In addition, the preliminary results of iodine metabolism in pigs fed cassava diets are presented. Substitution of maize with up to 50% fermented cassava resulted in performances that compared favorably with the control. Total substitution of the maize component of the chicks' diet by fermented cassava did not depress performance appreciably. Further improvement in the protein quality of the fermented cassava and proper supplementation with other nutrients will make a significant contribution to poultry and pig diets. (*Author's summary*) H03

0259-7921 JOB, T.A. **Utilization and protein supplementation of cassava for animal feeding and the effects of sulphur sources on cyanide detoxification.** Ph D. Thesis Ibadan, Nigeria, University of Ibadan, 1975. 807p. Engl , Sum Engl., 383 Refs., Illus.

Cassava. Tubers. Feeds and feeding. Swine. Sheep. Rats. Feed mixtures. Legume crops. Fattening. Silage. Composition. ACN content. Protein content. Detoxification. Methionine. Digestibility. Diets. Cooking. Timing. Supplements. S. N. Thiocyanates. Maize. Analysis. Statistical analysis. Finishing.

A review of literature on cassava, its nutritive value and toxicity, and its role in human and animal nutrition was made, with emphasis on its protein deficiency and potential as an energy source. A review was also made of the role of legumes in nutrition and the elimination of their toxic factors. The ensiling process for fermenting, detoxifying and preserving cassava was explored as a means of detoxifying soybeans and cowpeas. The role of supplemental sulfur in cyanide detoxification was also examined. Five experiments including an N balance study were conducted to evaluate the effect of using cooked, ground and germinated soybeans, ensiled or not, with cassava plus methionine supplementation on the nutritive value and digestibility for growing rats. A digestibility and N balance study was also conducted with growing pigs. Three experiments with rats evaluated cooked, raw and ensiled cowpea/cassava diets. Cooked soybean or cowpea/cassava diets were well utilized by rats; however, after 1 mo ensilage, performance was reduced significantly ($P<0.01$). Ensiling the cooked soybean/cassava mixture for 3 mo improved performance significantly ($P<0.01$) as compared to the 1-mo period. Although methionine supplementation (0.1-0.2%) did not improve the unensiled, cooked soybean/cassava diets, it improved the cooked cowpea/cassava mixture. Methionine supplementation (0.1%) did improve performance significantly ($P<0.01$) of the cooked soybean/cassava mixture when ensiled for 1 mo. Neither the raw soybean or cowpea/cassava mixture nor the raw, raw ground, or germinated soybean/cassava supported growth when ensiled; in fact, feeding the raw soybean/cassava mixture caused a nonsignificant ($P>0.05$) depression in crude protein digestibility and a significant depression ($P<0.05$) in N retention and serum protein ($P<0.01$) of growing rats. Ensiling for 2 mo increased protein digestibility and N retention of rats nonsignificantly ($P>0.05$). For growing pigs, however, it improved protein digestibility significantly ($P<0.01$) but not N retention. Grinding the raw soybeans before ensiling had no effect. Ensiling the raw soybean/cassava mixture for 3 mo improved performance nonsignificantly ($P>0.05$), except in the germinated form, which depressed growth further. Although methionine supplementation (0.1%) did not improve the raw, unensiled form of the soybean/cassava mixture, the improvement was significant ($P<0.01$) after ensiling for 1 mo. In the raw and raw, germinated forms, there was a nonsignificant ($P>0.05$) response to 0.2% methionine supplementation after ensiling for 1 or 3 mo; there was an improvement in PER for the raw, ensiled forms but a depression for the germinated forms. On the other hand, methionine supplementation (0.1%) significantly ($P<0.01$) improved the value of the cowpea/cassava mixture, either raw or after 1-mo ensilage. Two experiments with growing-finishing pigs on a 20, 30 or 40% maize/soybean meal supplement fed free choice with fresh cassava plus molasses or sugar showed nonsignificant ($P>0.05$) differences in overall performance, except for a significant ($P<0.01$) reduction in PER on the 30 and 40% protein supplements. Molasses or sugar supplementation of a fresh cassava/40% protein supplement diet fed free choice improved pig performance nonsignificantly ($P>0.05$). Experiments on the utilization of bitter and sweet cassava meal by growing pigs have shown that bitter cassava meal reduces performance significantly ($P<0.01$) but gives higher crude protein and DM digestibility and significantly ($P<0.01$) higher serum and urinary thiocyanate excretion. Nitrogen retention was similar for both diets and was increased nonsignificantly ($P>0.05$) on 0.2% methionine supplementation. Studies on the utilization and digestibility of cassava for sheep indicated that there was no difference in the utilization of cassava dehydrated plus poultry excreta, dried cassava, or a maize-based control diet. Fresh and dried cassava roots and peels were well utilized and digested by growing sheep. Experiments were conducted with growing pigs to evaluate the effect of 0.2% methionine, 0.785% sodium thiosulfate or 0.2% elemental sulfur supplementation to a basal cassava meal diet on the performance, serum thiocyanate, urinary thiocyanate, N and S excretion of growing pigs. There were no significant ($P>0.05$) differences in performance. However, sodium thiosulfate supplementation increased urinary thiocyanate and sulfur excretion significantly ($P<0.05$), whereas sulfur significantly ($P<0.01$) increased urinary sulfur but not urinary thiocyanate excretion. Supplemental potassium cyanide did not change the pattern of responses *(Author's summary)* H03 H04

0260-7902 JIMENEZ P., I **La yuca en la alimentación de cerdos.** (*Cassava for swine feeding*). ICA Informa 10(5):3-4, 9-10. 1975. Span., Illus.

Cassava. Tubers. Fresh products. Swine. Detoxification. Animal nutrition. Colombia.

Cassava is grown throughout Colombia since it is well adapted to different climates and soils. Some varieties yield as much as 35-40 tons/ha Cassava is a rich energy source for pigs and can be used as a less expensive substitute for sorghum and maize Some varieties (i.e., CMC 84 and 85) are toxic because of their high HCN content Several methods are given for reducing toxicity. Fresh or ensiled cassava, as well as meal, may be used for swine. Preparation of rations based on fresh cassava with protein supplementation is explained. Life-cycle rations for growing, finishing, gestation and lactation periods are included. (*Summary by L.A. Trans. by I.B.Z.*) H03

0261-7901 JIMENEZ P., I. **Yuca seca y yuca ensilada en la alimentación de cerdos.** (*Dried and ensiled cassava for swine feeding*). ICA Informa 10(6):1-6. 1975. Span., Illus.

Cassava. Cassava meal. Swine. Animal nutrition. Waste utilization. Colombia.

Different uses of cassava and some of its by-products for swine feeding are explained. Methods for processing dried and ensiled cassava, as well as sample rations, are given. Ensiled cassava may be stored for 8 mo or longer without deterioration. Stems and leaves, which are not well accepted by pigs, should not be included. A forage silo adapted for cassava is described. Waste products of starch extraction (i.e., spent pulp and supernatant material) can be used in swine rations. Cassava leaf meal with a protein content of 15-18% can be fed (up to 10% of the ration) to growing-fattening pigs; for gestating sows, 15% may be used. (*Summary by L.A. Trans. by T M.*) H03

0262-8058 KHAJARERN, S. and KHAJARERN, J. M. Use of cassava as a food supplement for broiler chicks. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.246-250. Engl., Sum. Engl., 12 Refs.

Cassava. Chicks. Pellets. Cassava meal. Dietary value. Feed contituents. Animal nutrition. Thailand.

Two experiments were conducted to determine the substitutional value of cassava for maize in broiler rations. One-day-old Arbor Acres broiler chicks were used. In the 1st experiment, no significant differences in body wt gain and feed conversion were noted for chicks receiving 0, 7.5, 15, 22.5 and 30% cassava pellets. However, in experiment 2, significantly poorer body wt gain and feed conversion ($P<0.05$) were noted from 1-5 wk of age when the rations contained 0, 10, 20, 30, 40 and 50% cassava meal. It was also noted that body wt gain was not depressed until the rations contained more than 30% cassava meal. The chicks' ability to utilize cassava meal increased with age. From 5-9 wk of age and 1-9 wk of age, there were no significant differences observed in body wt gain and feed conversion when the concentration of cassava root meal increased in the rations. Limiting factors in maximum replacement and economic feasibility of substituting cassava products for maize were fiber and protein content; prices of cassava compared to those of fish and soybean meals. (*Author's summary*) H03

0263-7533 LEBOUTE, E M., ROFFLER, R E. and BOHRER, J.L. **Influência do consumo de proteína e energia digestíveis na manutenção do quilíbrio nitrogenado em ruminantes.** (*The*

effect of protein intake and digestive energy in maintaining the nitrogen balance in ruminants). Revista da Faculdade de Agronomia e Veterinaria da Universidade Federal do Rio Grande do Sul 1(1):53-70. 1975. Port., Sum. Port., 27 Refs.

Cassava. Cassava meal. Feeds and feeding. Sheep. Digestibility. Dietary value. Diets. Protein content. Food energy. Dry matter. Animal nutrition. Brazil.

A study was made of 6 pelletized rations based on molasses, soybean bran, cassava meal, maize cobs, rice straw and a mineral mixture. The diets were balanced for dry matter intake, 2 levels of digestible energy intake (100 and 135 kcal/kg $^{0.75}$) and 3 levels of digestible protein (0.55, 1.01 and 2.18 g/kg $^{0.75}$) per day, respectively. A Latin square experimental design was used with 6 sheep receiving the 6 treatments in 6 experimental periods, determining digestibility and nitrogen balance A detailed analysis is made of these variables and individual differences in the animals. Under the experimental conditions, approx. 1/3 of the daily digestible protein requirements, tabulated according to the feeding patterns, was sufficient for maintaining the N balance in sheep when a minimum of 2/3 of the tabulated digestible energy requirements was consumed. (*Author's summary. Trans. by T.M.*) H03

0264-8032 MONTILLA, J.J., VARGAS, R. and MONTALDO, A. **The effect of various levels of cassava leaf meal in broiler chicken rations.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.143-145. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava meal. Leaves. Chicks. Dietary value. Animal nutrition. Venezuela.

Cassava leaf meal was used as a protein source in the rations of 1-day-old Vantress x White Rock chicks. When rations were administered in meal form, body wt gain and dietary efficiency were depressed at all levels of foliage addition up to the 6th wk. This depression was noticeable during the last 4 wk only at the top level of substitution Pelleting greatly improved the adverse effects that appeared when the feed was given in meal form. (*Author's summary*) H03

0265-7454 MOORE, C. P. **El uso de forraje de yuca en la alimentación de rumiantes.** *(Cassava forage for ruminants).* *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 270-288. Span., Sum. Span.

Cassava. Forage. Nutritive value. Leaves. Proteins. Analysis. Animal nutrition. Colombia.

The nutritive value of cassava as a forage is not well known, especially in the tropics, to which it is native. Here, the advantages are given of cassava forage (under the conditions of the study) as a source of protein that competes efficiently with other sources of plant protein, as shown by animal performance. Annual dry matter production per hectare is very high in comparison to other tropical plants rich in protein, which makes its use as a forage very attractive. Highest yields were obtained with a population of 111,000 plants/ha and a 90-day interval between harvests *(Author's summary. Trans. by T.M.)* H03

0266-8173 ONAGHISE, G.T.U. and BOWLAND, J.P. **Influence of dietary faba beans and cassava on performance, energy and nitrogen digestibility and thyroid activity of growing pigs.** Canadian Journal of Animal Science 57:159-167. 1977. Engl., Sum. Engl., Fr., 19 Refs.

Cassava. Nutritive value. Swine. Diets. Composition. Animal physiology. Fattening. Finishing. Feed constituents. Animal nutrition.

The nutritional value of ground, unprocessed broad beans was studied with 120 growing pigs from 4 wk of age to market wk of 84 kg. Fifteen diets were fed using broad beans as a partial or total replacement for soybean meal (SBM) in barley-baseddietscontaining 0,20 and 40% cassava during the 1st 9-wk starting. phase. During this phase, av daily feed intake, daily gain and efficiency of feed conversion were not significantly altered by up to 21% replacement of SBM by broad beans. Supplementation with L-lysine and DL-methionine did not improve performance significantly. Total replacement of SBM, even with lysine and methionine supplementation, produced significantly lower ($P<0.01$) av daily feed intake, daily gain and feed conversion efficiency although amino acid supplementation improved these diets significantly. Up to 40% cassava in the diet did not significantly affect the parameters studied, nor were there significant effects on blood thyroxine or triiodothyronine levels. Digestibility of energy and nitrogen tended to be reduced as broad bean levels increased, but this could account for only a small proportion of reduced performance. During the finishing phase, partial or total replacement of SBM by broad beans had no significant effects on feed conversion efficiency. Broad bean diets produced significantly ($P<0.01$) lower av daily feed intake and daily gain When supplemented with lysine and methionine, broad beans may replace up to 21% of SBM in rations for weanling pigs (*Author's summary*) H03

0267-7487 PEIXOTO, R.R. and MAIER, J.C. **Avaliação da farinha de mandioca como alimento energético para aves, quando o fator consumo é eliminado.** (*The value of cassava meal as an energy feed for chicks when the intake factor is eliminated*) Revista da Sociedade Brasileira de Zootecnia 3(1):70-79. 1975. Port , Sum. Port., Engl., 11 Refs.

Cassava. Cassava meal. Maize meal. Feed constituents. Dietary value. Chicks. Animal nutrition. Brazil.

An experiment with chicks from birth to 4 wk of age was conducted at the Universidade Federal de Pelotas (Brazil) to study the nutritive value of cassava meal fed ad libitum as compared to maize (consumption limited to level consumed by cassava-fed chicks) A 4 x 4 Latin square design was used with 320 birds. Treatments were as follows: A, 60% maize; B, 60% cassava meal; C, 36% cassava meal + 24% maize; D, 18% cassava meal + 42% maize. All diets contained a premix of meat meal, soybean meal, bone meal and limestone. As regards liveweight gain and feed efficiency, there was a statistically significant difference ($P<0.05$) between treatment B (the worst) and the others. Intake, as a factor, had a definite influence on the value of cassava meal as regards wt gain. When intake was artificially imposed on the other rations, the cassava meal diet was equivalent to 84-86% of the maize control diet. It is suggested that when cassava meal is the sole energy source in starter rations, an attempt should be made to improve feed conversion, perhaps through the inclusion of fat or methionine The cost of rations must also be taken into account (*Author's summary*) H03

0268-7365 PETTERSSON, G. R. **Animal nutrition and livestock development.** Pan American Health Organization Scientific Publication 295:31-39. 1975. Engl., 22 Refs.

Cassava. Animal nutrition. Nutritive value.

Swine, poultry and cattle feeding practices in tropical America, especially Mexico, are reviewed. As regards cassava, fresh roots (ensiled or dry) may be used in swine feeding. In trials conducted in the Mexican tropics, it was shown that a diet composed of 44% dried cassava, 25% grain and

24% protein supplement gave greater wt gain (895 g) and better food conversion (3.72) than one with 76% grain and 17% protein supplement (874 and 3.89 g, respectively). Similar results have been obtained in other Latin American countries. Cassava can also be used up to 50% in chicken rations. It is concluded that (1) existing natural resources can maintain enough livestock to meet the population's requirements, even in less developed areas; (2) this increases the need to use all existing natural resources, as well as agricultural and industrial products and by-products, in animal nutrition; (3) a livestock technology must be developed for tropical conditions; and (4) present production techniques must be disseminated through extension programs appropriate for each area in accordance with its ecological, socioeconomic, cultural and political conditions. (*Summary by A.J. Trans. by T.M.*) H03

0269-8172 RIBEIRO, P.J. *et al.* **Melaço desidratado e raspa de mandioca como substitutos parciais do milho para produção de leite.** (*Dehydrated molasses and cassava meal as partial substitutes of maize for milk production*). Arquivos da Escola de Veterinária Universidade Federal de Minas Gerais 28(2):193-200. 1976. Port., Sum Port., Engl., 20 Refs.

Cassava. Cassava meal. Molasses. Dairy cattle. Diets. Composition. Milk. Production. Dietary value. Animal nutrition. Maize. Brazil.

The effects of partial substitution of maize by cassava meal and dehydrated molasses were compared in supplemental feeding for dairy cows. Twelve Holstein x zebu cows were used in a cross-over design with 3 treatments over a 63-day period (including an adjustment period of 10 days and 3 14-day experimental periods). Cows were fed 0.421 kg/kg milk produced. The av protein percentage of the ration was 15.66% and calculated TDM was 67.4%. A salt and mineral mixture was fed free choice. Under these conditions it was possible to substitute 50% of the maize. The cassava diet was palatable and did not cause any perceptible organic disturbance. There was no difference in weight gain among the treatments (*Author's summary*) H03

0270-6850 SER, E. S. DO **A mandioca na alimentação das vacas leiteiras.** (*Cassava as a feed for dairy cows*) Boletim da Cooperativa Central dos Produtores de Leite. 1953:349, 342. Novembro 1953. Port.

Cassava. Animal nutrition. Dairy cattle. Brazil.

The advantages of cassava as feed for dairy cows are discussed briefly. In addition to its being easy to grow on soils of low fertility at low cost, the best harvest coincides with the period when forage is scarce. From 4-8 kg fresh, chopped roots/day, can be fed with a protein-rich supplement Two such diets are given for 500-kg cows producing 7 1/2 kg milk/day (*Summary by S.S. de S Trans by T.M*) H03

0271-8178 SHIMADA, A.S **Utilización de la yuca en la alimentación animal.** (*Cassava in animal feeding*) Técnica Pecuaria en México no.25 50-57 1973. Span, 39 Refs

Cassava. Cassava tubers (vegetable). Cassava meal. Dried tubers. Tubers. Composition. Animal nutrition. Chicks. Swine. Leaves.

A literature review is presented of the use of cassava in animal feeding The 3 different ways in which cassava may be fed to animal are discussed. fresh roots, ensiled cassava and cassava meal.

Trials with fresh cassava (washed and ground or chopped) have been limited to swine feeding; levels up to 55% have given satisfactory results. There has been little experimentation with ensiled cassava. Cassava meal (50-54%) was satisfactorily fed to chicks; levels of 50-60% gave good results in swine feeding. For dairy cattle, 50% cassava meal gave better results than maize (7.5 and 7 7 kg of milk, respectively). An analysis of cassava roots and leaves is included The use of cassava as a feed depends on its relative price as compared to other energy sources (*Summary by A.J. Trans. by I.B Z*) H03

0272-5270 SOEWARDI, B. *et al.* **The influence of corn and cassava meal supplementation on the feeding value of alangalang. [*Imperata cylindrica* (L.) Beauv.] for Ongole grade heifers.** Malaysian Agricultural Research 4:123-130. 1975. Engl., Sum. Engl., 29 Refs.

Cassava. Cassava meal. Maize. Beef cattle. Feeds and feeding. Animal nutrition. Indonesia.

Ten young Ongole grade heifers (av wt 119.95 kg) were arranged in a cross-over design to compare the feeding values of *Imperata cylindrica* to *Pennisetum purpureum* (Napier grass). Both roughages were fed ad libitum. The chemical composition (%) for *I. cylindrica* (Group I) and Napier grass (Group II) respectively, was as follows: protein, 7.7 and 8.1; fiber, 46.9 and 36.6 ether extract, 11.5 and 1.7; ash, 7.1 and 14.3; and nitrogen free extract, 36.8 and 39.2. Biweekly gains/head for Group I averaged 1.96 kg, compared to 1.11 for Group II (not significant). Av daily DM intake for Group I (2.48 kg) was substantially higher than for Group II (2.20 kg). Digestion coefficients of dry and organic matter were similar for both rations: 60.9 and 66.9% for Group I and 58.2 and 61.4% for Group II. Ruminal ammonia concentration was 13.67 mg NH_3N/100 ml rumen fluid for Group I and 21.7 mg for Group II. The difference was highly significant. Biweekly gains/ head with maize were significantly different (7.63 kg) from those with cassava meal suplementation (3.34 kg). Av daily intake (2.93 kg/head) was significantly higher for maize than for cassava meal (2.61 kg/head), Ruminal ammonia concentrations in the maize and cassava meal treatments were 9.79 and 5.19 mg NH_3-N/100 ml rumen fluid, respectively, which was significant. *(Author's summary)* H03

0273-4857 SPERLING, L. Tapiokamehl. *(Cassava meal).* Futter und Futterung 44:343-344. 1954. Germ., 5 Refs

Cassava. Cassava meal. Processing. Animal nutrition. Feeds and feeding. Composition. Analysis. German Federal Republic.

After mentioning the sizable increase in cassava meal imports in Germany, the processing of the same is described Two types of cassava meal are analyzed, and their coefficients of digestibility for swine and wether lambs are given. The vitamin D content of cassava is emphasized for solving problems of malnutrition (i.e., rickets). In diets for fattening animals, cassava meal, which is rich in carbohydrates, can be used up to 40% of the feed. It is used more frequently for fattening swine in diets supplemented to make up for the low protein, fat and mineral content of cassava. For poultry, 20% protein must be added for hens and 10% for chicks *(Summary by H.P. Trans by T M)* H03

0274-3481 UPMANN, W. Das Tapiokawurzelmehl, seine Herkunft; Egenschaften und Verwendung als Nahrungs und Futtermittel. *(Cassava: its properties and present use in human and animal nutrition)* Mullerei 7:249-250 1954. Germ.

Cassava. Cassava flour. Cassava meal. Cassava leaf meal. Tubers. Composition. Analysis.

Nutritive value. Uses. Tapioca pearls. Animal nutrition. Human nutrition. German Federal Republic.

Cassava meal is being used increasingly for mixed feeds in Germany (even though it has to be imported) because of the advantages for fattening cattle and swine (high starch content). The process of obtaining tapioca pearls is explained; tapioca has a low vitamin B content as contrasted with wheat flour. Uses of cassava flour in composite bread flours in Brazil and Colombia are mentioned. A comparison is made of the composition of cassava roots and leaves, indicating that the latter are better for mixed forages because of their high protein content. Because of the high P requirements of ruminants, cassava meal would not be an ideal feed for dairy and beef cattle. *(Summary by H P. Trans by T.M.)* H03 H01

See also *0240* *0347* *0348* *0352* *0354* *0358* *0375* *0422*

H04 HCN Toxicity and Detoxification (For HCN content, see C03)

0275-8397 BARRET, M.D. *et al.* **Fate of orally dosed linamarin in the rat.** Canadian Journal of Physiology and Pharmacology 55(1):134-136. 1977. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. Toxicity. Linamarin. Laboratory animals. Laboratory experiments. Toxicology.

Wistar rats, about 100 g in wt, were dosed by stomach tube with 30 mg pure linamarin. No intact linamarin was identified in the feces or blood, but 5.65 mg was excreted in the urine along with 0.823 mg of thiocyanate ion. A 50-mg dose of linamarin was lethal to 7 of 10 rats receiving this dose. (*Author's summary*) H04

0276-2749 NEMOTO,Y. Estudo sôbre a toxidez do pão fabricado com farinha de raspa de mandioca, que contem acido cianidrico. (*Study on toxicity of bread made from cassava chips containing HCN*). Revista Alimentar 4(33).5-7. 1940. Port.

Cassava. Cassava flour. Cassava chips. HCN content. Linamarin. Detoxification processes. Linamarase. Breads. Brazil.

In tests on HCN content in cassava (produced when linamarin is hydrolyzed), it was found that boiling did not destroy linamarin and sulfuric acid did not hydrolyze it. Cassava was cut into chips and grated to determine HCN content. The more cassava is disintegrated (cell breakage), the faster linamarase acts on linamarin, yielding HCN. When cassava is well crushed, this reaction lasts only 1 h Linamarase is active under 62°C but loses its activity over 72°C. Both linamarin and linamarase are found in flour made from cassava chips. Linamarase acts on linamarin in the presence of water. The HCN in cassava flour is not harmful in breadmaking as the HCN volatilizes during the baking process. At rates below 0.017 g HCN/100 g composite flour (5, 10, 20% cassava), it does not hinder fermentation. (*Summary by I.B.Z.*) H04

0277-8055 OKE, O.L The prophylactic action of cassava. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976 Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.232-236 Engl., Sum. Engl, 26 Refs.

Cassava. HCN. Toxicology. Cyanogenic glycosides.

Cyanogenic glycosides are toxic in large doses, but the body can cope with small doses, which are converted to compounds of high physiological activity, e.g., glucose, cyanate and thiocyanate (used for sickle cell crisis and certain hypertension), salicylic acid and isomers (an antipyretic and analgesic), and HCN (a potent cytotoxin). Under certain conditions such as development of

neoplasm or schistosomiasis, the affected cells contain high amounts of glucosidases or glucuronidases, capable of hydrolyzing the glycosides but devoid of the enzyme rhodanese for converting the highly toxic HCN to the much less toxic thiocyanate. This results in selective toxicity in which the cells are destroyed, but the somatic cells with high amounts of rhodanese survive. Since the diets of people in developing countries contain a lot of cassava high in cyanogenic glycosides, this might account for the prophylactic property that results in rarity of sickle cell anemia and bowel cancer. (*Author's summary*) H04

0278-7809 OLAREWAJU, O. C. and BOSZORMENYI, Z. **The process of detoxification and residual cyanide content of commercial gari samples.** West African Journal of Biological and Applied Chemistry 18(1):7-14. 1975. Engl., Sum. Engl., 23 Refs., Illus.

Cassava. Gari. Leaves. Tubers. HCN content. Detoxification processes. Fermentation. Analysis. Nigeria.

Because of the increasing nutritional importance of cassava, the HCN content of commercial gari samples and the popular theories of its detoxification were reinvestigated. All the white gari samples contained HCN in the range of 20 ppm whereas the yellow samples containing palm oil had practically no HCN. The safe upper limit of the permissible HCN level in gari (fermented and roasted cassava roots) must be defined from the point of view of chronic toxicity. *(Summary by Absracts on Tropical Agriculture)* H04

0279-7557 PIERIS, N., PREMADASA, G.G. and JANSZ, E.R. **A method for assay of total potential cyanide in manioc flour.** Journal of the National Science Council of Sri Lanka 1:207-210 1973. Engl., 8 Refs

Cassava. Cassava flour. HCN content. Analysis. Biochemistry. Laboratory experiments. Sri Lanka.

In order to develop a standard analytical procedure for determining potential cyanide content (free and bound) in cassava flour, the following factors were taken into account: sample size, pH, addition of exogenous linamarase, time of incubation, recovery by aspiration with air or steam distillation, and the effect of temperature and time on recovery. The following method is recommended: (1) cassava flour (10 g) is introduced into a distillation flask, (2) water (200 ml) and excess linamarase (approx. 450 µg/min) is added, (3) the sample is incubated 2 h at room temperature, (4) the sample is distilled and 250-300 ml of distillate is collected in a solution of 0.5 g sodium hydroxide in 50 ml of water, and (5) cyanide content is estimated by the colorimetric picric acid method. (*Summary by A.J. Trans. by I.B.Z.*) H04

See also 0241 0244 0259

I00 PROCESSING, PRODUCTS AND USES

0280-4936 STARCH FROM JAVA. Trade and Engineering 49(928) 18-20. 1941. Engl.

Cassava. Processing. Uses. Cassava flour. Gaplek. Tapiocas. Production. Java.

A brief description is given of the processes used for manufacturing cassava flour in Java. The finest flour is from Bandoeng. The majority of the production is exported to the USA for manufacturing dextrins, adhesives, etc. In addition, gaplek, another product obtained from cassava, is used in making livestock feeds and glucose. (*Summary by A.J. Trans by S.S. de S.*) I00

0281-7912 ALLEN, J.E., HOOD, L. F. and PARTHASARATHY, M.V. **The ultrastructure of unmodified and chemically-modified tapioca starch granules as revealed by the freeze-etching technique.** Journal of Food Technology 11:537-541. 1976. Engl., Sum. Engl., 21 Refs , Illus.

Cassava. Cassava starch. Analysis. Laboratory experiments. Particle size.

The ultrastructure of cassava starch granules was studied using the freeze-etching technique in an attempt to overcome the problems associated with the other methods of preparation for electron microscopy. A chemically-modified cassava starch was also studied to ascertain whether chemical modification affected granule structure. Variations in fracture faces were observed in both modified and unmodified granules, suggesting that organization within the granules was not homogenous. Particles were present on granule fracture faces. The size range of the particles was 4-10 nm in the unmodified and 6-15 nm in the modified granules. These observations were similar to those found by others in freeze-etched starch granules and must be considered to be of some structural significance. In contrast to the fracture face, the outer surface of the granules was smooth and particles were not evident. *(Author's summary)* I01

0282-8317 BOUNDY, J.A *et al.* **Exoenzymic activity of *alpha*- amylase immobilized on a phenol-formaldehyde resin.** Carbohydrate Research 48:239-244. 1976 Engl , Sum. Engl., 7 Refs., Illus.

Cassava. Cassava starch. Enzymes. Biochemistry. Laboratory experiments.

Amylose and amylopectin from 2 starch sources (cassava and maize) were partially degraded by *alpha*-amylase immobilized on a phenol-formaldehyde resin. The degradation products were fractionated by gel-permeation chromatography and high-pressure liquid chromatography. Two distinct fractions were obtained from cassava amylose One is a fragment with a mol wt exceeding 200,000, the other consists of oligosaccharides of low mol wt with a degree of polymerization of 1-8 In contrast, treatment of cassava amylose with soluble *alpha*-amylase produces a single fraction, nearly all of which has a mol wt of-<35,000, with only traces of small oligosaccharides detectable by high-pressure liquid chromatography. Even wider differences were observed in degradation products from cassava amylopectin. Similar activity patterns were obtained with immobilized and soluble enzymes when using maize amylose and amylopectin as substrates. Immobilization of *alpha*-amylase on the resin apparently restricts enzyme activity to the ends of the starch molecules, making it appear to be limited to exoenzymic activity. (*Author's summary*) I01

0283-3870 CONWAY, R. L. and HOOD, L. F. **Pancreatic alpha amylase hydrolysis products of modified and unmodified tapioca starches.** Staerke 28(10):341-343. 1976. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Cassava starch. Modified starches. Enzymes. Hydrolysis. Laboratory experiments. Analysis.

Three gelatinized cassava starches [unmodified (A), hydroxypropyl distarch phosphate (B), and hydroxypropyl starch (C)] were hydrolyzed by hog pancreatic α-amylase (EC 3.2.1.1. -1,4-glucan 4-glucanohydrolase). Oligosaccharide constituents of the hydrolysates were separated by thin-layer chromatography and quantified by spectrodensitometry. Glucose, maltose, maltotriose and maltotetraose were identified by chromatography. Hydrolysates from starches B and C had lesser amounts of the lower mol wt oligosaccharides (G_1-G_4) than did those from starch A. The products of hydrolysis varied quantitatively with the degree of hydrolysis. (*Author's summary*) 101

0284-6993 KERR, R.W. **Chemistry of starch in relation to its use in paper coating.** *In* Bingham, R.T., ed. Starch for paper coating. New York. Technical Association of the Pulp and Paper Industry. Tappi. Monograph Series no.3. 1947. pp.4-13. Engl., 22 Refs , Illus.

Cassava. Cassava starch. Industrial starches. Paper industry.

The use of starch as a water-dispersible adhesive carrier is discussed. The composition and general properties of paper coating are described, as well as the chemical composition and structure of starch Starch is composed of only 2 types of polymers, "linear" or amylose and "branched" or amylopectin. Starches from maize, cassava and potato contain amylose and amylopectin in different proportions (cassava, 20% amylose). The relative degree of polymerization of the amyloses has recently been computed from viscosity and osmotic pressure measurements. Differences noted may account for its variable behavior Chain length of cassava amylose is greater than that of maize but smaller than that of potato. Cassava amylose in an unmodified state is the most stable in solution Due to the chemical behavior of native amylose, the amylopectin component of starch is more suitable as an adhesive carrier. Procedures that will either remove the amylose fraction or alter its colloidal characteristics are being worked on. (*Summary by I.B Z.*) 101 102

0285-7911 KIM, S. K., CIACCO, C. F. and D'APPOLONIA, B.L. **Kinetic study of retrogradation of cassava starch gels; a research note.** Journal of Food Science 41(5):1249-1250. 1976. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Cassava starch. Gelatinization. Analysis. Laboratory experiments.

The kinetics of crystallization of cassava starch during aging were studied at different temperatures using the expression $\theta = \exp(-kt^n)$, where θ is the fraction of uncrystallized material remaining after time t. The values for the rate constant (k) indicated that the firming process for the cassava starch gels was characterized by a negative temperature coefficient. The Avrami exponent (n) was found to be unity over the range of temperatures studied (2—30°C), suggesting that the mechanism of starch crystallization is instantaneous nucleation followed by rodlike growth of crystals. *(Author's summary)* 101

0286-0044 LINDNER, W. **Zur Mikroskopie des Maniokmehles.** *(The microscopic examination of cassana flour).* Zeitschrift fur Lebensmittel - Untersuchurg und - Forschung 110(1). 14-15. 1959. Germ., 3 Refs.

Cassava. Cassava flour. Laboratory experiments. Analysis. German Federal Republic.

This is a review of literature by 4 German authors who have done microphotograhic studies of elements in cassava roots (reticulate tracheids, tracheids, parenchyma and sclerenchyma tissue) and flour (starch granules). However, the feasibility of progressing in the microphotographic study of plant elements is limited since it is difficult to reproduce the characteristics of each element. *(Summary by H.P Trans. by T.M.)* 101

0287-7568 ODIGBOH, E.U. **Viscometric characterization of cassava starch pastes.** Ph. D. Thesis. University Park, Pennsylvania State University. Department of Agricultural Engineering, 1974. 136p. Engl., Sum. Engl., 70 Refs., Illus.

Cassava. Cassava starch. Analysis. Viscosity. Statistical analysis. pH. Temperature. Particle size. Laboratory experiments. Uses. USA.

This study was aimed at the determination of the characteristics of unmodified cassava starch pastes based on paste viscosity measurements. Of the numerous genetic, varietal, cultural and production factors affecting paste viscosity, the following were studied: drying temperature, cooking temperature and paste temperature at several paste concentrations The raw starch used in the study was processed from cassava roots obtained from Florida. The wet starch was divided into 3 portions and each dried under 1 of these 3 conditions: air dried at room temperature at 25°C (DT_1), oven dried at 50°C (DT_2), and oven dried at 70°C (DT_3). The MacMichael and Stormer viscometers were used for measurements With the MacMichael viscometer, a 3 x 4 x 4 x 4 factorial experiment was designed in which paste viscosity was measured at 4 concentrations, 4 cooking and 4 paste temperatures for each of the 3 samples The effects of these factors, singly and in combination, on paste viscosity were evaluated by statistical analysis. Measurements with the Stormer viscometer followed the viscosity profile of the cassava starch paste through the cooking-cooling process. Only the DT_2 sample was so treated at 4 different concentrations, cooking to 95° and cooling to 50°C. Conclusions were as follows: (1) Cassava starch pastes exhibited plastic fluid flow behavior (2) Stable pastes were formed about 60-65°C during the cooking phase. Pastes were translucently clear and had a bland flavor, both of which are useful properties in the food industry. (3) The pastes had high hot-paste viscosities, particularly at the higher concentrations. The temperature at which the peak viscosity occurred decreased with increasing concentration. On the average, peak hot-paste viscosity was obtained at 72-85°C Lower hot-paste viscosities, peak and otherwise, were obtained from the DT_3 sample (4) Cooked beyond the temperature of peak viscosity, the pastes had long "cohesive textures," while below that temperature, textures were a lot less stringy. For food applications where long cohesive textures are undesirable, pastes should be cooked to below 80°C. At 70°C pastes had the "shortest texture." (5) The freeze-thaw stability of pastes was significantly affected by drying temperature and concentration. Whereas stability decreased with increasing concentration, it increased with higher drying temperature. The overall good stability of the cassava starch pastes to freezing and thawing is useful for frozen food processing applications (6) The pastes exhibited pronounced setback on cooling. Concentration was the most important factor influencing the cold-paste variation. Application of shear during cooking reduced the extent of retrogradation (7) Pastes thinned down considerably under shear Maximum work-softening occurred about the temperature of peak viscosity. (8) For most food applications, a desirable modification of cassava starch is one that reduces the long cohesive paste texture. This may be achieved by acid treatment to lower the pH and cause partial gelatinization of the starch. Drying the starch at high temperatures (70°C or higher) will also yield "short textured" pastes. (9) For use in high acid foods, the long cohesive texture of the unmodified cassava starch may be advantageous since at the lower pH, partial hydrolysis of the starch would result in a past of good body and texture. Similarly, use of unmodified cassava starch in food products with added sugar is advantageous since sugar inhibits swelling, thereby retarding gelatinization *(Author's summary)* 101

0288-2614 VITTI, P. **Amido de mandioca por via sêca e úmida.** (*Cassava starch from fresh and dried roots*). Coletânea do Instituto de Tecnologia de Alimentos 2.123-133. 1967/68. Port., Sum. Port., Engl., 2 Refs., Illus

Cassava. Processing. Cassava starch. Viscosity. Temperature. Analysis. Timing. Cultivars. Brazil.

Either fresh (maximum postharvest storage time, 36 h) or dehydrated cassava roots may be used for obtaining starch. Results are given of an experiment carried out with 5 different cassava varieties, comparing the use of fresh or dried roots. Viscosity was determined by the Brabender amylograph-viscograph, there was a marked difference in starch quality, the fresh roots being the better. The starch viscosity curves obtained by both processes were characteristic of cassava starch. (*Author's summary. Trans. by T.M.*) 101

0289-2627 VITTI, P. **Variedades de mandioca para fins industriais.** (*Cassava varieties for industrial use*). Coletanea do Instituto de Tecnologia de Alimentos 1:229-240 1965/66. Port., Sum. Port., Engl., 2 Refs., Illus.

Cassava. Cultivars. Tubers. Starch content. Cassava starch. Viscosity. Gelatinization. Analysis. Brazil.

Roots of 2 cassava varieties were compared for industrial properties Gum color, starch content and viscosity were determined. Branca de Santa Catarina had a white gum color whereas that of Mantiqueira was pinkish (unsuitable for some industrial purposes). Starch content on a DM basis ranged from 78 3-83.7%, being slightly higher for Mantiqueira, whose viscometric curves were also slightly better than those of Branca de Santa Catarina (*Author's summary*) 101 C03

See also 0230

0290-7895 AGROINDUSTRIAL MONAGAS, C.A. **AGROINMOCA; planta deshidratadora de yuca.** (*AGROINMOCA, a cassava dehydrating plant*). Jusepin, Monagas, Venezuela, 1975. 16p. Span., Ilus.

Also in English.

Cassava. Cassava programs. Cassava meal. Pellets. Industrialization. Factories. Industrial machinery. Venezuela.

A description is given of the processing of cassava meal to be used as a feed constitutent at the AGROINMOCA plant in Venezuela. Root dehydration and pelletization processes are explained. The fully automated process includes (1) washing and peeling the roots, (2) grinding, (3) rasping, (4) pressing, (5) dehydrating to a 12% water content, (6) pelletization, (7) ensiling, and (8) packing. The plant has a capacity for 120 tons of pellets/day, requiring 360 tons fresh roots/day (5400 ha/yr). (*Summary by A.J. Trans. by I.B.Z.*) 102

0291-6171 ALFA-LAVAL. **Alfa-Laval manioc starch plant.** Tumba, Sweden, 1971. 70p. Engl., Illus.

Also in Portuguese.

Cassava. Cassava starch. Industrial machinery.

This catalog presents the specifications, dimensions, photographs and diagrams of the machinery required for each of the steps in processing cassava starch. The layout for a factory with a capacity of processing 240 tons of fresh roots/day is also included. (*Summary by M.O. de H. Trans. by T.M.*) 102

0292-4609 ALFA-LAVAL **Reference list of machines and complete plants for the starch industry.** Tumba, Sweden, 1969. 12p. Engl., Illus

Cassava. Cassava starch. Factories.

A list is given of customers who use Alfa-Laval equipment for manufacturing starch They are grouped by countries and raw materials (i e., cassava, maize, potatoes, rice, sorghum, sweet potatoes and wheat) (*Summary by I.B Z*) 102

0293-4923 ALMEIDA, J.R. DE **Fabricação do alcoôl de mandioca.** (*Alcohol from cassava*). Piracicaba, Brasil, Jornal de Piracicaba, 1943. 92p. Port., 19 Refs., Illus.

Cassava. Alcohol. Production. Fermentation. Equipment. Costs. Brazil.

Starchy products are an important source of industrial alcohol in many European countries, the USA, China and Japan. Alcohol production from cassava is viable and necessary in Brazil. The purpose of this study is to explain the different steps in the manufacturing process: preparation of the malt, must and yeast (bacterial or chemical), fermentation of the must and distillation of the wine. Projects are included for building several distilleries with capacities for producing 1,000 - 6,000 liters of rectified alcohol and 10,000 liters or anhydrous alcohol/day. The cost of producing one liter of alcohol from cassava is also given. (*Summary by S.S. de S. Trans. by T.M.*) I02

0294-5267 AYERNOR, G.S. and STEINBERG, M.P. **Hydration and rheology of soy-fortified pregelled corn flours.** Journal of Food Science 42:65 - 69. 1977. Engl., Sum. Engl., 19 Refs., Illus

Cassava. Composite flours. Cassava starch. Uses.

The objective of this work was to prepare a soy-fortified maize dough having the same rheological properties as the unfortified material. Water sorption isotherms and hydration kinetics of pregelled maize flour, maize/soy and starch powder systems were investigated. The effect of adding processed full-fat soy flour on hydration, reconstitution and rheological properties of dough systems were studied with Brabender Farinograph and Extensograph instruments. Soy flour imparted an undesirable plasticizing effect on pregelled maize doughs. Rheological properties of model dough systems were studied to solve this problem. Results indicated this effect could be reversed by the addition of pregelled cassava starch as an elasticizing agent. A maize flour: soy flour: cassava starch 60:30:10 mixture produced a dough with rheological properties similar to those of maize flour dough. *(Author's summary)* I02

0295-1603 AYRES, J.C. **Processing cassava for industrial and food uses. VIII.** *In* Hendershott, C.E. *et al.* A literature review and research recommendations on cassava (*Manihot esculenta* Crantz). AID Contract no. csd/2497. Athens, University of Georgia, 1972. pp.183-326. Engl., 847 Refs.

Cassava. Developmental research. Cassava flour. Cassava starch. Industrial starches. Tapioca macaroni. Protein enrichment. Processing. Uses. Industrialization.

A literature review on cassava processing for industrial and food purposes in presented. A list is included on the use of the different parts of cassava and its by-products. The process of flour manufacturing is described. The chemical aspects of starch, its food and industrial uses, and processing are discussed. Several aspects of bread and macaroni making and flour enrichment are dealt with. If cassava is to compete with other starches, the following changes must be made: (1) development of high-yielding, disease-resistant, nontoxic varieties, (2) sufficient production of cassava for continuous processing, (3) efficient mechanization and good sanitary conditions in processing, (4) availability of pure soft water; (5) uniform quality of products; (6) improvement of nutritional and functional properties of products. (*Summary by A.J.*) I02

0296-7546 BALAGOPAL, C., DEVI, S.B. and PILLAI, K.B. **Microflora of cassava chips.** Agricultural Research Journal of Kerala 12(1):80-81. 1974. Engl., Sum. Hindi.

Cassava. Cassava chips. Mycoses. Bacterioses. Storage. India.

Populations of bacteria, actinomycetes and fungi were estimated in 10 g of parboiled, sun-dried and fresh cassava chips, stored for 6 mo in gunnysacks, taken from 3 different markets in Kerala. Bacteria and fungi were found on all samples studied and actinomycetes, on the parboiled samples from 1 market. Fresh chips had higher bacterial populations than the others, probably because of their higher moisture content Morphological identification of the fungi revealed that *Penicillium* and *Aspergillus* were most common, followed by *Rhizopus* and *Fusarium*, probably because the former are able to utilize the starch as a carbon source. (*Summary by A.J. Trans. by T.M*) I02

0297-0161 BARROSO, M.A.T. **Experimentações com panificação a base de misturas com produtos de mandioca.** (*Breadmaking experiments based on composite flours containing cassava products*). *In* Banco do Nordeste do Brasil, S.A. Departamento de Estudos Econômicos do Nordeste (ETENE). Divisão de Agricultura. Pesquisas tecnológicas sôbre a mandioca. Fortaleza, Brasil, 1972. pp.115-200. Port., Sum. Port.

Cassava. Cassava flour. Cassava starch. Uses. Breads. Composite flours. Analysis. Brazil.

A series of breadmaking experiments were conducted with different cassava products (i.e., cassava flour from sweet and bitter varieties, pregelatinized flour from sweet cassava, flour from cassava chips, cassava starch and starch from fermented roots). Although good-quality bread can be made with any of these wheat substitutes, difficulties were encountered, especially with regard to the percentage of water in the formulas, which should be as low as possible. Wheat flour with a high gluten content should be used; hard wheat is recommended and is less expensive. Cassava flour should be used at rates no higher than 10%. Starch-based mixtures had a strong tendency to high retrogradation and rapid aging; this can be corrected by using more complex mixtures. Pregelatinized (crystalized) flour had the best organoleptic qualities. The advantages of sweet cassava-based flour are given. In general the dough should not be fermented for long periods of time. The different mixtures tested did not alter the protein content of the bread. (*Summary by I.B.Z. Trans. by T.M.*) I02

0298-6032 BAUER, H.F., BAUER, J V. and HAWLEY, D.M. Adhesive composition. U.S. Patent 2,145,195 1939. 6p. Engl.

Cassava. Cassava starch. Industrial starches. Dextrins. Patents. Roll-dried adhesives. USA.

A composition that has strong adhesive properties and which, in the form of dried films, may be remoistened and develops tackiness rapidly consists essentially of a British gum converted to a solubility of about 70-95% in water at 24° and a dextrin content less than about 55% (as determined by Babington, Tingle and Watson's method), which has been intimately dispersed in the presence of water with about 3-30% of urea (based upon the wt of the gum), up to about 5% borax and about 1-10% of glycerol. Examples using cassava British gum, cassava dextrin and British gum from cornstarch are given. (*Summary by Chemical Abstracts*) I02

0299-2772 BAUER, H.F., BAUER, J.V. and HAWLEY, D.M. Adhesive composition. U. S. Patent 2,238,767. 1941. 6p. Engl.

Cassava. Cassava starch. Industrial starches. Dextrins. Patents. Roll-dried adhesives. USA.

Use is made of a remoistening adhesive consisting mainly of a starch conversion product (root starches such as sago, cassava, and sweet popato) converted to a solubility of less than 50% and a dextrin content of 10-20%, which contains urea in amounts ranging from about 5-25%, based on the wt of the starch conversion product Borax and glycerol may also be used, various details of which are given *(Summary by Chemical Abstracts)* I02

0300-5214 BAUER, H.F , BAUER, J.V. and HAWLEY, D.M. **Gummed tape manufacture.** U S Patent 2,188,329. 1940. 6p. Engl.

Cassava. Cassava starch. Industrial starches. Patents. Roll-dried adhesives. Dextrins. USA.

A remoistening tape is formed of a flexible sheet material such as paper carrying a dried coating of adhesive consisting mainly of a root starch conversion product converted to a solubility of about 3-50% in water at a temperature of 24°, a viscosity of 15-400 sec, and a dextrin content less than about 55%, intimately dispersed with about 3-30% urea based upon the wt of the conversion product, about 1-5% borax and about 1-10% glycerol. Such an adhesive when moistened develops tackiness and then sets rapidly. Examples are given using a cassava conversion product, cassava dextrin and a corn conversion product. *(Summary by Chemical Abstracts)* I02

0301-5035 BAUER, H.F., BAUER, J.V. and HAWLEY, D M **Method of applying gummed tape labels and the like.** U.S. Patent 2,167,629. 1939. 5p. Engl

Cassava. Cassava starch. Industrial starches. Dextrins. Adhesives. Patents. USA.

An amylaceous, water-soluble adhesive, such as a dried composition containing British gum and glycerol, is moistened with a solution containing borax and urea. Examples using cassava British gum and cassava dextrin are given *(Summary by Chemical Abstracts)* I02

0302-4939 BIE, H.C.H. DE. **De cultuur van cassave in de Preanger Regentschappen en het gebruik, dat van dit gewas door de bevolking wordt gemaakt en hare verwerking tot tapioça-meel.** (*Cultivation of cassava in the Preanger region of Java and its uses*). Teysmannia 11 273-298 1900. Dutch.

Cassava. Cultivation. Uses. Cassava meal. Trade. Java.

In the region of Preanger (Java), cassava is cultivated up to 1000 m, planting preferably at the end of the rainy season Cultural practices are given The fresh roots are used for food, young foliage for vegetables and older foliage for cattle forage Most of the production is made into a fermented meal; the process used by the natives is described. The ampas are used for fuel and fodder The best meal is transported to Djakarta for exportation to Europe, secondary quality mainly to Singapore. Chinese merchants manage to control prices for the roots and meal; measures should be taken to change this situtation so that local producers obtain fair prices. (*Summary by R van G*) 102 D02

0303-5417 BLAW-KNOX FOOD AND CHEMICAL EQUIPMENT. BUFLOVAK DIVISION. **Industrial drum dryers.** Buffalo, N.Y., Catalog 405B. 1973. 8p. Engl , Illus.

Cassava. Cassava starch. Industrial machinery.

The mechanisms, dimensions and specific uses (i.e , drying starch) of drum driers produced by BUFLOVAR are described and illustrated in this catalog. (*Summary by A.J. Trans. by T.M.*) 102

0304-8123 BOOTH, R.H. **Storage of fresh cassava (*Manihot esculenta*). II. Simple storage techniques.** Experimental Agriculture 13(2):119-128. 1977. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Tubers. Fresh products. Storage. Deterioration. Packaging. Timing. Temperature. Colombia.

The development of 2 simple techniques—box storage and field clamps, which allow curing and storage of fresh cassava roots for 1- and 2-mo periods— is decribed. Consistent and acceptable results have been obtained following storage of roots in boxes packed in moist but not wet sawdust and kept at ambient temperatures. The design of field clamps that maintain internal temperatures below 40°C for successful curing and storage varies according to season. Storage life of roots is enhanced by the selection of roots in good condition, any delay in placing the roots in storage results in poorer outturns. (*Author's summary*) 102

0305-7021 **BREAD FROM composite flours.** *In* Composite flour programme; development of bakery products and paste goods from cereal and non-cereal flours, starches and protein concentrates. Documentation package vol.1. 2 ed. rev. Rome, Food and Agriculture Organization of the United Nations, Food and Agricultural Service, 1973-. pp.27-29. Engl., Sum. Engl.

Also in French and Spanish.

Cassava. Cassava starch. Composite flours. Breads. Bakery products.

A description is given of 2 innovations being tested to employ larger quantities of cassava, maize or sorghum flours in breadmaking: (1) Bread without gluten. Substances that agglutinate starch, in this case glyceril monostearate (10% emulsion), are used to substitute wheat gluten. To compensate nutritional inferiority of all-starch bread, considerable amounts of plant protein are added in the form of peanut or soy flours, producing a bread that is more nutritious than traditional ones. (2) Bread made from modified flours. The proportion of nonwheat flours (cassava or maize starch and soy flour) is increased to more than 10%. Mechanical breadmaking is substituting traditional fermentation procedures. The Chorleywood method results in more uniform mass consistency and in a reduction (65 to 35%) of imported hard wheats. FAO experts offer assistance to member states that want to adopt these innovations. (*Summary by M.O. de H. Trans. by I.B.Z.*) 102

0306-7257 BUSHUK, W. and HULSE, J.H. **Dough development by sheeting and its application to bread production from composite flours.** Cereal Science Today 19(9):424-427. 1974. Engl., 5 Refs., Illus.

Cassava. Cassava flour. Composite flours. Breads. Analysis.

The process of developing dough by means of sheeting rolls, which eliminates the long fermentation period, is described. The results are comparable to those for composite flours obtained with the more sophisticated Chorleywood process. Three types of composite flours (70% wheat flour plus African or US millet or cassava and defatted soybean flour) were stored at 4

and 25°C for up to 3 mo to evaluate their storage ability. At 40° there was no change in breadmaking quality; at 25° loaf volume decreased 10% with storage time. The composite flours investigated were quite stable for periods of several months. (*Summary by A.J. Trans. by I.B.Z.*) I02

0307-6962 **CONSERVE MANDIOCA com sal; alimente melhor seus animais todo o ano.** (*Preserving cassava chips with salt*). Sumocultura 5(37)·14-15 1963. Port , Illus.

Cassava. Storage. Brazil.

Finely grated cassava roots can be stored up to 1 yr in wooden crates by adding 2-3 kg salt/ 100 kg cassava Weights are placed on the top to remove the liquid from the mass. This may be used for feeding animals after sun drying for 20 days (*Summary by I.B Z.*) I02

0308-3823 DREWS, B. and SPECHT, H. Zur Verarbeitung von Maniokamehlen in Brennereien. (*Alcohol from cassava flour*). Branntweinwirtschaft 81(3).49-51. 1959. Germ , Sum Germ., 8 Refs

Cassava. Cassava flour. Alcohol. Analysis. Processing. Fermentation. Germany.

The processing of alcohol from cassava flour is of growing importance in Germany. Various samples of flour are analyzed for their starch, fiber, ash and moisture contents The fermentation procedure is described in detail. (*Summary by T.M.*) I02

0309-0117 FARIA, G. DE **Novas fontes de produção de alcool para o Brasil.** (*New sources of alcohol production for Brazil*). Ceres 4:151-168. 1943. Port.

Cassava. Alcohol. Ethanol. Production. Productivity. Analysis. Economics. Brazil.

A historical review is made of fuel production in the world, especially in Brazil, to find little-used raw materials for producing ethyl alcohol Several processes used by a factory in Divinópolis (Minas Gerais) for obtaining alcohol from cassava are described, and production data are given for the period 1932-43. Yields for alcohol made from cassava, maize and rice are compared in a table. (*Summary by S.S. de S. Trans. by T.M.*) I02

0310-0971 **FECULERIE DE Manioc.** (*Cassava starch factory*) Revue Internationale des Produits Coloniaux. 1951:332-333. 1951. Fr.

Cassava. Cassava starch. Processing. Factories.

A brief description is given of the steps for preparing cassava starch· washing and rasping of roots, extraction of starch, purification of the starch-milk, cooking of the purified starch in metal basins, and drying. (*Summary by S S. de S. Trans. by T.M.*) I02

0311-6010 FONSECA M., A. **Industrialización de la yuca.** (*Cassava processing*) Medellin, Colombia Secretaría de Agricultura y Fomento. Publicación Especial no. 127 1974. 43p. Span., Sum Span., 6 Refs , Illus

Cassava. Cassava starch. Equipment. Factories. Processing. Production. Colombia.

A study was made of cassava processing plants in several municipalities of the state of Antioquia (Colombia) as a basis for improving the technology for making cassava starch. A flow chart is given of the different steps involved, which are described. The necessary equipment is described and illustrated. Basic production data and costs are given. *(Summary by T.M.)* I02

0312-5207 GROBOT and SIMPHAL. **Le tapioca.** (*Tapioca*). Revue Internationale des Produits Coloniaux 1929.90-92. 1929. Fr.

Cassava. Tapiocas.

A general description is given of tapioca processing, its importance and economic possibilities. The best tapiocas are from Rio (Brazil); they are white, hard and vitrified. The quality of tapiocas from Bahia (Brazil), Singapore, Java (Indonesia), Madagascar and Réunion are also described. (*Summary by I.B.Z.*) I02

0313-7525 GURGEL, L. **Avaliação de porcentagens dos componentes de farinhas mistas.** (*Evaluation of percentages of components of composite flours*). Boletim do Instituto de Química Agrícola no.5:1-32. 1940. Port., 12 Refs., Illus.

Cassava. Cassava flour. Composite flours. Analysis.

A detailed microscopic evaluation (counting and determination of areas) is made of wheat, cassava, maize and rice starches found in diverse proportions in composite flours. (*Summary by I.B.Z. Trans. by T.M.*) I02

0314-5378 HORIE, S [**Acetone-butyl alcohol fermentation. III. Utilization of various protein-rich raw materials as the source of nitrogen**]. Journal of the Agricultural Chemical Society of Japan 16:321-330 1940. Jap , 1 Ref.

Cassava. Waste utilization. Alcohol. Fermentation. Production.

Nitrogen compounds must be added for the acetone-butyl alcohol fermentation of dried sweet potato and sweet potato starch waste. Gluten meal is usually a suitable source of N. If this is inadequate, it is fortified by the addition of peptone Beer waste is also a useful source of N. Acetone (8-9%) was produced from dried sweet potato starch waste by adding a mixture of 0.5% soy waste and 0 3% gluten meal Wheat bran is useful as an N source for cassava whereas rice bran is suitable for dried sweet potato; both are effective for sweet potato starch waste. Fresh and dried sweet potato were fermented without adding a source of N. *(Summary by Chemical Abstracts)* I02

0315-5688 **IDEIAS SOBRE a fabricação do pão: o pão feito com farinha de mandioca.** (*Breadmaking with cassava flour*). Campo 7(79):49. 1936. Port., 1 Ref.

Cassava. Cassava bread. Cassava flour.

A brief explanation is given on the utilization of cassava flour in the making of unleavened bread, in countries where little wheat or rye is cultivated. (*Summary by A.J. Trans by I.B.Z.*) I02

0316-6173 INSTITUTO DE INVESTIGACIONES TECNOLOGICAS (COLOMBIA) Panadería y similares. (*The breadmaking industry in Colombia*) *In*_ Industrialización de productos agrícolas y relacionados en Colombia Bogotá, 1974. 15p Span .

Cassava. Cassava bread. Breads. Production. Processing. Colombia.

A general picture is given of the breadmaking industry in Colombia and its present situation (raw material, machinery, equipment, technical level, products made, levels of production, packaging and marketing). The quality of locally produced wheat, maize and cassava flours should be improved. Training personnel, lack of capital and other problems are discussed. (*Summary by I.B.Z. Trans. by T.M.*)102

0317-7662 KAUFMAN, C W. **Un programa de cooperação melhora a tapioca brasileira. II parte.** (*A program to improve Brazilian tapioca. Part II*) Fazenda (USA) 44(9):38-40 1949. Port , Illus

Cassava. Tapiocas. Legal aspects. Processing. Brazil.

Specifications for Brazilian tapioca production are proposed. The following evaluation tests and their methodology are included: (1) particle size (140 mesh), (2) lot uniformity, (3) smell, (4) moisture content (10-13%), (5) ash content (0.2%), (6) color, (7) contamination by foreign matter (alkali coagulation test), (8) pH, measured by a potentiometer or a LaMotte-Taylor indicator, (9) viscosity as determined by a Brabender viscograph and (10) SO_2 content. (*Summary by I.B.Z*) 102

0318-1845 KOSACK, H. **Die Tapiokastärke; ihre Gewinnung und Verwendung.** (*Cassava starch: its processing and uses*) Starch 8:37-39. 1956. Germ.

Cassava. Cassava starch. Processing. Uses. Composition. Drying. Centrifuging.

The importance of cassava in the Middle and Far East is pointed out, comparing it to potatoes in Europe. The composition of both are given. A detailed description is given of the manufacture of starch in the countries where cassava is grown in connection with the starch industry. Two methods are used to break down cell walls in the roots to free the starch grains. biochemical and mechanical (more common). In Java, the world's largest producer, an electrolytic process is used. The starch is dried in the sun or on iron sheets heated at a low temperature. In Brazil, the largest producer in the Western Hemisphere, a more technical process with centrifugation and vacuum driers is used They also obtain by-products such as alcohol and vinegar (*Summary by H.P. Trans by T.M.*) 102

0319-8051 McCANN, D J. **Cassava utilization in agro-industrial systems.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp 215-221. Engl., Sum. Engl., 10 Refs., Illus

Cassava. Uses. Developmental research. Industrialization.

Cassava is an ideal crop for use in agro-industrial systems, where agriculture and industry combine to achieve the greatest efficiency in utilization. The basic concepts for a correctly designed agro-industrial system based on cassava are explained, and those industrial processes with the greatest potential are discussed. (*Author's summary*) 102

0320-7430 MANSINGH, A. and PRATT JUNIOR, J J. **Effects of RNA, purines and pyrimidines on the development of *Tribolium confusum* (Duval).** Journal of Stored-Products Research 11(¾):155-160 1975. Engl., Sum Engl, 17 Refs.

Cassava. Tapiocas. Uses.

Growth period and survival of *Tribolium confusum* were studied on a chemically defined diet alone or supplemented with RNA; guanine, adenine, cytosine and uracil were also added to the basic diet either singly or in all possible combinations. The effect of supplementing a processed food (dehydrated tapioca pudding) with various levels of RNA on the growth and survival of the beetle was also studied. Diets supplemented with RNA or a mixture of guanime + cytosine or all the 4 nucleotides were equally effective in stimulating growth and increasing survival of the beetle; guanine + adenine also improved the diet but not as well as the other 3. In general, the purines guanine and adenine stimulated growth and the pyrimidine cytosine acted as a synergist while uracil had a slight retardatory effect. Tapioca pudding, which is inadequate for supporting growth of the beetle, was also improved by the addition of RNA. *(Authors summary)* I02

0321-4500 **MANUFACTURE OF tapioca starch.** U.S. International Cooperation Administration. Technical Digest Service. E-211. 1956. 6p. Engl.

Cassava. Cassava starch. Industrial machinery. Processing.

Plans are proposed for a modern cassava starch factory in Indonesia. In hot climates, processing must be rapid to prevent fermentation. Wet processing should be based on centrifugal sieving and separation. Discoloration caused by HCN may be avoided by using a noncorrosive material. Bitter tapioca is the most suitable for starch processing because of its higher starch content and higher fresh wt yields.,To minimize costs, roots should be bought at the fields and shipped by truck or tractor to the factory. Loading bunkers in the growing areas are recommended. Land, building, and plant equipment and requirements are given for the different steps in the process: preparation of roots, root disintegration and starch extraction, starch concentration, purification, dehydration, drying and cooling, sifting, bagging, diesel generating sets, water cleansing, maintenance and fitting, examination, transport and labor requirements. (*Summary by I B.Z.*) I02

0322-6766 MORIN, R L.M. **Vorrichtum zur behadlung von nährprodukten mittels dämpfe oder gase.** *(Apparatus for treating cassava, etc. with steam or gases).* German Patent 527.428. 1931. 5p. Germ., Illus.

Cassava. Processing. Equipment. Patents. German Federal Republic.

An apparatus was developed for the continuous treatment of diverse food substances obtained from grains and tubers (cassava among them) by means of steam or cold and hot gases, in processes such as bleaching, the destruction of harmful agents, etc Gases such as sulfur dioxide can be used without danger. The apparatus consists basically of an endless conveyor belt that passes the material through a heater chamber, pressurized at 6 kg/ cm^2. The material is protected from the direct action of the gas or steam. *(Sumary by H.P. Trans. by T.M.)* I02

0323-3202 NGODDY, P.O. **Gari mechanisation in Nigeria: the competition between intermediate and modern technology.** *In* Jéquier, U. ed Appropriate technology;

problems and promises. Paris Organization for Economic Cooperation and Development, 1974. pp.260-275. Engl., 15 Refs.

Cassava. Gari. Mechanization. Developmental research. Industrialization. Nigeria.

In Nigeria the production of gari represents 70% of cassava consumption. Importation of modern and totally mechanized technology (Mark III Newell Dunford gari plant) to replace traditional manual processes is dicussed. In reaction to the large-scale, expensive technology, intermediate technology (FABRICO plant) resulted. FABRICO's locally manufactured equipment is less expensive and just as efficient. The FABRICO plant requires 41 workers/10 tons/day whereas the ND requires 83 workers Comparative production costs are given. The decision to use either level of technology depends on salary level and interest rates. The FABRICO plant is better in terms of social maximization. (*Summary by A.J. Trans. by I.B.Z*) 102 J00

0324-8193 NOBRE, A. **Tecnologia dos productos tradicionais da mandioca.** (*Cassava products*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. v.1. pp.64-75. Port., 11 Refs.

Cassava. Cassava flour. Production. Cassava meal. Cassava starch. Tapiocas. Pellets. Processing. Legal aspects. Brazil.

Data are given on production and per capita supply of cassava flour in Brazil from 1961-70. Standards for classifying flour, meal and starch are given, based on production processes, color and percentage of starch. An outline of the different processes is given. Other products described briefly are tapioca pearls and pellets. (*Summary by I.B.Z.*) 102

0325-5269 ODIGBOH, E.U. **A cassava peeling machine: development, design and construction.** Journal of Agricultural Engineering Research 21:361-369. 1976. Engl., Sum. Engl, 5 Refs., Illus

Cassava. Tubers. Peeling. Mechanization. Equipment. Production. Timing. Nigeria.

Cassava peeling constitutes a major bottleneck in cassava processing. The design, construction and development of a continuous process mechanical peeler is described. The peeler consists basically of a cylindrical knife assembly and a solid cylinder, both mounted parallel and 20 mm apart on an inclined frame. The solution of various problems revealed by preliminary tests of the machine is discussed. *(Author's summary)* 102

0326-5415 OUDIT, D.D. **Polyethylene bags keep cassava tubers fresh for several weeks at ambient temperatures.** Journal of the Agricultural Society of Trinidad and Tobago 76(1):63-66. 1976. Engl., 8 Refs.

Cassava. Fresh tubers. Storage. Temperature. Trinidad and Tobago.

New methods are constantly being sought to store cassava to avoid rapid postharvest deterioration. The advantages are given of a simple method using sealed polyethylene bags (0.038 mm thick) to store the unwashed tubers in excellent condition for at least 4 wk at ambient temperature in Trinidad (23° at night, 30°C day) Further studies are being carried out in this respect. (*Summary by I.B.Z. Trans. by T.M.*) 102

0327-8126 PORTO, M.C.M. **Destilaria de álcool a partir da mandioca.** (*Distilling alcohol from cassava*). Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa-Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1977. 6p Port., 2 Refs.

Cassava. Alcohol. Production. Processing..Ethanol. Brazil.

The steps for the manufacture of ethyl-alcohol from cassava are described, including the preliminary treatments of the raw material: cooking, saccharification, fermentation, screening and distillation (*Summary by I.B.Z.*) I02

0328-5518 PRINGLE, W., WILLIAMS, A. and HULSE, J.H **Mechanically developed doughs from composite flours.** Cereal Science Today 14(3):114, 116, 118, 120. 1969. Engl., 4 Refs., Illus.

Cassava. Cassava starch. Uses. Breads. Composite flours. Bakery products.

A study was made of mechanical dough processing. Best results were obtained with an oxidizing system and level of energy input recommended in the Chorleywood Bread Process. The standard formula for the composite flour was wheat flour (64%), cassava starch (30%) and soy flour (6%) plus 20% MSG emulsion. Other successful formulas using maize starch and fish protein concentrate (alone or with soy flour) are also given. (*Summary by T.M.*) I02

0329-8099 PULLE, M.W. and INO, K **Physico-chemical characteristics of composite flours.** Journal of Milk and Food Technology 38(7).401-405. 1975. Engl., Sum. Engl., 19 Refs., Illus.

Cassava. Cassava flour. Composite flours. Analysis. Gelatinization. Viscosity. Temperature. Protein content. Breads.

Physicochemical parameters influencing dough attributes and baking quality were studied in different flours. Considerable variation in the starch and protein components was observed in the different formulations of wheat and substituent flours. Incorporation of *Eleusine coracana* (kurakkan), sorghum or cassava flour increased gelatinization temperature, viscosity and amylose content, regardless of the percentage of substitution. Although increases in amylose content were within tolerable limits, changes in gelatinization temperature and viscosity characteristics necessitate the use of chemical agents and modified technology for preparing acceptable products. There was a marked reduction in protein cotent in the cassava-wheat composite flours so nutritive fortification would also be required. (*Author's summary*) I02

0330-4608 PULVA CORPORATION. **Pulva-sizer; the modern impact type pulverizer.** Perth Amboy, New Jersey. Pulva Sizer Catalog no.6710. 1973. 15p. Engl., Illus.

Cassava. Cassava starch. Industrial machinery.

Specifications of a mill (PULVA SIZER MODEL C-4) that could be used for grinding finished cassava starch are presented. An illustrated catalogue is included. (*Summary by A.J.*) I02

0331-8168 RAJAGOPAL, M.V. **Production of beer from cassava.** Journal of Food Science 44(2):532-533. 1977. Engl., Sum. Engl., 8 Refs., Illus

Cassava. Cassava beer. Analysis. Nigeria.

Malt for beer production in Nigeria is imported at present. Substitution of malt with cassava, an indigenous crop, would reduce foreign exchange payment and also create employment opportunities for any workers on cassava plantations. Preliminary results show a satisfactory product can be made with cassava, comparing favorably with beer made from conventional malt Among the cultivars used, Nwugo gave the best results. (*Author's summary*) 102

0332-6833 ROTSCH, A. **Uber die Backeigenschaften von Maniokmehl.** *(The baking properties of cassava flour).* Brot und Gebäck 23(16):121-122. 1969. Germ.

Cassava. Breads. Biscuits. Cassava flour. Cassava bread. Wheat flour.

Cassava flour is used a great deal for breadmaking, especially in developing countries; however, it must be mixed with wheat or rye flour in order to obtain a spongy bread with satisfactory volume. Besides, dough made from cassava flour is bluish gray in color and has a low HCN content The process for breadmaking developed in Malawi is given, including a recipe based on 75 parts wheat flour, 25 parts cassava flour and 150 parts cassava starch. *(Summary by H P Trans. by T.M.)* 102

0333-5428 **SAGO (PEARL tapioca) from manioc.** Sri Lanka, Ceylan Institute of Scientific and Industrial Research. Information Bulletin no.1. 1957. 18p. Engl.

Cassava. Tapioca pearls. Processing. Peeling. Washing. Screening. Drying. Packaging. Centrifuging. Small-scale equipment. Sri Lanka.

The possibility of processing pearl tapioca in Sri Lanka is discussed. An explanation is given of the process, which includes (1) peeling, slicing and washing the roots, (2) rasping, (3) starch separation, (4) settling and purifying, (5) drying, (6) granulation of the starch, (7) roasting the granules, (8) sun drying, sieving, sorting and packing. Machinery requirements are given for a small capacity (1 ton/day) plant. (*Summary by A.J. Trans. by I.B.Z*) 102

0334-3214 SCHNEIDER, E. **Die pneumatische Trocknung.** *(Pneumatic dryng)* Stärke 2(4).107-110 1950. Germ.

Cassava. Cassava starch. Drying. Equipment.

An explanation is given of the functioning and applications of a system in which hot air is the principal agent used to dry material as it passed on a constantly moving belt It is thus possible to obtain a uniform effect in seconds The system can be used for finely granulated material or small lumps that are gradually crumbled as they pass over grids The system is of simple construction, inexpensive and easily operated. In the USA these flash driers are being used in the starch industry. *(Summary by H.P. Trans by T.M.)* 102

0335-8260 SILVA, M. L. DA *et al.* **Determinação de ácidos organicos em plantas e alimentos da Amazonia. I. Acidos organicos do Tucupi.** (*Determination of organic acids in plants and foods from the Amazonian region. I. Organic acids in cassareep*) Acta Amazónica 6(2).235-236. 1976. Port., Sum. Port , Engl., 3 Refs.

Cassava. Cassareep. Composition. Analysis. Brazil.

Three types of cassareep were analyzed by gas chromatography. The following acids were found: acetic, propionic, plamitic and oleic, in the yellow, white and the macaxeira type (obtained from sweet cassava); butyric and valeric in the yellow type; and succinic in the yellow and white types (*Author's summary*) I02

0336-7202 **SMALL-SCALE techniques for producing starch from cassava and sweet potatoes.** U.S. International Cooperation Administration. Technical Inquiry Service. IR-28167. 1961. 4p. Engl., 2 Refs.

Cassava. Cassava starch. Small-scale processing.

The machinery for a small cassava or sweet potato starch factory consists of a washer, rasper, sieves, strainer, vats or tubs, cooking pans and miscellaneous items. These articles may be rather crudely made and still be effective. The following steps are described: washing, which may be carried out manually by immersing the roots in water and brushing them, or in a simple washing cylinder; rasping, in one of 3 rasps; sieving, through a muslim bag, cloth, frame, or a cylindrical framework. The spent pulp may be partly dried and used as animal feed: settling, in tanks made of cement or other watertight material: purification and agitation in wooden tubs with wooden paddles; drying in drying sheds, where the starch sediment is broken up into small pieces manually; cooking, which depends upon the end product (i.e., flour, pearls, seeds, flakes and siftings). (Summary by I.B.Z.) I02

0337-3328 STAIGER, Z. Manioka, ein Brennereirohstoff? *(Alcohol from cassava).* Zeitschrift für Spiritusindustrie 54.322 1931 Germ

Cassava. Tubers. Composition. Alcohol.

Cassava and its modifications tapioca and sago are prepared from cassava roots, the approx. composition of which is H_2O 11.3, protein 1.3, fat 0.3, starch 73 6, sugar 0 6, fiber 2 0 and ash 1.8%. To ensure efficient saccharification of cassava and good yields of EtOH, it is necessary to gelatinize it at 100° for at least 6 h prior to hydrolysis A maximum yield of 45.6 cc EtOH / 100 g is obtained by steaming the cassava 1-2 h at 2-3 atm, followed by saccharification with 10% malt at 55°, rising later to 62°. In Germany, distilleries are not permitted to use cassava for the manufacture of EtOH to protect the tapioca industry. *(Summary by Nutrition Abstracts and Reviews)* I02

0338-8105 STURTEVANT, W C. Taino agriculture. Antropologica no.2:69-82. 1961. Engl, 64 Refs.

Cassava. History. Cultivation. Processing. Haiti.

A synchronic description is given of Taino agriculture, especially in Hispaniola, at the time of 1st contact with the Spanish. It is difficult to estimate the relative importance of agriculture as compared to fishing, hunting and gathering. Among the cultivated plants, cassava was the most important. at least 6 varieties of bitter and some sweet cassava were cultivated. Bitter cassava was grated and then squeezed in a press, the pulp was baked into cassava bread on clay griddles, and the expressed juice was boiled and then used as a flavoring No starch was made by the Taino, nor did they store prepared pulp Several agricultural techniques were used, especially for cassava Cassava was planted in mounds arranged in rows, 3 ft apart The reasons for this practice are: (1) easier collection of mature roots, (2) provision of sufficient soil in areas of thin humus, (3)

loosening of the soil to allow increased root growth, (4) aid in controlling the growth of grass, (5) improvement of drainage in wet regions, and (6) long preservation of mature but unharvested roots (*Summary by I B.Z.*) 102

0339-7556 **SUBSIDIOS PARA fixação de preços mínimos para farinha de mandioca no estado do Amazonas.** (*Subsidies for setting minimum prices for cassava meal in the state of Amazonas*). Manaus, Brasil, Associação de Crédito e Assistência Rural do Amazonas — Secretaria do Estado de Produção Rural, 1975 22p. Port., 6 Refs

Cassava. Cassava meal. Marketing. Prices. Cassava programs. Production. Costs. Legal aspects. Storage. Brazil.

In order to promote the production of cassava meal on a large scale to meet the local demand in the state of Amazonas, a minimum price policy based on subsidies was proposed. As a basis for setting prices for the different grades of meal (3 each of «farinha seca» and «d'agua»), samples of cassava meal were classified according to preferences of producers, consumers and dealers. (*Summary by T.M.*) 102 J00

0340-2692 TEIXEIRA, C.G. **Produção de álcool de mandioca; utilização de bolores na sacarificação do amido.** (*Alcohol from cassava; use of molds in saccharization*). Bragantia 10(10):277-286. 1950. Port., Sum. Engl., 9 Refs., Illus.

Cassava. Cassava chips. Cassava meal. Alcohol. *Aspergillus*. Industrial microbiology. Fermentation. Analysis. Culture media. Production. Waste utilization. Feeds and feeding. Nutritive value. Brazil.

It has been shown that cassava starch can be converted into alcohol most efficiently when fungal enzyme preparations from submerged cultures are used to hydrolyze starch into sugar. The use of barley malt in the process for conversion of cassava starch has resulted in alcohol yields of 70-74% of the theoretical. Cassava mashes converted by submerged fungal cultures (*Aspergillus niger* van Tieghem, strain NRRL-337) resulted in alcohol yields up to 90% of the theoretical. Substitutes for the distillers' dried solubles/ maize medium were tried. Screened cottonseed meal and soybean meal proved to be satisfactory substitutes. Dehydrated cassava chip meal was used effectively in place of the maize meal. A comparative study was carried out using several molds from the collection of the Instituto Agronômico, Campinas (Brazil) with the purpose of determining their enzyme activity. The mold that presented the highest enzyme potency was strain F-27 of *Aspergillus oryzae* (Ahlburg) Cohn, which had been isolated originally from sake (rice wine). Studies of the dehydrated residues (7% moisture) from hydrolized and fermented mash were found to contain approx. 25% protein, indicating their possible value in animal feeds. Simple substrates can be used for the propagation of the mold, which is a very efficient conversion agent. It is, in fact, the best saccharifying agent in countries where a good malt is not available at a low price. (*Author's summary*) 102

0[illegible] TESORO INTERNATIONAL CORPORATION Charcoal project 1968. New York, 1968. 50p. Engl.

Cassava. Industrial starches. Cassava starch. Uses. Ecuador.

Cassava starch is used as a binder in the manufacture of charcoal briquets in Ecuador because it is more economical than cornstarch. (*Summary by T.M.*) 102

0342-4926 THURY, A. **Farinhadas no antigo Aprendizado Agrícola do Estado.** (*Meal making at the former State Aprendizado Agricola*). Boletim da Associação Comercial do Amazonas 15(156):16-18. 1954. Port., Illus.

Cassava. Cassava meal. Processing. Production. Brazil.

The problems involved in improving production of cassava roots and meal (farinha seca) in Paredão are discussed. In spite of the many adverse climatic and edaphic factors in the area, agricultural yields were somewhat improved by using better varieties, appropriate planting dates and distances, and good-quality fertilizers. Industrial yields rose from 15 to 22 or 23% (25 kg meal/100 kg fresh roots is considered good) by improving the cylinder mechanism where the roots are broken up for processing. (*Summary by T.M.*) I02

0343-5491 TOH, K.B. **An investigation into the techniques of dehydration of tapioca by mechanical and artificial heat drying.** B. Sc. Thesis. Kuala Lumpur, University of Malaya, 1973. 120p. Engl., 24 Refs., Illus.

Cassava. Pulp. Drying. Temperature. Industrial machinery. Malaysia.

The pulp of cassava roots was subjected to different drying conditions using an apparatus consisting of a centrifugal fan that sucks in heated air to the tunnel drier. The temperatures studied were 60, 70 and 80°C and the air velocities, 5.5, 6.6 and 7.7 m/sec/m². Water content and different bed depths (1, 2 and 3 cm of pulp) were measured. The results show clearly that production rate increases with increased bed depth; but the optimal level, in terms of fuel expenditure and caloric efficiency, seems to be 2 cm. Increases in air temperature lowered drying time, however, high increases in air velocity were inefficient because of excess fuel consumption. Choice of air velocity should be determined by bed depth, temperature and capacity of air to pass through the mesh conveyor system. Efficiency of mechanical dehydration, fuel consumption and heat efficiency are also dealt with briefly. (*Summary by A.J. Trans. by I.B.Z.*) I02

0344-2599 TOSELLO, A. and VEIGA, A. DE A. **Ensaios sôbre desidratação de vegetais.** (*Experiments on dehydration of vegetables*). Bragantia 14(21).215-223. 1955. Port., Sum. Port., Engl., 3 Refs.

Cassava. Cassava tubers (vegetable). Drying. Analysis. Organoleptic examination. Storage. Timing. Brazil.

Results are given of experiments on dehydration of vegetables, conducted at the Instituto Agronômico, Campinas (Brazil). A hot air process in a specially built drier shaped like a vertical tunnel was used. Starch crops such as cassava were dried at temperatures between 40-55°C. Time of treatment varied from 5-10 h, according to the thickness of the material on the drier shelves. Cassava was dried at 45° for 10 h (*Summary by T.M.*) I02

0345-8194 URBAN, C.W. **Usina de produção de etanol a partir da mandioca.** (Ethanol from cassava). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. v.1. pp.76-100. Port., Illus.

Cassava. Cassava programs. Ethanol. Production. Processing. Factories. Industrialization. Developmental research. Brazil.

The potentials for using ethyl alcohol derived from cassava as a substitute for gasoline are explored, including advantages, disadvantages and the different steps in processing: (1) preliminary treatment of raw material (weighing, selection, cleaning, rasping or cutting), (2) cooking or gelatinization of starch, saccharification or hydrolysis, (4) fermentation, and (5) distillation. The different hydrolytic processes, as well as their economic aspects, are discussed. Tables are presented on the influence of raw material costs (sugar cane or cassava) on final product cost, estimated inputs, areas under cultivation, and costs of alcohol as related to distillery capacity. Suggestions are given for using the whole plants. (*Summary by I.B.Z.*) I02 J00

0346-7481 VELLOSO, J.F. **Fabricação de farinha de mandioca.** (*Processing of cassava flour*).Boletim de Agricultura 38:531-543 1937. Port., Illus.

Also in Campo 9(11):47-50. 1938.
Revista da Sociedade Rural Brasileira 18(219):37-41. 1938

Cassava. Cassava flour. Washing. Peeling. Rasping. Pressing. Drying. Screening. Centrifuging. Packaging. Brazil.

A brief description is given of small-scale, rudimentary processes for making cassava meal. The steps of the industrial process for making flour are described in detail: washing, peeling, rasping, pressing, drying, screening, centrifuging and packing. (*Summary by I.B.Z. Trans. by T.M.*) I02

0347-6836 WEBB, B.H., HUTAGALUNG, R. and CHEAM, S.T. **New developments in palm oil mill waste treatment.** Kuala Lumpur, Malaysia, University of Malaya, 1976. 13p. Engl., 4 Refs.

Paper presented at Workshop Study on Agro-Industrial Wastes, Kuala Lumpur, Malaysia, 1976.

Cassava. Cassava meal. Waste utilization. Animal nutrition. Malaysia.

A process denominated Censor (centrifugal solids recovery) is described, which permits the recovery of oil palm sludge for use as an animal feed. The materials used in the Censor system include cassava and oil palm kernel meal. Censor OTK meals (palm oil sludge + kernel meal) and OKO meal (palm oil sludge + kernel meal) were evaluated on broiler chicks as a 50% and 100% substitute for maize. Replacement of 50% maize did not affect feed intake although there was a slight reduction in wt gain. Total substitution resulted in increased feed intake but reduced growth rate and poorer feed conversion. Therefore, Censor can be used to substitute 50% of the maize in broiler rations. Cassava meal, high in starch content, is an ideal absorbent and diluent material to balance the high fat and fiber of the sludge solids and kernel meal. (*Summary by A. J. Trans. by I.B.Z.*) I02 H03

See also *0050* *0379* *0385* *0392* *0400* *0406* *0409*

I03 Industrial Microbiology

0348-7406 AZEVEDO, M.S. DE and GRAMACHO, D.D. **Composição química.** (*Chemical composition*). *In* Cruz das Almas, Brasil. Universidade Federal da Bahia. Escola de Agronomia. Convênio U.F. Ba./BRASCAN Nordeste. Projeto mandioca. Relatorio Semestral de Pesquisas no. 2. 1973. pp. 69-73. Port.

Cassava. Cassava starch. Protein enrichment. Industrial microbiology. Cassava chips. Starch content. Water content. Feeds and feeding. Cassava programs. Brazil.

A progress report is made on Subproject 8 (chemical composition), which forms part of a special research project on cassava at Bahia. Experiments include work on protein enrichment of cassava starch, using 2 microorganisms, *Penicillum digitatum* and *Candida utilis* (6.396 and 5.456% of protein, respectively). Cassava chips for swine and poultry feeding were prepared from 8 different varieties and analyzed, as well as 5 samples of poultry rations. Experiments are also being conducted on cooking the pulp of different varieties and classifying them on the basis of organoleptic characteristics. (*Summary by T.M.*) I03 H03

0349-5947 ESWARAN, S. and NGA, B.H. **A turbidimetric method for the screening of amylase-producing mutants of *Aspergillus niger*.** Experientia 33(3):401-402. 1977. Engl., Sum. Engl , 3 Refs.

Cassava. Cassava starch. Industrial microbiology. Enzymes. Analysis. Biochemistry. Culture media. Laboratory experiments.

The turbidimetric method for screening amylase-producing mutants of *Aspergillus niger* is based on the assumption that extracellular amylase produced by strains of *A. niger* in liquid culture hydrolyzes the starch in the media (cassava flour) and brings about a corresponding decrease in turbidity of the media. Mutant strains produced different quantities of amylase, exhibiting different degrees of decrease in turbidity of the media. A greater degree of decrease in turbidity was observed for higher quantities of amylase produced (*Author's summary*) I03

0350-8098 GADEN, E.L. **Substrates for SCP production.** *In* Davis, P. ed Single cell protein; Proceedings of the International Symposium. London, Academic Press, 1974. pp.47-60. Engl., 3 Refs.

Cassava. Cassava starch. Industrial microbiology. Uses.

A comparison is made of the various substrates that have been used or proposed for the manufacture of microbial or single-cell protein. These substrates are evaluated on the basis of

availability, technical suitability and competitive pressures. The substrates discussed are (1) the carbohydrates, i.e., saccharides and polysaccharides, (2) hydrocarbons and (3) alcohols. Cassava starch is one of the polysaccharides studied The basic steps involved in the production of microbial protein are also described, and its market prospects are analyzed (*Summary by L.A.*) I03

0351-8062 GREGORY, K.F. *et al.* **Establishment of a pilot plant for the production of fungal protein from cassava.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.267-270. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Industrial microbiology. Developmental research. ***Aspergillus.*** **Fermentation. Proteins. Production. Colombia.**

The establishment of a pilot plant for the nonaseptic, high-temperature production of protein from whole cassava mash by thermotolerant fungi was undertaken The only nutritional supplements required by the prototype culture (*Aspergillus fumigatus* I-21A, a nonspore-forming mutant) for the conversion of 4% carbohydrate (about 15% fresh cassava) were found to be urea (0.345%), KH_2PO_4 (0.05%) and sulfuric acid (about 0.15% of 9 *N* acid to adjust the medium to pH 3.5 and supply sulfur). The plant includes devices for washing and rasping the cassava roots, a self-aspirating 300-liter starter fermentor, a self-aspirating 4500-liter main fermentor, a roller-press filtration device for harvesting the biomass, and a unit with a sliding roof for sun and air drying the product. (*Author's summary*) I03

0352-4911 GREGORY, K.F. **Further thermotolerant fungi for the conversion of cassava starch to protein.** Animal Feed Science and Technology 2:7-19. 1977. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Industrial microbiology. Proteins. Analysis. Temperature. Cassava starch. Culture media. Laboratory experiments. Animal nutrition.

Fungi capable of growing with cassava starch at 50 and 55°C at pH 3.5 were sought from 687 soil samples. The higher selection temperature favored the isolation of fungi with high (>44%) crude protein content. From the 139 cultures isolated, the 20 highest protein cultures were assessed for yield in a cassava-based medium, growth rates at 45, 50 and 55°C, and content of α-amino nitrogen and methionine. The 7 cultures with greatest potential for the high-temperature, nonaseptic production of protein-rich animal feed were used in rat feeding trials Mycelia from 2 cultures (*Cephalosporium eichhorniae* 152 and *Rhizopus chinensis* 180) gave protein efficiency ratios and net protein ratios thath equaled or exceeded those given by casein when all diets contained 10% "true" protein and were supplemented with methionine. (*Author's summary*) I03 H03

0353-7403 GREGORY, K.F. **Microbial protein production from cassava: equipment and supplies required at CIAT.** Guelph, Canada, University of Guelph. 1974. 14p Engl

Cassava. Industrial microbiology. Equipment.

Specifications and layout drawings are given for equipment and supplies required to set up a laboratory and plant at the Centro International de Agricultura Tropical for producing microbial protein from cassava. (*Summary by T.M.*) I03

0354-7537 KHOR, G. L. *et al.* **Nutritive value of thermotolerant fungi grown on cassava.** Canadian Institute of Food Science Technology Journal 9(3): 139-143. 1976. Engl., Sum Engl., Fr., 23 Refs, Illus

Cassava. Food enrichment. Proteins. Industrial microbiology. *Aspergillus* Fermentation. Animal nutrition. Amino acids. Nutritive value.

Three strains of *Aspergillus fumigatus*, one strain of *Sporotrichum thermophile* and one strain of *Paecilomyces* sp. (all filamentous fungi) were grown on media based on cassava carbohydrate or whole cassava and evaluated for their nutritional quality. The amino acid content of the microbial proteins was determined by ion-exchange chromatography after acid hydrolysis. All the samples were found to have a low sulfur amino acid level. Biological evaluations of the microbial proteins were based on protein efficiency ratio (PER) and net protein ratio (NPR) methods. Rats fed the fungi supplemented with 0.6% DL-methionine produced significantly higher PER and NPR values, as well as better weight gains, than rats that consumed the same fungi without any methionine supplement. The protein control in this experiment showed significantly better results for PER, NPR and weight gain than the fungal proteins when crude protein levels (Kjeldahl N x 6.25) were compared. However, when fungi were evaluated with the protein level based on their α-amino acid content, the NPR values for the methionine-supplemented fungi were not significantly different from those for casein. Rats fed fungi grown on the whole cassava medium had a low overall weight gain because they were slow to adapt to the diet This effect also reduced the PER and NPR values. After the initial lag period, the growth rate improved greatly Selected fungi grown on cassava as an energy source are a means of greatly increasing the level of available protein. The quality of this protein can be improved significantly with methionine supplementation. *(Author's summary)* I03 H03

0355-5591 LIANG, T.E., HEN, N. B. and KAH, L.T. **Protein from yeasts.** Science Centre Bulletin 3(3): 11. 1976. Engl, Illus.

Cassava. Cassava starch. Culture media. Yeast production. Protein enrichment. Amino acids. Industrial microbiology. Laboratory experiments.

Two yeast strains were grown on starch obtained from cassava (*Manihot esculenta* Crantz), which has a very high carbohydrate content (68%) and a relatively low level of protein (approx. 1%) Cells of each strain were propagated, incubated and refrigerated (7°C) until required. About 0.2 ml aliquots were introduced to 100 ml growth media containing cassava starch and ammonium sulfate and water in Erlenmeyer flasks, then incubated for 8 days at 30°C and paper filtered. The portion that remained on the paper was oven dried and subject to amino acid analysis Strain no. 1 produced more than a 6-fold increase in total amino acid content; strain no. 2 produced about a 14-fold increase. (*Summary by I.B.Z.*) I03

0356-6696 OKAFOR, N. **Micro-organisms associated with cassava fermentation for gari production.** Journal of Applied Bacteriology 42:279-284. 1977. Engl., Sum. Engl., 11 Refs.

Cassava. Gari. Fermentation. Industrial microbiology.

The predominant microorganisms isolated from dewatered cassava pulp fermenting for gari production over a 6-day period were *Leuconostoc* and, to a lesser extent, yeast. *Corynebacterium* sp., implicated by earlier workers as the major bacterium fermenting cassava, was present in low numbers only. It is suggested that although the predominant bacteria would be expected to produce lactic acid from the free sugar of the cassava, the breakdown of the cassava glucoside linamarin is probably accomplished more by the endogenous enzyme linamarase than by bacterial activity. (*Author's summary*) I03

0357-2720 PARK, Y.K. *et al.* **Produção de amílase fúngica e sua aplicação na panificação.** (*Production of fungal amylase and its application in breadmaking*) Coletanea do instituto de Tecnologia de Alimentos 2.317-331. 167/68. Port., Sum. Port., Engl., 15 Refs., Illus.

Cassava. Industrial microbiology. Cassava flour. Composite flour. Breads. Analysis. Brazil.

Amylase was produced in semisolid and submerged cultures, using *Aspergillus oryzae* NRRL 695 to produce the enzyme. After fermentation, the enzyme was obtained by precipitation with an organic solvent. Alpha-amylase activity was compared; the product from the semisolid culture showed higher enzyme activity than that from the submerged culture method. Both products were tested for making quality; they produced good texture and greater bread volume. (*Author's summary*) 103

0358-8059 VARGHESE, G., THAMBIRAJAH and WONG, F.M **Protein enrichment of cassava by fermentation with microfungi and the role of natural nitrogenous supplements.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp 250-255. Engl., Sum Engl., 8 Refs.

Cassava. Industrial microbiology. Fermentation. Fermented products. Protein content. Water content. Fat content. Fibre content. Ash content. Malaysia.

Attempts to produce protein-enriched cassava for animal feed by solid state fermentation with selected local strains of *Rhizopus, Aspergillus* and *Neurospora* showed that protein levels of the fermented products did not exceed 3% Because this value is low for animal, feed, the ability of natural nitrogenous supplements to increase microbial activity was tested. Supplementation with 35% chicken dung increased protein levels to 8-10.5%; and with soybeans, peanuts and pineapple bran at 25%, the protein levels were 40, 10 and 7%, respectively. In combination with chicken dung (12.5 + 12.5%), protein values varied between 8 and 18% for soybeans, 8 and 10% for peanuts, and 5 and 7% for pineapple bran Supplementation increased fermentation efficiency and contributed to higher protein values. A procedure for solid state fermentation of cassava with natural nitrogenous supplements was developed as a 1st stage toward the design of a pilot plant for continuous production of the material. (*Author's summary*) I03 H03

See also 0390

J00 ECONOMICS AND DEVELOPMENT

0359-0890 ACIMA DE 2 milhões de dólares; a venda de tapioca para os E.U.A. (The US market for Brazilian cassava starch). Revista de Química Industrial 20(340):22. 1960. Port.

Cassava. Tapiocas. Marketing. USA.

Information is given on a tapioca marketing study sent to the Brazilian office of trade expansion in New York. The USA imports cassava starch for food manufacture, as well as for industrial purposes. When intended for use in foods, the Food and Drug Administration inspects the cassava. There is strong competition from maize and potato starches. Thailand is the main supplier of tapioca to the US (166, 176, 746 lb), followed by Brazil (50, 969, 161 lb), Taiwan and Cuba. Seven major importers were consulted on market conditions and on their preferences. In general, their choices were based on price rather than on quality; 100-lb cotton or paper sacks are preferred. (*Summary by I.B.Z.*) J00

0360-4632 ALMEIDA, O. DE. **Fecularias e destilarias cooperativas; um depoimento e uma esperança.** (*The status of cooperative starch factories and distilleries*). Cooperativismo 5(50):3-5. 1950. Port.

Cassava. Cassava programs. Production. Brazil.

An analysis is made of the problems faced by the cassava industry in Brazil. The Comissão Executiva dos Produtos de Mandioca was created to back cassava producers and manufacturers, provide technical assistance and promote alcohol manufacturing. New problems arose because of the scarcity of construction materials and misunderstandings between the two parties, which resulted in unsatisfactory financial support from the government. The formation of cooperatives is recommended for improving this situation, especially for small cassava growers. (*Summary by T.M.*) J00

0361-7460 AMEZQUITA, M. C Utilización de la estadística y el diseño experimental en investigaciones en yuca. (*The use of statistics and experimental design in cassava research*). *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 306-332. Span., 5 Refs , Illus.

Cassava. Experiment design. Research. Statistical analysis. Colombia.

The role of the biometrics unit at the Centro Internacional de Agricultura Tropical (CIAT), as well as the need for such a unit at a research center, is explained. A definition is given of the scientific method, which is the integration of the different stages a researcher passes through from

the critical observation of a phenomenon to the inference of conclusions This makes it possible to understand better the relationship between the question the researcher is asking and the experimental design he should use to prove his hypothesis. The usefulness of statistics in research is pointed out. The experimental designs most frequently used in cassava are described completely randomized, randomized whole blocks, split plots and systematic designs. Trials carried out at CIAT are given as examples, including the statistical analysis of regional yield trials in 1975. *(Summary by S.S. de S. Trans. by T.M.)* J00

0362-6927 ARISTIZABAL, G. **Mercadeo.** (*Marketing*). *In* Curso sobre producción de yuca. Medellín, Instituto Colombiano Agropecuario, Regional 4., 1975. pp.1-12. Span.

Cassava. Cassava programs. Marketing. Colombia.

The different steps of marketing cassava until it reaches the consumer are analyzed. The typical commercialization process, regarded as a risk-transferring mechanism, includes the producer, middleman, wholesaler and retailer. The characteristics the product must have (color, weight, packaging, selection and preservation treatment) are given. The centralized wholesale provision markets lower marketing risks by establishing closer links between wholesalers and the production sector. Wholesalers to wholesalers can offer the producer better trading conditions an at the same time can cover a wider range of products A wholesale provision market can implement and information service that reflects current market situations, as well as innovative systems (auction sales, new markets, retailing chains) that will guarantee a stable product demand. Complementary services such as agricultural supply stores, banks and transportation can also be set up. (*Summary by A.J. Trans. by I.B.Z.*) J00

0363-8166 BARBERIS, C. **Aspetti della cooperazione con i Paesi in via di sviluppo; un progetto per la produzione di "cossettes" di manioca nel Togo.** (*Cooperative project for producing cassava chips in Togo*). Rivista di Agricoltura Subtropicale e Tropicale 70.67-75. 1976. Ital.

Cassava. Cassava programs. Industrialization. Cassava chips. Developmental research. Development costs. Feeds and feeding. Togo.

A proposal is made for establishing a factory for producing cassava chips in Togo for export, mainly to Italy, to be used in animal feeding. A production of 300,000 tons cassava roots/yr is required for a plant with a capacity of 100,000 tons chips/yr. An agro-industrial enterprise is recommended. Operations at Sato, Alati and Haké would be subdivided, each with two 4000-ha zones, large enough for mechanization. The process as well as water and energy supplies, transportation and road network, housing, hangars, workshops and other facilities is discussed. Input costs and financial data are estimated for 13 yr. (*Summary by I.B.Z.*) J00

0364-8319 BARRINGTON, F. **Important discoveries about the big energy food crop.** African Development 10(9):933. 1976. Engl., Illus.

Cassava. Cassava programs. Developmental research.

Cassava research, supported by 2 Canadian organizations (International Development Research Centre and International Development Agency) has produced results of importance in human and animal nutrition. A brief report is given of progress made on crop yields, pest resistance,

rapid propagation systems and high-protein varieties. (*Summary by M.O. de H. Trans. by T.M.*) J00

0365-7456 BERNAL N., F. **Conceptos generales sobre los costos de producción en yuca.** *(Cassava production costs)* *In* Curso sobre producción de yuca Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp 342-351. Span , Sum. Span.

Cassava. Production. Costs.

Production costs play a vital role in good management. The types of information needed to estimate costs are listed, and definitions are given of the following types of costs: fixed, variable, total and unitary, opportunity, disbursable and nondisbursable, direct and indirect. *(Summary by T.M.)* J00

0366-7458 BERNAL N., F. **Conceptos sobre administración de la producción del cultivo de la yuca.** *(Cassava production management)* *In* Curso sobre producción de la yuca Ed prelim. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 352-360 Span., Sum. Span.

Cassava. Production. Economics. Costs. Colombia.

The development of high-yielding cassava varieties with low inputs is being sought. Efficient production management is a decisive factor in accomplishing these objectives since it takes into account risk, contingencies, production levels, price behavior, legal dispositions, supply and demand, and production cost behavior. A brief explanation is given of the multidisciplinary expertize required, the scope of production management, production alternatives, risk reductions, analysis of results, records to be kept and organization of work *(Summary by T.M.)* J00

0367-3265 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava production systems.** *In* _____. Annual Report, 1972. Cali, Colombia, 1973. pp. 44-88. Engl , Illus.

Cassava. *Manihot esculenta.* Cassava programs. Plant physiology. Plant breeding. Entomology. Diseases and pathogens. Cultivation. Propagation. Spacing. Soil requirements. Weeding. Storage. Injurious insects. Cassava superelongation. Productivity. Plant physiological processes. Cultivars. Cassava bacterial blight. *Cercospora caribaea. Cercospora henningsii. Silba pendula. Erinnyis ello.* Herbicides. Deterioration. Tubers. Fresh products. Colombia.

A report is given of the highlights of the Cassava Program at the Centro Internacional de Agricultura Tropical (CIAT) during 1972. The most outstanding points in the diverse areas of research were as follows: (1) The germplasm bank (2,000 accessions) has been freed of bacteria using a green shoot propagation method. (2) A new disease causing superelongation was reported for the 1st time and is being investigated. (3) Preliminary observations suggest that under dry conditions thrips may become a serious pest; however, resistance has been found in some cassava lines. (4) On the experimental farm, acceptable yields of about 30 tons/ha can be obtained in less than 1 yr. (5) Optimal plant spacings and fertilizer levels are being studied; under CIAT conditions optimal spacing appears to be between 2 to 10,000 plants/ha. Since the soil is relatively fertile, there was no response to N, P or K. (6) A large no. of herbicides, as well as different times of application, were tested on a small scale (7) The development of simple, on-the-farm

techniques of fresh root storage is progressing rapidly; and the possibilities of using a soil and straw storage unit are good. The drying characteristics of cassava are also being studied so that simple solar driers can be designed. *(Summary by A J. Trans by T.M.)* J00

0368-5435 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava production systems.** *In*___. Annual Report 1974. Cali, Colombia, 1974. pp.54-109. Engl, Illus.

Cassava. Cassava programs. Plant physiology. Plant physiological processes. Plant development. Tuber productivity. Cassava bacterial blight. Cassava superelongation. Nematodes. *Erinnyis ello. Silba pendula.* Plant breeding. Resistance. Cultivars. Cultivation. Spacing. Planting. N. P. K. Ca. Magnesium. Fertilizers. Weeding. Herbicides. Field experiment. Storage. Economics. Production. Colombia.

Yields of 46 tons/ha of cassava were obtained after 12 mo on relatively poor soils, using limited inputs on farms near CIAT-Palmira. A variety similar to the one producing the highest yield recorded at CIAT has been used extensively in the breeding program in an attempt to produce high-yielding, disease- and insect-resistant types. The germplasm has been completely evaluated for agronomic characters, and the 1st hybrids are being tested. The most promising types are undergoing field testing in 14 areas of Colombia. Resistance to most major diseases and pests has been encountered, and rapid screening methods are being developed. In the case of the cassava hornworm (*Erinnyis ello*), no varietal resistance has been found; but biological control by *Trichogramma* sp. and *Polistes* sp. is effective. Weeds can be controlled effectively by 3 hand weedings; less weed control is needed when plant populations are increased. Work has continued on developing a plant ideotype for cassava. It has been found that a balance between root and stem production is required so that a leaf area index of 3-4 is maintained through a long leaf life. Tentative critical levels for nutrients in leaves were determined; a marked response to fertilizer was found, particularly to K. Preliminary results of an economics survey show that most cassava in Colombia is grown under monoculture and suffers from attack by a large no. of diseases and pests. Certain practices such as plant density appear to be less satisfactory than those used for optimum production. A clamp storage system was developed whereby cassava roots can be stored up to 2 mo when packed in moist sawdust. (*Summary by T.M.*) J00

0369-8202 CHANDRA, S. and DE BOER, A.J. **The allocative efficiency of the Fijian root crop producers in the Sigatoka Valley, Fiji.** Tropical Root and Tuber Crops Newsletter no. 9,33-37. 1976. Engl, Sum. Span, 3 Refs

Cassava. Developmental research. Production. Economics. Fiji.

The efficiency is described with which Fijian farmers allocate their farm resources such as land, labor, capital and current expenses to produce cassava, sweet potatoes, taro, yams and potatoes (*Summary by Abstracts on Tropical Agriculture*) J00

0370-7446 COCK, J.H. and NESTEL, B.L. **Significado global de la yuca.** *(The importance of cassava in the world). In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. XIX-XXIII. Span.

Cassava. Cassava programs. Production.

A brief explanation is given of the resarch on tubers being done by the International Institute of Tropical Agriculture (cassava, sweet potatoes and yams) and the Centro Internacional de

Agricultura Tropical (cassava). The importance of cassava is discussed; a table on world production in 1973 is included. *(Summary by S.S. de S. Trans. by T.M.)* J00

0371-5583 COLOMBIA. MINISTERIO DE AGRICULTURA. OFICINA DE PLANEAMIENTO DEL SECTOR AGROPECUARIO. Yuca. (*Cassava*). *In.* Programas agrícolas. Bogotá, 1974. pp.271-275. Span.

Cassava. Cassava programs. Production. Productivity. Costs. Colombia.

An evaluation is made of the objectives accomplished in the cassava program during 1973. Also included are a preliminary assessment of 1974, programming for 1975 and projection for 1976. Aspects dealt with are area under cultivation, production, yields, credit, inputs, technical assistance, labor, production costs, value of production and marketing. (*Summary by A.J. Trans by T.M.*) J00

0372-3143 COLOMBIA. MINISTERIO DE AGRICULTURA. OFICINA DE PLANEAMIENTO DEL SECTOR AGROPECUARIO. Yuca. *(Cassava) In*_____. Programas Agrícolas 1974. Bogota, 1975. pp.183-188, 284. Span , Illus.

Cassava. Cassava programs. Statistical data. Production. Productivity. Colombia.

An evaluation is made of the fulfillment of objectives programmed by the Colombian Ministry of Agriculture for 1973, with regard to area, production, yield and credit for growing cassava The demand for cuttings, the need for fertilizers, pesticides, technical assistance and marketing are discussed. The programming for 1974 is also presented. *(Summary by A.J. Trans. by T M.)* J00

0373-7673 COUTINHO, N. **Economia e política alcooleiras.** (*Alcohol production: economics and policies*). Brasil Açucareiro 87(1):19-44. 1976. Port., Illus.

Cassava. Alcohol: Production. Developmental research. Brazil.

The formalization of the Brazilian alcohol program is presented, together with background data on its creation and the complete text of Decree no.76,593 of 1975, which regulates this program. The history of the first attempts at using alcohol as a fuel in Brazil is reviewed. At present the country has industrial facilities with a capacity for processing 9,773,000 liters of alcohol/day. The raw materials for alcohol production can be grouped into 3 categories: sugars (sugar cane and beets), starches (barley, maize, rye, wheat, sweet potatoes and cassava), and celluloses (wood). Of the by-products derived from this process, carbon dioxide, the spent pulp and fusel oil are described. Data are also presented on alcohol production and consumption in Brazil, as well as production of cassava flour and gasoline consumption for automobiles from 1971-75. (*Summary by M.O. de H. Trans. by T.M.*) J00

0374-8190 DANTAS, W. **Mercado internacional de amido de mandioca.** (*International market for cassava starch*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. v.1. pp.29-44. Port., 3 Refs.

Cassava. Cassava starch. Trade. Prices. Canada. Japan. Europe. USA.

A study is made of the starch market for 1968-70. especially that of cassava, which appears to be uncertain because of the possibilities of starch substitution and modification by chemical products. In 1980 the USA, Canada and Japan are expected to commercialize from 111-411 thousand tons of cassava starch. The market for cassava starch is affected by the prices of other starches, by the difficulties of entering protected markets, and by the marketing systems and channels used. (*Summary by I.B.Z.*) J00

0375-8192 DANTAS, W. **Mercado internacional de produtos forrageiros de mandioca.** (*International market for cassava forage products*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. v.1. pp.45-52. Port., 4 Refs.

Cassava. Cassava chips. Cassava meal. Trade. Feeds and feeding. Brazil. Thailand. Indonesia. Europe.

Data are given on imports of cassava from 1962-1970. by Germany, Holland and Belgium (1,361,500 tons in 1970) and on the main exporting countries: Thailand (936,828 tons of chips in 1970), Indonesia, Angola and Tanzania. Although Brazil is the world's largest producer of roots, it forms part of the group of small exporters, with only 9,069 tons of chips in 1971. Explanations are given for this disproportion and irregularity of Brazilian exports, and marketing perspectives for forages (especially pellets) are analyzed. (*Summary by I.B.Z. Trans. by T.M.*) J00 H03

0376-7459 DIAZ D., R.O. Aspectos económicos de la producción de yuca. Estudio de caso, Colombia. (*Economic aspects of cassava, the Colombian case*). *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976. pp. 361-398. Span., Illus.

Cassava. Economics. Costs. Production. Productivity. Diseases and pathogens. Injurious insects. Weeds. Statistical analysis. Developmental research. Maps. Colombia.

The principal objective of this agro-economic study on cassava production in Colombia is to supply data to aid in establishing research priorities. The survey was conducted with 300 cassava growers in the states of Atlántico, Magdalena, Quindío, Tolima, Meta, Valle and Cauca. The analysis was oriented to 4 basic aspects: (a) the description of production processes, (b) the identification of factors limiting to production and productivity, (c) the estimation of the relative importance of each of these factors, and (d) the type of technology preferred by the farmer. A representative description is given of all the production activities, types of soil insect problems, diseases, weeds and water, inputs utilized, production costs and returns for each of the sectors studied. The economic analysis seeks an economic optimum on the basis of the experimental data, bearing in mind that the farmer's objective is normally not to maximize yield, but rather net income. Methods of calculating the economic optimum, the role of risk and uncertainty, as well as their implications for the farmer at the sectorial level, are discussed. (*Summary by S.S de S. Trans. by T.M.*) J00 D00

0377-4544 DIAZ D., R.O. *et al.* **Descripción agroeconómica del proceso de cultivar yuca en Colombia.** (*Agro-economic description of the cassava-growing process in Colombia*). Cali, Colombia. Centro Internacional de Agricultura Tropical. Boletín Preliminar no. 1,2,3. 1973-74. 191p. Span., Illus.

Cassava. Production. Cultivation. Injurious insects. Mycoses. Weeds. Colombia.

A survey was made of cassava cultivation in Colombia. Based on interviews with farmers in different regions of the country, preliminary data were obtained on the following aspects. varieties planted, pests, diseases, weeds, cutting size and source and method of planting (horizontal or at an angle). Three visits were made to the farms from 1973-74. (*Summary by T.M.*) J00 D02

0378-5352 EMPRESA BRASILEIRA DE PESQUISA AGROPECUARIA. CENTRO NACIONAL DE PESQUISA DE MANDIOCA E FRUTICULTURA. **Ensaios de sistemas de produção para mandioca.** *(Guidelines for cassava production systems).* Cruz das Almas, Bahia, Brazil, 1975. 25p. Port, Illus.

Cassava. Cassava programs. Developmental research. Experiment design. Statistical analysis. Cultivation. Cuttings. Fertilizers. Pest control. Weeding. Brazil.

This report presents a series of recommendations on diverse agronomic practices for cultivating cassava, as well as the experiments to be carried out throughout Brazil but especially in the northern and northeastern states by the Empresa Brasileira de Pesquisa Agropecuária, diverse research units in the state of Bahia, schools of agronomy, private enterprises and farmers, under the leadership of the Centro Nacional de Pesquisa de Mandioca e Fruticultura. The objectives are to test different cassava production systems in different regions of the country, determine which of the components of these systems require research, and multiply the promising varieties. In this way the food supply for both internal consumption and exportation should be increased, as well as the availability of raw materials for producing alcohol and other industrial uses. For all experiments, records will be kept on these items: location, soil characteristics, liming, soil preparation and conservation, fertilization, planting dates, varieties, weed control, pests, climatological conditions, plant stand, harvesting, starch content. An explanation is also given of the decree whereby the National Alcohol Program was created to deal with matters concerning domestic and foreign fuel consumption. (*Summary by S.S. de S. Trans. by T.M.*) J00

0379-7670 **ESTUDIO DE factibilidad agrícola e industrial para el establecimiento de una planta "chips" secos de yuca en San Carlos.** (*Feasibility study of an agro-economic enterprise for processing dry cassava chips in San Carlos*). San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1974. 72p. Span., Sum Span, Illus.

Cassava. Developmental research. Cassava programs. Cassava chips. Industrialization. Factories. Consumption. Trade. Development costs. Costs. Costa Rica.

A feasibility study was made for a cassava processing plant in San Carlos. The project would benefit small- and medium-sized farmers belonging to cooperatives in this region. The plant is designed to produce cassava chips to meet domestic demands for animal feeds, as a substitute for maize and other grains. The foreign market is also promising West German economic and technological assistance will be provided on the condition that the Unión de Cooerativas in San Carlos provides the plant and other required installations. The plant would initiate operations operating at a 10 ton/hr capacity, 20 h/day, 200 days/yr, producing 16,000 tons of chips/yr. This would require 40,000 tons of fresh roots/yr. To guarantee sufficient raw material, the cultivation of some 2,000 ha of cassava would be financed. (*Summary by I.B.Z. Trans. by T.M.*) J00 I02

0380-7671 HENNINGSEN, H.F. **Análisis del mercado europeo de tapioca relacionado con posibilidades de venta desde Costa Rica.** (*Analysis of the European market for cassava from Costa Rica*). *In* San José. Costa Rica. Dirección de Planeamiento. Departamento de

Economía y Estadísticas Agropecuarias. Estudio de costos de producción de yuca en la zona norte, zona de San Francisco de la Palmera. San José, 1973. 45p. Span., 12 Refs.

Cassava. Cassava chips. Pellets. Trade. Consumption. Feeds and feeding. Prices. Legal aspects. Costa Rica.

Supply and demand studies for cassava chips and pellets were conducted in Belgium, West Germany, the Netherlands, Central America and Africa. An increase of 2.5-2.8 million tons in the demand for cassava products was projected for 1980. The demand for cassava depends on the price of wheat. Costa Rican products must meet the following quality requirements; more than 70% starch content, 2.5% or lower sand and 13% or lower water content. It is recommended that in the initial phase Costa Rica produce high-quality chips using the low-cost, fast-drying Koenigsfelder blades. (*Summary by A.J. Trans. by I.B.Z.*) J00

0381-1753 HONE,A. **The importance of tapioca as a foodstuff, feeding material and industrial raw material in India; with particular reference to Kerala State.** Oxford, England. Institute of Commonwealth Studies, 1973. 39p. Engl , 4 Refs.

Cassava. Production. Costs. Prices. Consumption. Marketing. Cultivation. Uses. Processing. Cassava programs. Developmental research. India.

An analysis is made of current and future trends of cassava in India, especially in the state of Kerala. Production, cultivation, uses and a historical recount of government policies with regard to cassava are discussed, as well as economic aspects, research and extension work, and level of industrialization. Cassava is used for both human and animal foodstuffs, as well as in industry. There is a need for an integrated agricultural program that would increase farmers' income, the feed supply for livestock programs and foreign exchange. (*Summary by A.J. Trans by I.B.Z.*) J00

0382-4335 INTERNATIONAL TRADE CENTRE UNCTAD/GATT. **Cassava export potential and market requirement.** Geneva, 1977. 65p. Engl., Sum. Engl., 11 Refs.

Cassava. Developmental research. Pellets. Consumption. Cassava starch. Production. Trade. Prices. Indonesia. Thailand. Europe. USA. Japan.

World cassava production was estimated at 105 million tons in 1975. Cassava has 3 main uses: as a staple source of carbohydrate for human consumption in many tropical countries, as an ingredient in animal feeds in EEC countries, and as a source of starch. Cassava pellet imports by the EEC increased on av by 15%/yr between 1971-75, reaching 2.3 million tons. In 1976, imports increased by another million tons and should reach 4 million tons in 1978, when it should then level off. Major consumers are the Netherlands, the Federal Republic of Germany, Belgium and France. Two types of pellets (brand and native) are manufactured in Thailand and Indonesia. Quality standards are based on starch, moisture, fiber and sand content: pellets may not contain 3% by wt of binding agents. Cassava can compete in terms of price with cereals in the EEC and does not face serious competition from other cereal substitutes. Market prospects are discussed in detail, together with problems involved in improving pellet quality. Requirements for establishing such an industry in other developing countries are discussed, using the Indonesian and Thailand cases as examples. Cassava starch competes with others in the overall market. Thailand is the main exporter, followed by Malaysia and Brazil. Main importers are the USA and Japan, where cassava faces strong competition from the domestic industry. Market potentials are not good; and in the future, cassava starch industries in developing countries will likely be for domestic requirements rather than for export markets. (*Summary by T.M.*) J00

0383-7820 JENNINGS, D.L. and MARTIN, F.W. Comp. **The utilization of cassava variability on an international basis; the report of a study group.** Dundee, United Kingdom, Scottish Horticultural Research Institute, 1973. 21p. Engl.

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

Cassava. Cassava programs. Developmental research. Plant breeding. Germplasm.

The International Society for Tropical Root Crops set up a study group to discuss the use of cassava variability at the international level. The following conclusions were reached: It is highly advantageous to organize cassava variability on an international basis. Broad breeding goals, including acquisition of materials and screening for basic traits, can best be handled at the large international centers whereas local needs should be handled locally. A system of international germplasm centers in Africa, Asia and the Americas is proposed. The creation of a cassava breeders association is also advocated. (*Summary by I.B.Z.*) J00 G01

0384-8100 JONES, A. **Notes on the market for grocery tapioca in the United Kingdom and Western Europe.** London, Tropical Products Institute, 1974. 21p. Engl., Illus.

Cassava. Tapioca flakes. Tapioca pearls. Marketing. Prices. Packaging. Trade. United Kingdom. Europe.

Sources of supply (Malaysia, Brasil and South Africa), analysis of imports and recent price trends, division of the market (retail: 1150 tons/yr, catering market: 1000 tons/yr), structure of the trade, shipping and packing, quality and tariffs are described for seed pearl, medium pearl and flake tapioca. Also, a list is given of brokers, traders and canners in the United Kingdom. A brief recount of the tapioca market in the German Federal Republic, Italy, the Netherlands, Denmark and France is presented. (*Summary by I.B.Z.*) J00

0385-7401 JONES, W.O. and AKINRELE, A.I. **Improvement of cassava processing and marketing; recommendations and report.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1976. 53p. Engl., 40 Refs.

Cassava. Cassava programs. Developmental research. Consumption. Marketing. Gari. Cassava flour. Cassava starch. Industrialization. Processing. Cassava meal. Cassava chips. Glucose. Nigeria.

The multiple elements of a market development project for cassava and its products are explained. Strategies include a pilot community gari-making center, a pilot central gari cooker, a low-cost cassava chipper and drying area, and development of well-supported major bulking markets for gari. Livestock producers would be acquainted with the potential value of cassava chips The development of composite flours (cassava and wheat) is also proposed. The following aspects are dealt with improvement of cassava processing and marketing, the demand for cassava, meeting the increased demand for gari (marketing, manufacture, reducing costs and other ways to increase marketing efficiency), markets for cassava (customary food uses, composite flours, starch, glucose, livestock feeding, exports), and increasing productivity of labor. The appendix includes 2 articles by the authors on the technology of gari making and the demand for cassava and its products. (*Summary by T.M.*) J00 I02

0386-7978 J.R.A. **In one year, 78 alcohol projects passed.** Gazeta Mercantil, São Paulo; Dec., 1976. 1p. Engl.

Cassava. Alcohol. Production. Brazil.

In one year, 78 alcohol projects were approved by the National Alcohol Commission (CNAL) in Brazil: 53 involved new plants and 25 involved expansion plans. Only 2 of these involved the manufacture of alcohol from cassava; a 3rd cassava project (60,000 liters/day) in Curvelo, Minas Gerais was not included on the CNAL list but directly approved by the Ministry of Trade and Industry. (*Summary by I.B.Z.*) J00

0387-7397 KRAUSZ, J.P. Competition among the root and cereal staples in tropical agricultural development. Ithaca, N.Y. Cornell University. New York State College of Agriculture and Life Sciences. Department of Agricultural Economics. Cornell Agricultural Economic Staff Paper no. 74-12. 1974. 21p. Engl., 21 Refs.

Cassava. Starch crops. Production. Economics. Productivity. Marketing. Consumption. Prices. Nutritive value. Africa. Caribbean.

To reduce the disparity between availability of food, population growth and employment, a comparative study was made of the basic tropical cereals (rice, maize, sorghum and millet) and the tropical root and tuber crops (cassava, sweet potatoes, yams, cocoyams and potatoes) so that the small farmer can increase crop yields and his income. The regions of Central-West Africa and the Caribbean were chosen for the study, with special reference made to Ghana, Nigeria, Jamaica and Trinidad. The following aspects of production are dealt with: necessary inputs and production costs, present and potential yields and marketing (transportation, processing and storage). Consumer preferences, relative prices, elasticity of demand and future demand are studied. It is concluded that roots and tubers produce more calories per unit of area, per unit of time and that their still unexplored genetic potential is greater than that of cereals. Although production costs of the farmer are lower, storage and transportation need to be improved. Differences in protein content are not as great as believed. Emphasis is placed on the importance of further study of tropical roots and tubers.(*Summary by S.S. de S. Trans. by T.M.*) J00

0388-2237 LEJOILLE, R. **La recherche peut constituer, dans le cas du manioc, une aide efficace pour l'économie de Madagascar et d'autres pays de la zone franc.** (*Research on cassava can be an effective aid to the economy in Madagascar and other countries in the free zone*) Marchés Tropicaux no.782:2378-2379. 1960 Fr.

Cassava. Cassava programs. Marketing. Malagasy Republic.

The market for cassava has suffered continuous setbacks in France, mainly because of the poor quality of cassava imports and competition from Italian pastes. Because of the need for sound policies and marketing promotion, the French Institute for Cassava was created. In addition to promoting the consumption of cassava and developing recipes for cassava-based foods, they are furthering research on the crop. (*Summary by I.B.Z. Trans. by T.M.*) J00

0389-7979 LUZURIAGA V., H. **Descripción agroeconómica del proceso del cultivo de yuca en el Ecuador.** (*Agro-economic aspects of cassava cultivation in Ecuador*). Quito, Ecuador, Instituto Nacional de Investigaciones Agropecuarias. Publicación Miscelánea no. 33. 1976. 52p. Span., Sum. Span , 20 Refs., Illus.

Cassava. Land preparation. Planting. Weeding. Harvesting. Inter-cropping. Labour. Income. Production. Costs. Productivity. Cultivars. Marketing. Prices. Development research. Ecuador.

A descriptive analysis is made of the agro-economic aspects of cassava cultivation in Ecuador as a basis for allocating resources for research, extension and production. Data are given on farm size, types of crops grown, area planted to cassava, soil types, varieties and planting systems preferred by 104 farmers in the 3 zones studied (Manabí, Pichincha and Los Ríos). Marketing centers, prices and product uses are dealt with. Finally, an analysis is made of the economic aspects such as yields, costs, profits and relative profitability of the different planting systems Most cassava growers are small and do not apply adequate technology. The study of yield-limiting factors, the demand for fresh cassava and low-cost technological changes is recommended. (*Summary by A.J. Trans. by I.B.Z.*) J00 D00

0390-7399 MAC LENNAN, D.G. **Single cell protein from starch.** Sydney, Australia, University of Sydney. Department of Chemical Engineering, 1975. 17p. Engl , 22 Refs., Illus

Paper presented at the International Symposium on Continuous Culture of Micro-Organisms, 6th., Oxford, 1975

Cassava. Developmental research. Cassava starch. Protein enrichment. Animal nutrition. Human nutrition. Industrial microbiology.

A report is given on current and potential sources of single-cell protein (SCP), especially starch, for both human and animal nutrition. A suitable raw material would be one that is inexpensive, easily degraded microbiologically, available year round, or reliable quality, preferably available in developing countries and preferably accepted for human consumption. Cassava has a high potential because of its high starch content Economic and chemical aspects, as well as the advantages of using cassava for SCP production, are discussed. (*Summary by T.M.*) J00 J03

0391-2753 **MANDIOCA.** (*Cassava*). Acompanhamento da Situação Agropecuária do Paraná 2(10):41-44. 1976. Port.

Cassava. Cassava programs. Cultivation. Labour. Costs. Brazil.

A report is given on the present status of cassava cultivation and production in the regional centers of Umuarama, Paranaguá, União da Vitória and Paranavaí, state of Paraná (Brazil). Data include area planted, varieties used, prices for cassava and possible industrialization. Although Paraná is only the 7th largest producer of cassava, av yields are the highest (22 tons/ha). (*Summary by A.J. Trans. by T.M.*) J00 D01

0392-5437 **MANDIOCA.** (*Cassava*). Acompanhamento da Situacao Agropecuária do Paraná 2(11):37-38. 1976. Port.

Cassava. Cassava programs. Industrialization. Brazil.

Cassava cultivation in Paranavai (Brazil) will be increased to 3600 ha, an increase of 500% in 1 yr. A starch plant with a capacity of 130 tons/day is being installed Some 215,000 tons of fresh roots will be produced in Vitória (*Summary by T.M.*) J00 I02

0393-5466 **MANDIOCA.** (*Cassava*). Acompanhamento da Situação Agropecuária do Paraná 2(12):33-35. 1976. Port.

Cassava. Cassava programs. Cultivation. Brazil.

A brief report is given of several cassava-growing projects and problems encountered in the regions of Paranaguá, Vitória and Umuarama (state of Paraná), the production of which is destined for the alcohol distilleries of PETROBRAS in Curvelo. (*Summary by T.M.*) J00

0394-0093 **MANDIOCA.** Acompanhamento da Situação Agropecuária do Paraná 3(1):53-54 1977 Port

Cassava. Cultivation. Production. Costs. Cassava programs. Brazil.

Information is given on several trials conducted at the experimental station of Taquari-RS with the cassava varieties S-6118 and R-13 to produce forage for animal feeding as an additional benefit from cassava. Through the use of modern technology, the production in Paraná can be doubled (from 20 to 44 tons/ha). (*Summary by I.B.Z.*) J00

0395-6694 **MANDIOCA.** (*Cassava*). Acompanhamento da Situação Agropecuária do Paraná 3(5):62-64. 1977. Port.

Cassava. Cassava programs. Cultivation. Production. Costs. Brazil.

A report is given on the present status of cassava cultivation in the regional centers of Umuarama and Paranavaí, state of Paraná (Brazil). Special reference is made to production, productivity and costs of credit for these operations. (*Summary by A.J. Trans. by T.M.*) J00 D01

0396-5407 MIEGE, J. **Project d'experimentation sur maniocs pour 1953.** *(Cassava experimentation project for 1953).* Abidjan, Ivory Coast, Centre d'Adiopodoumé Institut d'Enseignement et de Recherches Tropicales, 1953. 14p. Fr.

Cassava. Cassava programs. Experiment design. Ivory Coast.

Indications are given on how experiments planned for 1953 in Adipodoumé (Ivory Coast) should be conducted The variety to be used was Tabouca and the trials to be conducted were planting dates and systems, varietal screening (10 cultivars and Tabouca as the check), effect of cutting type and length according to the part of the stem it was taken from, effect of direction of the beds (N-S, E-W), screening of the clones in the collection, and breeding and hybrization trials in the field and in seed beds. *(Summary by S.S. de S. Trans. by T.M.)* **J00 D00 G01**

0397-7041 OFOSU, A **Some characteristics of gari on which product standardisation may be** based. Pokoase, Ghana, Crops Research Institute, 19. 7p. Engl.

Cassava. Gari. Legal aspects. Ghana.

As a result of interviews with people who consume gari, the following factors should be taken into account when establishing product quality standards: moisture content, extraneous matter, particle size, swelling capacity, HCN content, and acidity (% of lactic acid). Analyses are made of gari samples from different markets in Ghana. (*Summary by A.J. Trans. by I.B.Z.*) J00

0398-1584 **O QUE A mandioca tem?.** (*Cassava*). Petrobrás no.270:24-29. 1974. Port., Illus.

Cassava. Cassava programs. Production. Industrialization. Brazil.

The characteristics are given of several preferred Brazilian varieties. Differences between sweet and bitter cassava are explained. Cassava is a popular food, especially cassava flour, which should be protein enriched. The Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) has been experimenting with flour enrichment, using soybean protein. The lack of stimulus has affected the cassava industry; the area of Araras (São Paulo) is a case in point: there were 100 highly productive factories in 1966 and there are only 18 now. EMBRAPA should develop techniques to make the cassava industry profitable. (*Summary by I.B.Z.*) J00

0399-8054 PHILLIPS, T. P. A profile of Thai cassava production practices. *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.228-232. Engl., Sum. Engl., 1 Ref.

Cassava. Production. Land preparation. Planting. Harvesting. Cultivation. Labour. Productivity. Costs. Colombia. Thailand.

Preliminary results are given of an agro-economic survey of Thai cassava producers. This study is part of a larger international network of studies completed or under way in Colombia, Nigeria and Brazil. All studies analyze the economic and agronomic relationships related to cassava production; however, owing to country differences, specific objectives are designed for each. For the Thai survey, they are (1) the prediction of total cassava production and acreage in Thailand for 1974-75, (2) the identification of major sets of production practices, and (3) the identification of factors encouraging or discouraging the use of certain technologies Data for this paper were extracted from 2 questionnaires: The 1st related to acreage and production (2153 farmers), the 2nd to specific production and marketing practices (501 farmers). (*Author's summary*) J00 D00

0400-8125 PORTO, M.C.M. Plano nacional do álcool, análise e aplicações. (*National alcohol plan · analysis and applications*). Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1977. 11p. Port., 8 Refs.

Cassava. Cassava programs. Developmental research. Alcohol. Production. Economics. Ethanol. Brazil.

Although the growth index of Brazil is satisfactory, there is an unfavorable balance of trade (US$ 12 billion). Of the total oil consumed, Brazil produced only 20%. Photosynthetic energy offers good perspectives as a fuel but yields are low (2%). New internal sources of liquid energy are being explored, mainly ethyl alcohol from plants, especially cassava (1 ton cassava roots produces 300-350 kg flour, 300-350 kg chips, 200-250 kg starch and 180-190 liters ethyl alcohol). The advantages and disadvantages of alcohol as a fuel are given, as well as production outlook, goals and measures taken by the National Alcohol Program. (*Summary by I B Z.*) J00 102

0401-7545 PRIOR, A.J. Cassava. Farming in Zambia 9(2):16. 1975. Engl

Cassava. Production. Uses. Cassava programs. Zambia.

The importance and potential of cassava as a food for humans and animals, especially swine and poultry, is pointed out. Aspects of its nutritional value and demand on the market are discussed in the light of its possible extensive cultivation in Zambia. (*Summary by A.J. Trans. by T M.*) J00

0402-5205 PYTTERSEN, T.J. **De toekomst van verschillende cultures in Suriname. III Cassave.** *(Perspectives of different crops in Surinam. III. Cassava).* *In* De West Indies gids. 'S Gravenhage, Netherlands, n.i., 1922. pp. 177-188. Dutch.

Cassava. Productivity. Production. Marketing. Economics. Surinam.

A comparison is made of cassava production levels in Surinam and Java. Surinam should be able to compete with Java since its climate and soils are generally more favorable, cassava matures earlier (12 mo vs. 16 mo in Java), and transportation is cheaper. On the other hand, Java has cheaper labor and plow cattle. The feasibility of mechanizing cassava production should be looked into. Since local manufacturers are reluctant to risk investments in this industry, the Government should study the possibility of investing in this project, which is important to the rebuilding of Surinam's economy. (*Summary by R. van G.*) J00

0403-7559 RAMOS A., A. **Anotaciones y programa para investigación sobre yuca industrial en el Proyecto Magdalena #1.** (*Magdalena Project no.1 for industrial development of cassava*). n.i., 1969. Span.

Cassava. Cassava programs. Cultivars. Selection. Planting. Land preparation. Harvesting. Mechanization. Diseases and pathogens. Injurious insects. Plant breeding. Colombia.

With the purpose of developing a cassava research program for industrial utilization in the banana-growing zone of Colombia, the following recommendations were made: (1) define a system for classifying clones, (2) screen local varieties and the Instituto Colombiano Agropecuario (ICA) collection, (3) carry out fertilizer and herbicide trials, (4) look into the mechanization of harvesting, irrigation requirements and sanitary conditions of the region (a list of pests recorded by ICA is included), (5) determine optimum planting dates, methods (on the ridge and on the flat) and distances, as well as planting position of the cuttings, (6) determine starch content of roots of clones, (7) initiate a plant breeding program, and (8) study the integral use of the plant, production costs and the influence of soil moisture on starch content. (*Summary by M.O. de H. Trans. by T.M.*) J00

0404-8189 RAMOS, E. L. **Mercado interno.** (*The domestic market*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fructicultura, 1976. v.1 pp.15-28. Port., 15 Refs.

Cassava. Cassava programs. Marketing. Prices. Production. Consumption. Economics. Brazil.

Data from different sources are presented on the dimensions of the cassava domestic market, particularly in the northeastern region of Brazil, which has the highest relative consumption of cassava. The Banco do Nordeste do Brasil estimates a 4% annual increase (from 1971-80) in demand for cassava in this region for nonhuman consumption. Tables are presented on 1961-65-70 cassava production for different states and the relative participation of the northeastern, southeastern and southern regions in national production; production/price response functions and supply/demand elasticities are given. A market model is suggested, as well as recommendations for future research. (*Summary by I.B.Z.*) J00

0405-6240 ROLFE, E.J. **Training overseas students in composite flour technology.** *In* Symposium of the use of non-wheat flour in bread and baked goods manufacture, London, 1970. Proceedings. London. Tropical Products Institute. G-62. 1970. pp.17-18. Engl.

Cassava. Cassava flour. Breads. Composite flours. Developmental research.

A brief report is given of research work on composite flours done by MS candidates at the National College of Food Technology. One trial was on the substitution of wheat flour by cassava flour in the manufacture of hard, semisweet biscuits. The dough was tested for water absorption, strength, specific recovery, water tolerance and baking. With regard to the biscuits, the characteristics measured were stack height, the wt and the diameter of 12 biscuits. Water absorption increased with cassava flour addition. There was little change in dough strength up to 15% cassava flour, but it was markedly depressed when increased to 25%. It appears that the addition of up to 25% cassava has little effect on specific recovery and water tolerance. The cassava flour gave the dough a yellowish color and a lighter texture; there was also some alteration in flavor. (*Summary by A.J.-Trans. by I.B.Z.*) J00

0406-7555 SANTANA, A.M. Alcool motor. (*Power alcohol*). Cruz das Almas, Brasil, Universidade Federal da Bahia. Escola de Agronomia, 1976. 18p. Port., 11 Refs.

Cassava. Developmental research. Cassava programs. Ethanol. Alcohol. Production. Processing. Brazil.

Legal, economic and technical aspects, as well as comparative data, are presented for the processing of ethyl alcohol, mainly from sugar cane, sweet potatoes and cassava. Among these raw materials for making anhydrous alcohol, cassava is outstanding, yielding 15-35 tons of roots/ha or 150-210 liters alcohol/ton. A brief description is given of the process for obtaining alcohol. By using 20% alcohol in gasoline, the Brazilian government would economize US$500 million/yr in foreign exchange destined for importing petroleum Data are given in table form on the domestic demand for alcohol and investment costs for installing a distillery. (*Summary by M.O. de H. Trans. by T.M.*) J00 I02

0407-8261 SEIF, A.A. and CHOGOO, P. Cassava in Kenya. *In* African Cassava Mosaic, Muguga, Kenya, 1976. Report of an interdisciplinary workshop. Ottawa, Canada, International Development Research Centre, 1976. pp.7-10. Engl., 5 Refs.

Cassava. Production. Cassava chips. Cultivation. Cassava programs. Kenya.

Cassava is a major supplementary food to maize and millet, which form the main diet of the people in Kenya. Cassava production, agronomy (land preparation, time of planting, planting material, fertilization, harvesting, chipping, marketing) and diseases are some of the aspects dealt with. Although cassava is not currently processed in Kenya, its av yield of about 23 tons/ha fresh wt, together with its relative proximity to European countries, increases its potential as a cash crop. Its role as a source of energy supply is stressed: 250 kcal as compared to rice (176), maize (200), sorghum (114) and wheat (110). (*Summary by I.B.Z.*) J00

0408-6928 SIERRA L., J.M. Aspectos económicos del cultivo de la yuca. (*Economic aspects of cassava cultivation*). *In* Curso sobre producción de yuca. Medellín, Instituto Colombiano Agropecuario, Regional 4., 1975. pp.221-231. Span.

Cassava. Production. Cultivation. Labour. Costs. Developmental research. Economics. Animal nutrition. Colombia.

An analysis is made of several aspects of cassava cultivation in Colombia. Av national production is 8 tons/ha, which indicates a low technological level. Cassava is generally grown on small plots and impoverished soils. Family labor requires 84 man-days/ha/yr whereas technical exploitation

requires only 65. Production costs depend on several factors: location, season, prices of inputs. Several considerations are given for increasing productivity: (1) increases in cost and income by adopting technological innovations, (2) ways to reduce price and production uncertainty, (3) efficient product utilization, and (4) use in animal feedstuffs. (*Summary by A.J. Trans. by I.B.Z.*) J00 D00

0409-7923 STARCOSA G.m.b.H. **Cotización de precios por la maquinaria para la producción de 1.000 toneladas de almidón de yuca por año.** (*Bid estimate for machinery to produce 1000 tons of cassava starch per year*). Braunschweig, Germany, 1973. 6p Span.

Cassava. Cassava starch. Industrial machinery. Prices. Processing. Development costs.

It is estimated that it takes 200 h work to produce 5 tons of cassava starch/24 h from 20 tons of fresh roots with normal starch content. Based on a production of 1000 tons cassava starch/yr, investment costs are given for a plant that would meet these requirements. (*Summary by T M.*) J00 I02

0410-8185 STEELE, P.J.B. **The pattern of agriculture in Angola.** World Crops 26(1).31-33. 1974. Engl.

Cassava. Production. Productivity. Developmental research. Cultivation. Angola.

The pattern of agriculture in Angola, divided into 5 zones, is described Cassava is grown everywhere, except in the southern zone. In 1970-71, cassava was grown only as a subsistence crop, with an av yield of 1.8 tons/ha. Several aspects of governmental policies are discussed, together with the future pattern of agricultural growth. (*Summary by A.J. Trans. by I.B.Z.*) J00 D00

0411-7457 TORO M., J. C and CELIS A., E. **Planeación del cultivo de la yuca.** (*Planning for cassava production*) *In* Curso sobre producción de yuca. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1976 pp. 334-340. Span.

Cassava. Production. Costs. Planting. Land preparation. Cuttings. Labour. Weeding. Insect control. Harvesting. Colombia.

A concrete example is given of the costs involved in cultivating I ha of cassava in the Cauca region of Colombia. Knowing costs is a useful tool in crop planning, making it possible to determine capital needs, labor and other inputs, as well as their flow during the production process. It must be kept in mind that any budget is approximate; it must be adjusted to each particular case and 10% left for contingencies. In general, contingencies may vary from Col.$5,000 to $25,000/ha; in this case they were $21,000. To calculate costs, the following facts were taken into account: land preparation, seed, planting, weed and insect control, overseer, harvesting and leasing of land. (*Summary by S.S. de S. Trans. by T.M.*) J00 D00

0412-7667 TOSELLO, A As farinhas na alimentação brasileira. (*Flours in Brazilian nutrition*) Boletim do Instituto de Tecnologia de Alimentos 21:1-8. 1970. Port.

Cassava. Cassava flour. Production. Consumption. Human nutrition. Brazil.

Cassava is the most important source of carbohydrates in Brazilian diets, followed by rice, maize, wheat and beans. An analysis is made of the production, quality and consumption of 3 flours: cassava, wheat and maize. Cassava flour is of poor quality, produced in rudimentary home industries. Its present volume of consumption is due to the government's policy of mixing cassava flour with wheat flour. A large-scale industry should be built for exporting cassava flour. (*Summary by I.B.Z. Trans. by T.M.*) J00 H00

0413-8030 UMANAH, E. E. **Cassava research in Nigeria before 1972.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.137-141. Engl., Sum. Engl., 10 Refs.

Cassava. Cassava programs. Research. Plant physiology. Cultivation. Genetics. Injurious insects. Diseases and pathogens. Cultivars. Productivity. Nigeria.

This review of cassava research in Nigeria over a 20-yr period pays particular attention to plant breeding, agronomy, chemical analysis, physiology, pests and diseases, and cytogenetics. Breeding objectives and varieties recommended for the various ecological areas of the country are discussed. A package of management practices is given. The karyotypes of some *Manihot* species including cassava were determined; it is suggested that cassava is an allopolyploid with a chromosome no. of 2n = 36 and a basic chromosome no. of X= 9. (*Author's summary*) J00

0414-3286 UNIVERSIDADE FEDERAL DA BAHIA. ESCOLA AGRONÔMICA **Relatório semestral de andamento e avaliação de pesquisas.** *(Semiannual progress report and evaluation of research).* Bahia, Brasil, Convênio U F.BA./Brascan Nordeste. Projeto Mandioca, 1972. 181p. Port., Illus.

Cassava. Cassava programs. Plant breeding. Germplasm. Clones. Resistance. Insect control. Mite control. Disease control. Soil water. Fertilizers. Minerals. Phenology. Planting. Timing. Spacing. Cuttings. Forage. Socioeconomic aspects. Brazil.

A report is given on research conducted by the Universidade Federal de Bahia (under the U.F. BA/Brascan Nordeste agreement) from July-Dec. 1972 The report is divided into 2 sections, (1) administrative and technical aspects related to the different subprojects and (2) objectives and results of laboratory and field experiments in 12 subprojects: genetic improvement, pest biology and control, diseases, irrigation, study of climatic factors, cultural practices, chemical composition of varieties, toxicity, production of forage, socioeconomic aspects and dissemination of results. *(Summary by S S de S. Trans. by T M.)* J00

0415-0129 UNIVERSIDAD FEDERAL DA BAHIA. ESCOLA DE AGRONOMIA. **Projeto mandioca.** *(Cassava project).* Cruz das Almas, Brasil Convênio U.F.BA./Brascan Nordeste. Relatorio Semestral de Pesquisas no. 4. 1974. 81p. Port., 4 Refs.

Cassava. Cassava programs. Field experiments. Plant breeding. Germplasm. Clones. Pest control. Resistance. Water requirements (plant). Fertilizers. Minerals. Planting. Timing. Spacing. Tuber productivity. Analysis. HCN content. Cassava flour. Forage. Animal nutrition. Socioeconomic aspects. Costs. Trade. Brazil.

A report is given of research on cassava done from January-June, 1974 by the Universidade Federal da Bahia, under the U.F. BA/BRASCAN Nordeste agreement. Results of 12 subprojects

are given: genetic improvement, pests, diseases, risk, soils (amendments and fertilization), influence of climate, cultural practices, technical-chemical studies, toxicity, forage production, socioeconomic studies and dissemination of information *(Summary by S.S. de S. Trans by T.M.)* J00

0416-5734 UNIVERSIDADE FEDERAL DA BAHIA. ESCOLA DE AGRONOMIA. **Sistema de produção da mandioca recôncavo e sul da Bahia.** *(Cassava production systems in coastal and southern Bahia). In* Projeto mandioca. Cruz das Almas, Brazil. Convênio U.F.BA./Brascan Nordeste. Série Extensão, v.1, no. 1. 1975. 30p. Port., Illus.

Cassava. Cassava programs. Climatic requirements. Soil requirements. Land preparation. Fertilizers. Minerals. Cultivars. Cuttings. Planting. Timing. Spacing. Injurious insects. Injurious mites. Diseases and pathogens. Pest control. Harvesting. Rotational crops. Storage. Processing. Uses. Costs. Brazil.

The Universidade Federal da Bahia, with financial backing and technical assistance from BRASCAN Nordeste, is developing a program of cassava breeding and cultivation in northeastern Brazil. A report is given of results obtained to date in coastal and southern Bahia, as well as in other northeastern regions that have similar characteristics. The following aspects are dealt with briefly: climatic and edaphic requirements, soil preparation, use of amendments and fertilizers, planting (preparation of propagation material, planting systems, spacing, weeds, harvesting, rotations), principal pests (ants, hornworms, mites, shoot flies, stemborers) and diseases (leaf spots, rust, anthracnose, root rot, bacterial blight). Finally, agricultural inputs and operations for both small- and large-scale plantings are given, specifying costs and investments required. (*Summary by S.S. de S. Trans. by T.M.*) J00

0417-3372 VAISSIERE, P. DE LA **Typologie des exploitations agricoles en zone forestière de Côte d'Ivoire; premiers resultats.** (*Typology of agricultural estates in the forest zone of the Ivory Coast; first results*). Cahiers Ivoriens de Recherche Economique et Sociale no.9:59-84. 1976. Fr., Illus.

Cassava. Production. Developmental research. Ivory Coast.

An analysis is made of the production systems of estates below 100 ha. The results are given of 3 typological investigations dealing with relations between area and permanent labor, combinations of various crops (cacao, coffee, coconuts, cassava and *Oryza sativa*); and importance and kinds of labor are recorded. (*Summary by Abstracts on Tropical Agriculture*) J00

0418-8053 VALDES S., H. **The importance of cassava processing in the economy of Colombia.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.226-228. Engl., Sum. Engl.

Cassava. Processing. Economics. Cassava programs. Colombia.

Many countries, including Colombia, will never be self-sufficient in producing certain cereals such as wheat. Since cassava flour is an adequate substitute for wheat flour, the production of cassava should be expanded to ensure an adequate quantity of raw material to support processing industries. (*Author's summary*) J00

0419-1814 **VIELFALTIGE VERWENDUNG von Maniok; ein Bericht der Business Analysis for Africa.** (*Multiple uses of cassava; a report by Business Analysis for Africa*). Afrika Heute no. 7:107-108. 1970. Germ.

Cassava. Industrial starches. Cassava flour. Cassava chips. Uses. Marketing. Africa.

An analysis is made of a report presented by the firm Business Analysis for Africa, which studies the possibilities of exporting African cassava to the USA for making industrial starches, flour for human consumption and chips for animal feeds. African research institutions have promoted the use of modern processing and storage methods. With stable export prices, local industries using starch or flour for textiles, paper and adhesives have arisen. The growing EEC market for cassava chips is interesting, precisely when the USA is trying to improve their cattle industry with feed-lot systems. Kenya is studying the possibility of using cassava to replace more expensive cereals. In Senegal, cassava will be used in the feed concentrates industry for beef cattle. The multiple uses of cassava are especially appropriate for small industries, and it is technically feasible to adapt machinery at a low cost. If North American companies are to be interested in this enterprise, new forms of investment have to be implemented. Above all, it is necessary that the African governments and businessmen acquire more knowledge about the US market. *(Summary by H.P. Trans. by T.M.)* J00

0420-8181 WHOLEY, D W. **Versatile cassava is at home in Asia.** IDRC Reports 5(3).3-4. 1976. Engl , Illus

Cassava. Cassava programs. Production. Developmental research. Asia.

A brief description is given of cassava research activities, international cooperation, production and industrialization, which show cassava production is increasing rapidly in Asia. Aspects of its utilization in human and animal nutrition are discussed. The role of the International Development Research Centre in structuring a cassava research network in Asia is emphasized. (*Summary by A.J. Trans. by I.B Z*) J00

0421-5034 WIRTZ, H.A.A.M. **Eenige aateekeningen over de kwaliteit en den handel van cassavemeel in West-Java.** *(The quality and marketing of cassava meal in western Java)* Landbouw 13(7/8):514-523. 1973. Dutch.

Cassava. Cassava meal. Production. Trade. Java.

The cassava meal exported by western Java comes principally from small-scale operations in which roots are peeled in the fields and either sold to the factories or made into a fermented meal (kampong or gaplek) using primitive methods. Assessment of quality is based mainly on visual observations. Large-scale manufacturers generally buy this meal to produce a more refined product for export purposes; however, quality standards are irregular. The establishment of quality standards and certificates for export is recommended to improve export possibilities and prices. (*Summary by R. van G.*) J00

0422-7398 WOOD, A. S. **Netherlands increases use of nongrain items in feed.** Foreign Agriculture 14(19):6, 7, 12. 1976. Engl., Illus.

Cassava. Feeds and feeding. Cassava meal. Consumption. Netherlands.

A brief analysis is made of the changes that have taken place in the raw material used by the

animal feed industry in the Netherlands during the period 1965-74. It is pointed out that the ingredients have changed from the cereal grains, which predominated at the beginning, to cassava meal, beet pulp, molasses, soybean meal, etc. One factor contributing to this displacement is the import taxes levied by the ECC. *(Summary by A.J. Trans. by T.M.)* J00 H03

See also *0004* *0062* *0105* *0118* *0323* *0339* *0345* *0424*

K00 OTHER ASSOCIATED COMMODITIES

0423-7280 ZEHNTNER, L. **Estudo sôbre as maniçobas do estado da Bahia, em relação ao problema das seccas.** *(Manihot spp. in the dry regions of the state of Bahia).* Rio de Janeiro, Brasil. Ministerio da Viação e Obras Publicas. Inspectoria de Obras Contra as Seccas. Série I, A. Botanica. Publicação no. 41. 1914. 114p. Port., Illus.

Manihot. Manihot dichotoma. Manihot heptaphylla. **Plant anatomy. Taxonomy. Identification. Plant geography. Maps. Brazil.**

A study is made of the characteristics and habitat of the following species of Ceará rubber (Euphorbiaceae) grown in the state of Bahia (Brazil); *Manihot dichotoma. M. heptaphylla, M. piauhyensis, M. toledy, M. labroyana, M. lyrata, M. discolor, M harmasiana, M. cuneata, M. rotundata, M. bahiensis, M. trifoliata, M. sehntneri, M. ferruginea* and *M. microdendron.* The last 11 are new species. Aspects of quality and costs of rubber in Bahia, as well as market perspectives, are also discussed. Diseases and pests are indicated. (*Summary by S S de S. Trans. by T.M.*) K00

K01 Rotational Schemes and Intercropping

0424-8360 ALVAREZ, P., C. **Análisis comparativo de tres sistemas de producción de yuca.** (*Comparative analysis of three cassava production systems*). *In* Diaz, R.O. and Pinstrup-Andersen, P., eds. Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 24p. Span., Illus.

Cassava. Maize. Beans. Inter-cropping. Spacing. Labour. Productivity. Costs. Production. Colombia.

Based on interviews with farmers from Zone II in Colombia (states of Valle del Cauca and Quindío), an analysis is made of 3 intercropping systems: (1) cassava alone (39 farmers), (2) cassava + maize (21 farmers) and (3) cassava + beans (17 farmers). For each system an estimate was made of frequency distributions, means, statistical tests (Student, Chi-square distribution) and microeconomic parameters of av productivity, gross profit per unit of area and time. Av farm size was 45.7 ha; for cassava alone areas were larger (av 65 ha). Important limiting factors were excessive rains and K fertilization for systems 1 and 2. In systems 1 and 3, planting is done mainly on the ridge, which is highly correlated with the use of machinery for preparing the land. In system 2 it is done in furrows. There was no pattern for planting distances and densities. Av planting densities for cassava were basically in accordance with recommended practices, whereas those for maize and beans were much lower than those recommended for these crops in monoculture. Weeding, which was done by all farmers, requires a great deal of labor; system 3 required the most weedings and man-h. Fertilizers and insecticides were used by 46 and 54% of the farmers; respectively; whereas only 2.2 and 9.9% used fungicides and herbicides, respectively. Most inputs were used in system 1, followed by 3 and 2. More crops were financed in system 1 (45.7%) only 8.3% were financed in system 2. Differences in labor required for land preparation and application of inputs can be attributed to a greater degree of technology (mechanized land preparation) and not to the system itself. Av cassava production was best in system 3, followed by 1 and 2; but differences were not significant. Factors involved in influencing farmers' decisions as to which system to use are discussed. (*Summary by T.M.*) K01 J00

0425-8398 ALVIAR, N.G. and CUEVAS, S.E. **Management of selected coconut intercropped farms in Laguna, Batangas and Cavite.** Journal of Agricultural Economics and Development 6(2):184-196. 1976. Engl., 5 Refs.

Cassava. Inter-cropping. Cultivation systems. Philippines.

Out of the 15 case farms studied, a Batangas farm was found to have the highest cropping index (300%), which means that land is fully utilized throughout the year through rotational cropping. The largest area of cropland is a Lipa farm which is 13.5 ha and the smallest area is in Magdalena, Laguna, 0.8 ha. Cropping patterns have remained the same for the past 10 yr; however, one farm

in Cavite reported a development in cropping scheme; namely, during the last 4 yr rice was the intercrop followed by maize and then cassava. Now it has a more intensive cropping system: the intercropping of bananas, papayas, "gabi" and pineapple. This cropping pattern produced a bountiful yield, which gave the tenant a higher share and bigger returns when compared with the previous years' farm income. (*Summary by Abstracts on Tropical Agriculture*) K01

0426-7991 BEETS, W.C. **Multiple-cropping practices in Asia and the Far East.** Agriculture and Environment 2(3):219-228. 1975. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Cultivation systems. Inter-cropping. Maize. Rice. Productivity. Asia.

Intercropping, relay cropping, and multiple cropping are reviewed with particular reference to trials with maize and soybeans in Thailand; maize, cassava and rice in Indonesia; and rice and soybeans in Taiwan. The systems described were generally more profitable than monoculture. (*Summary by Field Crop Abstracts*) K01

0427-3482 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Association maïs-manioc.** (*Intercropping of maize and cassava*). *In*___. Rapport d'ensemble; années 1967 et 1968. n.p., IRAT Togo, Ministère de l'Economie Rurale, Direction de l'Agriculture, 1969?. pp.63-64. Fr.

Cassava. Maize. Inter-cropping. Productivity. Field experiments. Togo.

Maize-cassava associations were compared to a control cassava monocrop. A randomized block design with 4 replications was used. The Duncan test was used for data interpretation. During the 1st yr, the various phosphates tested did not produce significant yield differences. (*Summary by I.B.Z*) K01

0428-7364 NAIR, P.K.R., VARMA, R. and NELLIAT, E.V. **Intercropping for enhanced profit from coconut plantation.** Indian Farming 24(4):11-13. 1974. Engl., Illus.

Cassava. Inter-cropping. Cultivation systems. India.

The results are given of intercropping coconut palms with different crops including cassava (var. H 165 and M 4). Experiments were conducted at the Central Plantation Crops Research Institute in Kerala (India) from 1973-74. The 40- to 60-yr-old palms were planted at 7.5 x 7.5m. Cassava was planted at 90 x 90 cm (9500 plants/ha) and yield was 10.5 tons/ha. A cost-benefit analysis is included, and employment opportunities and availability of labor are discussed. Cassava did not affect the growth or yield of the coconuts, provided manuring was adequate. (*Summary by A.J. Trans. by I.B.Z.*) K01

0429-8409 NELLIAT, E.V. and KRISHNA JI, N. **Intensive cropping in coconut gardens.** Indian Farming 27(9):9-12. 1976. Engl..

Cassava. Inter-cropping. Cultivation systems. India.

Farm plan models for one-hectare rainfed or irrigated coconut gardens are given, intercropped with cacao, cassava, sweet potatoes, ginger, bananas, pepper, pineapple and yams. Good management is essential for this labor-intensive system. (*Summary by Abstracts on Tropical Agriculture*) K01

0430-8020 NITIS, I.M. and SUARNA, M. **Undersowing cassava with stylo grown under coconut.** *In* Symposium of the International Society for Tropical Root Crops, 4th., Cali, Colombia, 1976. Ottawa, Canada, International Development Research Centre, 1977. pp.98-103. Engl., Sum. Engl., 12 Refs

Cassava. Inter-cropping. Field experiments. Tuber productivity. Spacing. Tubers. Dry matter. Indonesia.

Three field experiments on undersowing cassava with stylo were carried out in Bali. Stylo drilled under the cassava at diagonal crossings produced root DM similar to that of cassava sown without stylo. Other methods of sowing stylo (broadcast, windrow, crisscross, and drilled midway between 2 cassava plants) significantly (P = 0.05) decreased root DM yield 32-51%. Windrow sowing the stylo under the cassava by replacing cassava with stylo so that the spacing increased from 40 x 40 cm (without stylo) to 40 x 80 cm (with stylo) and from 60 x 60 cm (without stylo) to 60 x 120 cm (with stylo) increased root production by 20 and 22%, respectively. At the wider cassava spacing, the replacement significantly decreased root DM yield by 28%. In the other experiment, windrow sowing stylo under the cassava decreased root DM yield 14% (P = 0.05). PK or PK + trace elements could alleviate such yield depression. The cassava + stylo combination produced about 69% more shoot DM than when sown without stylo. The importance of undersowing cassava with stylo in mixed farming systems is discussed (*Author's summary*) K01 D03

0431-7549 SASIDHAR, V.K and SADANANDAN, N. **A note on the performance of tapioca after cowpea in multiple cropping.** Agricultural Research Journal of Kerala 12(2) 197. 1974. Engl., Sum. Hindi.

Cassava. Rotational crops. Field experiments. Tuber productivity. Water requirements (plant). India.

A multiple cropping experiment was conducted during 1971-72 and 1972-73 at the College of Agriculture, Vellayani (India) with the object of developing suitable cropping patterns for the uplands of Kerala. One of the 5 cropping patterns tried was cassava followed by cowpeas. Cassava was planted the lst wk of Aug. and harvested the last wk of Mar., and cowpeas were planted the lst wk of April and harvested the last wk of July during both years. Cassava and cowpea yields were 25,446 and 580 kg/ha, respectively, the lst yr and 29,017 and 423 kg/ha, respectively, the 2nd yr. Cassava yields increased the 2nd yr due to the influence of the preceding cowpea crop. In addition to the high production of cassava tubers in the cassava/cowpea cropping pattern, it was also found that the water requirements of this cropping pattern were the lowest, clearly indicating its suitability in areas of low irrigation intensity. *(Full text)* K01

0432-2261 STATION CENTRALE DE BOUKOKO. **Les essais de cultures intercalaires; rapport annual 1956.** (*Intercropping trials; 1956 annual report*). Nogent-sur-Marne, France, Centre Technique de Agriculture Tropicale. Bulletin Trimestriel no.4:49-51. 1957.

Cassava. Inter-cropping. Field experiments.

Results are given of several intercropping trials (cassava, rice, sweet potatoes, *Pueraria javanica*). Intercropping did not interfere with normal crop growth. Temporary intercropping (18 mo) had no effect on growth on recently cleared forest soils; on savanna soils, however, this practice is not recommended. The statistical analysis of the results is presented. (*Summary by I.B.Z.*) K01

0433-5380 THAMBURAJ, S. and MATHUKRISHNAN, C.R. **Intercropping Bellary onion with tapioca.** Indian Horticulture 21(2):15. 1976. Engl.

Cassava. Cultivation systems. Inter-cropping. Productivity. India.

Cassava var. Malavella was grown on ridges under irrigated conditions. An array of catch crops were tested. Bellary onion was the most suitable and did not affect cassava yields (only 1% reduction). Tamil Nadu farmers are now intercropping Bellary onion with cassava for additional, short-term returns (3-4 mo). (*Summary by I.B.Z.*) K01

See also 0131

K02 Descriptive and Comparative Studies

0434-8262 OKIGBO, B.N. **Essais sur le maïs dans la plaine de Nsukka (Nigeria). III. Les effects de differents sortes de mulch sur le rendement du maïs en climat tropical humide.** (*Maize experiments on the Nsukka Plains. III. Effects of different kinds of mulch on maize yields in the humid tropics*). Agronomie Tropicale 27(10):1036-1047. 1972. Fr., Sum. Fr., Engl., Span., 8 Refs.

Cassava. Productivity. Cultivation systems. Nigeria.

Experiments were conducted to study the effects of 12 mulching treatments on maize yield and general performance. The favorable effects of the mulch appeared to have been due to their manurial value especially in the rainy season, whereas in the dry season, it was the moisture-conserving effect of the mulch that contributed to yield and growth. The same treatments that resulted in highest maize yields (semidecomposed ensilage and *Stylosanthes* tops) had the most pronounced residual effect on the yield of cassava grown the year immediately following the maize mulch experiments. (*Author's summary*) K02

Z00 GENERAL

0435-3127 ATANASIU, N. Cassava (Maniok). *In* Blackenburg, P. von, ed. Handbuch der Landwirtschaft und Ernähruna in der Entwicklungsländer. n.p., 1966? pp. 299-305. Germ., 16 Refs., Illus.

Cassava. Nutritive value. Cultivation. Composition. Processing.

The following aspects of cassava cultivation are dealt with briefly: economic significance, nutritional value in comparison to that of maize and potatoes, botanic characteristics, ecological conditions, edaphic and climatic requirements, agronomic practices including use of cuttings, planting, spacing, weeding, fertilization, harvesting methods, cassava meal and starch production, and breeding for resistance to diseases and high starch content. Mosaic is mentioned as the most important cassava disease. *(Summary by H.P. Trans. by S.S. de S.)* Z00

0436-5103 BERNEGG, S. VON Der Wurzelmaniok *(Cassava)*: *In* ——. Tropische und subtropische Weltwirtschaftsplazen; ihre Geschichte, Kultur, und Volkswirtschaftliche Bedeutung. Stuttgart, E. Enke, 1929. pp.206-234. Germ., 28 Refs., Illus.

Cassava. History. Plant anatomy. Cultivars. Cultivation. Uses. Cassava products. Cassava flour. Tapiócas. Trade.

This comprehensive study on cassava covers the following aspects: origin and history, morphologic and taxonomic descriptions, edaphic and climatic requirements, agronomic practices (planting, fertilization, etc.), common diseases and pests, nutritional status at different stages of plant growth, yields, preparation and composition of tapioca and cassava flour and uses (baked products, alcohol, beer and feed stuffs). In addition, export data for Brazil and the French colonies are presented. (*Summary by H.P. Trans. by S.S. de S.*) Z00

0437-4737 BRANDAO SOBRINHO, J. Mandioca (*Cassava*). São Paulo, Casa Duprat, 1916. 165p. (Bibliotheca Economica Thelymar, v.3). Port.

Cassava. History. Cultivars. Composition. Tubers. Leaves. Stems. Cultivation. *Xanthomonas manihotis*. Costs. Processing. Cassava flour. Cassava starch. Alcohol. Tapiocas.

Historical, botanical, agricultural, chemical, industrial, and commercial aspects of cassava are discussed, with emphasis on Brazil. Planting dates, cultural practices and yields are given for the different states. Control of *Xanthomonas manihotis* (=*Bacillus manihot*) is recommended by using resistant varieties, healthy planting material with no wounds and insect control. Aspects of processing starch, alcohol and other by products are also dealt with. (*Summary by A.J. Trans. by T.M.*) Z00

0438-6950 CERQUEIRA, C.V.E. DE **A mandioca no desenvolvimento agricola econômico da Baía; considerações historicas.** (*Historical aspects of the agro-economic development of cassava in Bahia*). Campo 7(75):49-51. (Cont.). 1936. Port., Illus.

Cassava. History. Brazil.

A historical recount is given of the early use of cassava and its introduction into Europe. Problems in development of the crop include rudimentary cultivation methods, limited marketing facilities and lack of government support. (*Summary by T.M.*) Z00

0439-5208 KOENSS, E.J. **Knolgewassen.** *(Root and tuber crops).* *In* Hall, C.J.J. van and Koppel, C. van de. De landbouw in de indische archipel. Part II A. 'S Gravenhage, Netherlands, U.V. Uitgeverij W. van Hoeve, 1948. pp. 163-200. Dutch, 92 Refs., Illus.

Cassava. Cultivation. Cultivars. Injurious insects. Gaplek meal. Trade. Indonesia.

The history of cassava, climatic and soil requirements, and a description of the plant are given. Java and Madura are the 2 main producers of cassava in the Dutch East Indies, with 950,000 ha planted in 1938. A large no. of varieties are cultivated; from 1908-13 several better yielding varieties were imported from Brazil. Cassava is normally cultivated throughout the year and sometimes between crops of paddy rice, peanuts or maize. Cultural practices such as soil preparation, planting of cuttings, planting distances, weeding and pruning are indicated. During the dry season, severe damage can be caused by the mite *Tetranychus bimaculatus*. White grubs of the beetle *Leucopholis rorida* feed on the roots of the plant; they are very difficult to control. Harvesting is best done at 12-18 mo for small-scale operations and 16-20 mo for industrial operations. On good soils yields of 18,000-50,000 kg/ha are possible. Most of the production is processed into a fermented meal (kampong or gaplek). Factories further process this meal for export, principally to the USA, England, Singapore, Hong Kong, the Netherlands and Japan. Prices obtained for cassava products are uncertain because quality standards are not maintained. (*Summary by R. van G.*) Z00

0440-4991 MITSUMATSU, Y.. [On cassava in Taiwan.] Japanese. Formosan Agricultural Review no. 362: 57-78; 363:153-186. 1937. Jap.

Cassava. History. Production. Cultivation. Climate requirements. Soil requirements. Planting. Fertilizers. Weeding. Diseases and pathogens. Injurious insects. Tubers. Composition. Storage. Uses. Marketing. Taiwan.

This paper gives a very general description of cassava as a crop. Cassava production in Taiwan before World War II and its potential. It includes chapters on the origin and distribution of the crop, the history of cassava production in Taiwan, agronomic characteristics, utilization, production, cultural methods including climate, soils, cultivars, land preparation and planting, methods, fertilizer, weeding, diseases and pests, starch and HCN content, harvesting and storage, and finally the foreign market possibilities It is concluded that cassava has an immediate future as a raw material for starch and alcohol production, the low production cost is the crop's strongest point. (*Summary by K.K.*) Z00

0441-2604 NOJIMA, K and HIROSE, S. Cassava cultivation in Southeast Asia. Indonesia. Japan International Cooperation Agency. Report no 49-23. 1975. 69p. Jap. 123 Refs., Illus.

Cassava. History. Taxonomy. Plant anatomy. Cultivars. HCN content. Detoxification

processes. Cassava leaves (vegetable). Tuber productivity. Cuttings. Planting. Spacing. Fertilizers. Weeding. Soil requirements. Pests. Harvesting. Timing. Intercropping. Processing. Cassava chips. Pellets. Costs. Feeds and feeding. Cassava starch. Cassava flour. Tapiocas. Storage. Marketing. Asia.

With the purpose of introducing cassava into Japan, a study was made of its cultivation in Southeast Asia. There are 15 chapters dealing with the following subjects: history of cassava and world production figures for 1970, Indonesian production from 1967-73; general and botanical characteristics of the plant; varieties from Malaysia and Indonesia, HCN content, yields, cultural practices including preparation of stem cuttings, intercropping, soils, nutrient requirements, continuous cropping, weeding, pests and diseases; optimum harvesting times; drying; pelletizing; processing of cassava starch, flour and tapioca; storage; uses; the market in the state of Rangpong, Malaysia; exports of products for feedstuffs, imports to Japan and problems involved; and the possibility of cultivating cassava in southern Japan *(Summary by Y.I.)* Z00

0442-4853 PECKOLT, T. **Mandioca.** (*Cassava*). *In* .Monographia do milho e da mandioca; sua historia, variedades, cultura, uso, composição chimica, etc., principalmente en relação as variedades cultivadas no Brasil. Rio de Janeiro, Brasil, Typographia Universal Laemmert, 1878. pp.79-175. Port.

Cassava. Cultivation. Taxonomy. Plant anatomy. Cultivars. Composition. Tubers. Human nutrition. Cassava products. Brazil.

This monograph on cassava covers taxonomic and morphological descriptions of *Manihot* spp., synonymy, common names, origin, habitat, different varieties cultivated in Brazil, cultural practices, chemical composition of roots, HCN content in sweet and bitter varieties, uses in native dishes, including different types of meals. (*Summary by T.M.*) Z00

0443-7666 ROGERS, D.J. and APPAN, S.G. **A general description of the cassava (*Manihot esculenta,* Crantz) plant, the areas of production and its importance in world food supply.** *In* Hendershott, C.H. A literature review and research recommendations on cassava (*Manihot esculenta,* Crantz). AID Contract c.s.d./2497. Athens, University of Georgia, 1971. pp.1-55. Engl., 176 Refs.

Cassava. Plant anatomy. Composition. Toxicity. Nutritive value. Cytogenetics. Taxonomy. Production. Productivity. Developmental research. History.

A bibliographic review is made on the following aspects of cassava: history of its domestication and early dissemination, nomenclature, biochemical properties, (protein and amino acid profile, cyanogenic glucosides, carbohydrates, vitamins and minerals), ecology and cytogenetics of *Manihot* spp., classification of varieties, areas of production and the importance of cassava in the world food supply. The last topic includes aspects of high calorie productivity, greater biological efficiency as food producers, adaptation to wide range of ecological conditions, resistance to insect pests and diseases, and ways to compensate for low protein content. (*Summary by A.J. Trans. by T.M.*) Z00

0444-7669 VIEGAS, A.P. **Estudos sobre a mandioca.** (*Studies on cassava*). São Paulo, Brasil, Instituto Agronômico do Estado de São Paulo, 1976. 214p. Port., 91 Refs., Illus.

Cassava. History. Taxonomy. Plant geography. Plant anatomy. Stems. Leaves. Tubers. Petioles. Seed. Flowers. Plant vascular system. Cuttings. Propagation. Germination. Planting. Harvesting. Soil requirements. *Oidium. Diplodia. Xanthomonas manihotis.* Etiology. Diseases control. Brazil.

This book contains unpublished data on cassava conducted at the Department of Plant Pathology of the Instituto Agronomica in Campinas, São Paulo (Brazil) in 1940. Detailed information is given on the history of cassava, the geographical distribution of 180 *Manihot* spp., the influence of different climatic factors, sweet and bitter varieties, taxonomy, morphology, anatomy (vegetative part, roots, the primary and secondary vascular system, chromosomes), phyllotaxy, buds, starch, ovules, rooting of cuttings, cultivation, transportation, the domestic market, protection for the industry, and diseases attacking cassava: their distribution, economic importance, symptomatology, etiology, varietal susceptibility and lifehistory. The 3 diseases dealt with at length are cassava ash, *Oidium manihotis*, dry rot of cuttings, *Diplodia* sp.; and bacterial blight, *Xanthomonas (Phytomonas) manihotus*. National and foreign terminology dealing with cassava and its cultivation are also defined. (*Summary by T.M.*) Z00

AUTHOR INDEX

Agroindustrial Monagas, C.A. 0290
Aguilar F., P. 0049
Alagianagalingam, M.N. 0160
Albuquerque, M. de 0097 0181 0182 0225
Alfa-Laval 0291 0292
Allen, J.E. 0281
Almeida, J.R. de 0293
Almeida, O. de 0360
Alvarez P.,C. 0424
Alviar, N.G. 0425
Amézquita, M.C. 0361
Angulo, J.J. 0243
Aragao, H. de B. 0146
Aristizabal, G. 0362
Arraudeau, M. 0123
Atanasiu, N. 0435
Athanassof, N. 0246 0247
Ayres, J.C. 0295
Ayernor, G.S. 0294
Azevedo, M.S. de 0348

Balagopal, C. 0296
Banco do Nordeste do Brasil 0050
Barberis, C. 0363
Barret, M.D. 0275
Barrington, F. 0364
Barrios, J.R. 0098
Barrios R., J.R. 0019
Barroso, M.A.T. 0297
Bauer, H.F. 0298 0299 0300 0301
Beets, W.C. 0426
Bellotti, A. 0183 0184
Benvenuti, G. 0099
Berlier, Y. 0071
Bernabai, A. 0226
Bernal N., F. 0365 0366
Bernays, E.A. 0173
Bernegg, S. von 0436
Bianchini, M. 0001
Bie, H.C.H. de 0302
Blaw-Knox Food and Chemical Equipment. Buflovak Division. 0303
Bock, K.R. 0161 0162 0163
Boey, C.G. 0029
Booth, R.H. 0304
Botton, H. 0072
Boundy, J.A. 0282
Brandao Sobrinho, J. 0437
Brathwaite, C.W.D. 0172
Breuning, S. 0185
Bruns, P. 0227
Bushuk, W. 0306

Campos, F.A. de M. 0228
Campos, H. dos R. 0073
Castro, M., A. 0100 0101
Cavalli, R. 0249
Centro Internacional de Agricultura Tropical. 0367 0368
Cerqueira, C.V. de 0438
Chandra, S. 0369
Chaves, J.M. 0229
Chazeau, J. 0186
Chen, C.T. 0152
Chen, T.L. 0126 0127
Chen W.T. 0124 0125
Chevaugeon, J. 0153 0154
Chew, W.Y. 0074
Chiu, F.H. 0128
Chiu, F.S. 0129
Chou, K.C. 0250
Cock, J.H. 0009 0020 0021 0102 0370
Coelho, C. 0130
Colombia. Ministerio de Agricultura. Oficina de Planeamiento del Sector Agropecuario. 0371 0372
Conceicao, A.J. da 0075 0103
Conway, R.L. 0283
Costa, A.P. da 0030
Coursey, D.G. 0155
Coutinho, N. 0373

Dantas, W. 0374 0375
Das Gupta, H.P. 0022
De La Cruz, E.T. 0052

Delange, F. 0244
Devendra, C. 0251
Dharmaputra, T.S. 0104
Diaz, R.O. 0156 0187 0376 0377
Doll, J. 0105
Drews, B. 0308
Dustan, W.R. 0027

Edwards, D.G. 0076
Empresa Brasileira de Pesquisas Agronomicas 0200
Empresa Brasileira de Pesquisa Agropecuaria. Centro Nacional de Pesquisa de Mandioca e fruticultura. 0378
Ene. L.S.O. 0106
Eswaran, S. 0349
Ezumah, H.C. 0201

Fafunso, M.A. 0231
Faria, G. de 0309
Fonseca M., A. 0311
Fritz, J. 0107

Gaden, E.L. 0350
Gallego M., L. 0188
Gallo C., J.T. 0252
Gamborg, O.L. 0164
Ghosh, S.P. 0077
Gioelli, F. 0222
Gómez, G.G. 0253 0254
Gómez C., P.L. 0202
González, R.H. 0189
Gopal, T.K.S. 0031
Gopinatan Nair, V. 0023
Gregory, K.F. 0351 0352 0353
Grobot and Simphal 0312
Guidolin, J.A. 0053
Gurgel, L. 0313

Hadi, J.W. 0108
Hahn, S.K. 0203
Hall, C.J.J. van 0179
Hall, N.T. 0032
Hellendoorn, E.W. 0033
Henke, L.A. 0255
Henningsen, H.F. 0380
Hew, V.F. 0256
Holmes, E.B. 0010
Hone, A. 0381
Hood, L.F. 0232
Hooker, W.J. 0002
Horie, S. 0314
Hoving, E. 0078
Howeler, R.H. 0079 0080 0081
Hume, D.J. 0011
Hunt, L.A. 0012
Hutagalung, R.I. 0257 0258

Institut de Recherches Agronomiques de Madagascar 0204 0205 0206 0207 0208
Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres 0109 0132 0133 0134 0209 0427
Institut National pour l'Etude Agronomique du Congo Belge, Division de Plantes Vivrieres 0210
Intituto de Investigaciones Tecnológicas. Colombia 0316
International Institute of Tropical Agriculture 0131 0211
International Trade Centre. UNCTAD/GATT. 0382

J. R. A. 0386
Jennings, D.L. 0003 0212 0383
Jerath, M. L. 0190
Jiménez P., I. 0260 0261
Job, T.A. 0259
Jones, A. 0384
Jones, W.O. 0385
Jong, A.W.K. de 0034

Kamalan, P. 0110
Kanwar, J.S. 0082
Kartha, K.K. 0024
Kaufman, C.W. 0317
Kaufmann, T. 0175
Kawano, K. 0213 0214 0215
Kerr, R.W. 0284
Ketiku, A.O. 0233
Khajarern, S. 0262
Khor, G.L. 0354
Kiernowski, S. 0111
Kim, S.K. 0285
Kiok, W. 0004
Koch, L. 0005 0112 0135
Koenss, E.J. 0439
Kosack, H. 0318
Krausz, J.P. 0387
Kungu, U.M. 0054

Lacayo L., E.J. 0055
Lambert, M. 0056
Langworthy, C.F. 0234
Larios, J. 0157
Larios, J.F. 0158
Leboute, E.M. 0263
Lejoille, R. 0388
Lelong, M. 0235
León, J. 0006
Leu, L.S. 0147
Liang, T.E. 0355
Lin, Y.P. 0113
Lindner, W. 0286

Longanathan, S. 0083
Loomis, R.S. 0013
Lozano, J.C. 0142 0143 0144 0145
Lüdecke, H. 0057
Luetzelburg, P. von 0223
Luisoni, E. 0165
Luzuriaga V., H. 0389

Ma, W.C. 0176
McCann, D.J. 0319
Mac Lennan, D.G. 0390
Mahon, J.D. 0014
Mansingh, A. 0320
Martin, F.W. 0025
Martino, G. 0236
Miege, J. 0396
Mitsumatsu, Y. 0440
Miya, E.E. 0237
Modder, W.W.D. 0177
Moh, C.C. 0035 0199
Mohan Kumar, C.R. 0084
Montaldo, A. 0136
Montilla, J.J. 0264
Moore, C.P. 0265
Morin, R.L.M. 0322
Muthuswamy, P. 0036

Nair, P.K.R. 0428
Narasimhan, V. 0166
Nartey, F. 0015 0037 0238
Nassar, N.M.A. 0038 0216
Nelliat, E.V. 0429
Nemoto, Y. 0276
Ngoddy, P.O. 0323
Ngongi, A.G.N. 0085
Nicol, B.M. 0239
Nigeria. Department of Agricultural Research 0217 0218 0219
Ninan, C.A. 0016
Nitis, I.M. 0430
Nobre, A. 0324
Nojima, K. 0441
Nyiira, Z.M. 0191

Obigbesan, G.O. 0086 0148
Odigboh, E.U. 0287 0325
Ofosu, A. 0397
Okafor, N. 0356
Oke, O.L. 0277
Okigbo, B.N. 0434
Olarewaju, O.C. 0278
Onaghise, G.T.U. 0266
Opsomer, J.E. 0115
Ortiz, D.O. 0240
Oudit, D.D. 0326
Oyefeso, J.A. 0241

Park, Y.K. 0357
Payen, M. 0039
Peckolt, T. 0442
Peixoto, R.R. 0267
Peña, J. 0178 0192
Peterson, J.F. 0167 0168
Pettersson, G.R. 0268
Phillips, T.P. 0399
Pickel, D.B. 0059
Pieris, N. 0279
Pillai, K.S. 0193
Porto, M.G.M. 0327 0400
Pringle, W. 0328
Prior, A.J. 0087 0401
Prudhomme, E. 0040
Pulle, M.W. 0329
Pulva Corporation 0330
Pyttersen, T.J. 0402

Rajagopal, M.V. 0331
Rajendram, N. 0041
Ramos, E.L. 0404
Ramos A., A. 0403
Ramos-Ledon, L.J. 0042
Ribeiro, P.J. 0269
Rivera L, P.H. 0245
Rocha, Z.M.M. da 0017
Roger, L. 0169
Rogers, D.J. 0007 0116 0443
Rolfe, E.J. 0405
Rosas, C. 0018
Rossem, C. van 0043
Rotsch, A. 0332

Sampaio, C.V. 0060
Santana, A.M. 0044 0088 0406
Santos, E. O. 0061
Saradamma, K. 0194 0195
Saraswat, V.N. 0089
Sasidhar, V.K. 0431
Schmidt, H.L. 0159
Schmiedel, O. 0062
Schneider, E. 0334
Schoonhoven, A. van. 0179
Seif, A.A. 0407
Sena, Z.F. de 0090
Ser, E.S. do. 0270
Shanmugam, A. 0117 0137
Shimada, A.S. 0271
Sierra L., J.M. 0408
Silva, J.R. da. 0091 0063
Silva, M.L. da 0335
Silva, W.J. da 0220
Silvestre, P. 0064 0065
Sinha, S.K. 0028
Siqueira, L.A. 0066
Soewardi, B. 0272
Solorzano, N. 0092
Solorzano V., N. 0045

Spain, J.M. 0093
Sperling, L. 0273
Springensguth, W. 0067
Staiger, Z. 0337
Starcosa G.m.b.H. 0409
Station Agronomique du Lac Alaotra 0026 0221
Station Centrale de Boukoko 0432
Steele, P.J.B. 0410
Stock, J.E. van der 0119
Sturtevant, W.C. 0338

Takatsu, A. 0149
Teixeira, C.G. 0340
Terry, E.R. 0150 0151 0170 0171 0196
Tesoro International Corporation 0341
Thamburaj, S. 0433
Thury, A. 0094 0342
Tineo, J. 0120
Toh, K.B. 0343
Toro, J.C. 0121 0411
Tosello, A. 0344 0412
Toye, S.A. 0180
Tsai, C.I. 0122 0138 0139

Ulate M., J.L. 0068
Umanah, E.E. 0413
Universidade Federal da Bahia. Escola de Agronomia 0414 0415 0416
Upmann, W. 0274
Urban, C.W. 0345

Vaissiere, P. de la 0417
Valdés S., H. 0418
Van Veen, A. 0046
Varghese, G. 0358
Velloso, J.F. 0346
Viegas, A.P. 0008 0444
Vignoli, L. 0242
Vitti, P. 0288 0289

Wahab, A.H. 0095 0140
Webb, B.H. 0347
Wholey, D.W. 0420
Wider, J.A. 0197
Wilson, G.L. 0141
Wirtz, H.A.A.M. 0421
Wood, A.S. 0422
Wyllie, D. 0224

Yaseen, M. 0198
Yeoh, H.H. 0047

Zehntner, L. 0423
Zijl, C.E. van der 0070

SUBJECT INDEX

Absorption 0045 0057 0079 0080 0092

Acaricides 0194

Adaptation 0019 0020 0050 0091 0127 0129

Adhesives 0298 0299 0300 0301

Agricultural equipment 0121

Alcohol 0337
- Fermentation 0293 0308 0340
- Processing 0293 0308 0327 0333 0340 0406 0437
- Production 0293 0309 0327 0340 0373 0386 0400 0406
- Uses 0308 0309 0340 0437

Aleyrodidae 0169 0183 0321

Amino acids
- Analysis 0032 0047 0238 0259
- Dietary value 0250 0259
- Industrial microbiology 0354 0355
- Leaves 0047 0238
- Tubers 0238 0259

Anaemia 0243

Anastrepha pickeli
- Insect control 0183

Animal physiology 0232 0236 0240 0248 0250 0258 0266

Aonidomytillus albus
- Insect control 0183

Ash content 0042 0226 0358

Aspergillus
- Industrial microbiology 0340 0351 0354

Backcrossing 0203

Bacteriosis 0143 0146 0150 0155 0156 0296 0437
- Disease control 0144 0145 0147 0151 0444
- Resistance 0147 0148 0211 0368

Bakery products 0230 0305 0306 0316 0328 0329 0332 0357

Bemisia
- Cassava mosaic virus 0169
- Insect control 0183

Biochemistry 0199 0279 0282 0349

Biological control 0186 0188 0191 0192 0197 0198

Bitter cassava
- Starch content 0067 0237
- Tuber productivity 0052 0062

Boron 0080

Branching 0012 0021 0023 0217

Breads
- Analysis 0297 0306 0329 0357
- Cassava flour 0276 0297 0306 0316 0329 0332 0357 0405
- Cassava starch 0297 0305 0328

Calcium 0045 0076
- Deficiencies 0080 0093
- Tuber productivity 0368

Carbohydrate content 0050 0070 0078 0086
- Leaves 0148 0226
- Tubers 0034 0043 0046 0148 0226

Carpolonchaea chalybea
Insect control 0183

Cassareep 0335

Cassava bacterial blight 0367 0368

Cassava beer 0331

Cassava bread 0315 0316 0332

Cassava brown streak virus 0162

Cassava chips 0193 0246 0348 0407
Consumption 0379 0380 0385
Costs 0379 0441
Detoxification processes 0276 0441
HCN content 0276 0441
Industrialization 0363 0379 0385
Marketing 0375 0380 0385 0419 0441
Prices 0380
Processing 0340 0385 0441
Storage 0296 0441
Swine 0258
Trade 0375 0379 0380

Cassava common mosaic virus
Disease control 0145

Cassava flour 0233 0286 0297 0306 0313 0315 0320 0332 0405
Composition 0062 0274 0276 0279 0329 0437 0441
Consumption 0062 0385 0412
Costs 0050 0062 0415 0437 0441
Detoxification processes 0276 0441
Drying 0346
Industrial microbiology 0357
Industrialization 0050 0295 0385 0437
Marketing 0385 0415 0419 0436 0437 0441
Nutritive value 0050 0274
Processing 0050 0280 0295 0308 0316 0324 0346 0385 0437 0441
Production 0050 0280 0316 0324 0412
Protein content 0329
Storage 0441
Trade 0415 0436 0437

Cassava leaves (vegetable) 0224
Composition 0032 0033 0441
HCN content 0441
Human nutrition 0032 0033
Nutritive value 0032
Protein content 0032

Cassava meal 0248 0250 0264 0267 0272
Composition 0226 0263 0269 0271 0273 0274
Consumption 0385 0422
Detoxification processes 0254
Digestibility 0263
Fattening 0249 0255 0257
Feed mixtures 0257
Industrialization 0050 0290 0385
Factories 0050 0290
Nutritive value 0050 0226 0274 0340
Pellets 0262 0290 0324
Prices 0249 0339
Processing 0050 0273 0324 0340 0342 0385
Storage 0339
Swine 0249 0253 0254 0255 0256 0257 0261 0271
Trade 0302 0375 0421

Cassava mosaic virus 0016 0160 0162 0166 0168
Bemisia 0169
Disease control 0161 0164
Resistance 0107 0132 0133 0134 0169 0203 0211 0217 0218 0219 0221
Vectors 0167 0169

Cassava pastes 0133

Cassava products 0039 0225 0226 0228 0436 0442
Fresh products 0155 0246 0260 0271 0326
Cassava tubers (vegetable) 0246 0271
Processed products 0062 0159 0193 0227 0229 0232 0233 0235 0246 0249 0253 0254 0255 0256 0258 0261 0262 0263 0264 0267 0269 0271 0276 0279 0280 0283 0288 0289 0290 0291 0292 0295 0296 0297 0303 0305 0306 0312 0313 0315 0316 0317 0321 0324 0328 0329 0330 0331 0335 0339 0342 0346 0348 0349 0350 0355 0357 0359 0363 0374 0379 0380 0382 0384 0385 0405 0407 0412 0437
Cassareep 0335
Cassava beer 0331
Cassava bread 0315 0316
Cassava chips 0193 0246 0258 0276 0296 0348 0363 0379 0380 0385 0407
Cassava flour 0062 0233 0276 0279 0280 0295 0297 0306 0313 0315 0316 0324

0329 0346 0357 0385 0405 0412 0437
Cassava meal 0249 0253 0254 0255 0256 0261 0262 0263 0264 0267 0269 0271 0290 0324 0339 0342 0385
Cassava starch 0062 0227 0229 0232 0235 0283 0288 0289 0291 0292 0295 0297 0303 0305 0312 0321 0324 0328 0330 0348 0349 0350 0355 0359 00374 0382 0384 0385 0437
Gaplek 0280
Gari 0233 0385
Pellets 0262 0290 0324 0380 0382
Tapiocas 0235 0280 0312 0317 0324 0359 0384 0437

Cassava programs 0009 0026 0044 0060 0064 0065 0066 0073 0075 0088 0095 0105 0109 0118 0131 0167 0290 0339 0348 0353 0360 0362 0370 0371 0372 0388 0391 0392 0393 0394 0395 0396 0398 0401 0404 0406 0407 0416
Animal nutrition 0050 0415
Developmental research 0345 0363 0364 0378 0379 0381 0383 0385 0400 0420
Germplasm 0200 0206 0211 0217 0218 0219 0224 0383 0414 0415
Plant breeding 0200 0202 0204 0205 0206 0207 0208 0209 0211 0212 0214 0217 0218 0219 0220 0221 0367 0368 0383 0403 0414 0415

Cassava starch 0227 0229 0232 0291 0303 0305 0312 0330
Alcohol 033 0406 0437
Analysis 0050 0230 0234 0281 0283 0285 0287 0288 0289 0297 0349 0352
Consumption 0062 0382 0385
Costs 0050 0062 0437 0441
Dextrins 0298 0299 0300 0301
Digestibility 0234 0235
Drying 0318 0333 0334
Enzymes 0282 0283 0349
Factories 0050 0292 0310 0311 0437
Gelatinization 0285 0288 0289
Glucose 0385
Hydrolysis 0283
Industrial microbiology 0348 0349 0350 0352 0355 0390
Industrial starches 0230 0284 0295 0298 0299 0300 0301 0318 0341
Industrialization 0050 0295 0310 0311 0385 0437
Marketing 0359 0374 0384 0385 0437 0441
Packaging 0333 0384
Particle size 0281 0287
Prices 0374 0382 0384 0409
Processing 0050 0230 0285 0288 0295 0310 0311 0318 0321 0324 0333 0334 0336 0385 0406 0409 0437 0441
Storage 0441
Trade 0374 0382 0384 0437
Uses 0050 0230 0287 0294 0295 0297 0298 0300 0301 0318 0328 0341 0350 0437 0441
Viscosity 0287 0288 0289

Cassava tubers (vegetable) 0344
Animal nutrition 0246 0271
Composition 0271

Cassava vein mosaic virus 0145

Cattle 0272

Cercospora caribaea 0153 0154 0156 0367
Disease control 0145

Cercospora henningsii 0153 0154 0156 0211 0367
Disease control 0145

Chicks
Cassava meal 0248 0262 0264 0267 0271

Chickwangue 0132 0133

Climatic requirements 0054 0078 0416 0440
Growth 0021
Productivity 0020 0021 0077 0093

Clones 0107 0200 0211 0414 0415

Coelosternus granicollis
Insect control 0183

Composite flours 0294 0297 0305 0306 0313 0328 0329 0332 0357 0405

Composition 0032 0033 0038 0039 0044 0067 0085 0086 0090 0107 0126 0134 0217 0258 0266 0335 0358 0435 0443

Cassava flour 0062 0274 0276 0279 0329 0437 0441
Cassava meal 0226 0263 0269 0271 0273 0274
Cassava starch 0062 0229 0230 0234 0318 0348 0437 0441
Leaves 0028 0035 0042 0047 0095 0097 0148 0216 0226 0238 0271 0278 0437
Tapiocas 0226 0274 0437 0441
Tubers 0022 0028 0030 0031 0034 0035 0036 0040 0041 0042 0043 0046 0051 0062 0084 0099 0148 0216 0226 0237 0238 0259 0271 0274 0278 0337 0437 0440 0442
Stems 0095 0437

Confectioneries 0230

Cooking 0259

Copper 0080

Cortex
Composition 0035
HCN content 0035

Crossbreeding 0202 0205 0212

Cultivars 0021 0028 0034 0035 0036 0038 0040 0042 0043 0045 0047 0058 0061 0066 0068 0070 0075 0092 0093 0135 0137 0147 0153 0157 0169 0195 0196 0202 0221 0231 0237 0288 0289 0367 0389 0413 0416 0436 0437 0439 0442
Adaptation 0020 0050 0091 0095 0127 0129
Ecology 0020 0050
Germplasm 0206 0217 0218 0219
Identification 0005 0050 0067 0123 0130
Selection 0050 0060 0063 0119 0123 0199 0204 0206 0209 0210 0215 0217 0218 0219 0403
Starch productivity 0065 0077 0094 0134
Tuber productivity 0010 0050 0053 0062 0063 0064 0065 0077 0087 0094 0095 0099 0100 0102 0104 0107 0109 0117 0119 0124 0125 0126 0127 0128 0129 0132 0133 0134 0138 0139 0140 0141 0148 0179 0204 0368 0441

Culture media 0024 0076 0157 0340 0349 0352

Cuttings 0054 0068 0101 0120 0142 0143 0378 0411
Grafting 0104
Propagation 0104 0106 0110 0114 0116 0444
Rooting 0106
Spacing 0066 0070 0075 0099 0103 0104 0107 0113 0414 0416 0441
Storage 0111 0116 0416 0441
Tuber productivity 0063 0099 0104 0107 0115 0119 0122 0441

Cyanides
Detoxification 0259
Thiocyanates 0259
Toxicity 0259

Cyanogenesis 0027

Cyanogenic glycosides 0254 0275 0276 0277

Cytogenetics 0222

Deficienty diseases 0243

Deterioration 0155
Tubers 0144 0304 0367

Detoxification 0031 0254 0259 0260 0278 0441

Developmental stages 0100
Branching 0012 0021 0023
Germination 0015 0025 0026 0106 0107 0110 0140 0444
Rooting 0106
Tuber development 0009 0012 0014 0076 0216

Dextrins 0298 0299 0300 0301

Diets 0246 0249
Dietary value 0233 0239 0250 0253 0256 0257 0258 0259 0263 0269
Nutritive value 0236 0266

Digestibility 0259
Cassava leaves (vegetable) 0033
Cassava meal 0263
Cassava starch 0234 0235

Disease control 0068 0142 0414
Bacteriosis 0144 0145 0147 0151 0444
Micoplasmosis 0144

Micosis 0144 0145 0444
Virosis 0144 0145 0161 0164 0165

Dried tubers 0193 0226 0246 0258 0271 0276 0296 0340 0348 0379 0407
Marketing 0380 385 0419 441

Drying 0344
Cassava flour 0346
Cassava starch 0318 0333 0334

Ecology 0001 0004 0191 0197 0198
Cultivars 0020 0050

Endemic goitre
Clinical manifestations 0244

Erinnyis alope
Insect control 0197

Erinnyis ello
Biological control 0183 0188
Insect agents 0188 0197
Insect control 0188 0197

Ethanol 0309 0327 0345 0400 0406

Factories 0345
Cassava chips 0379
Cassava flour 0050 0437
Cassava starch 0050 0292 0310 0311 0437
Pellets 0290
Tapiocas 0437

Fattening
Swine 0249 0255 0257 0259 0266

Feed constituents 0249 0250 0252 0255 0258 0262 0266 0267 0269

Feed mixtures 0257 0259

Fermentation 0258 0278 0293 0308 0340 0351 0354 0356 0358

Fermented products 0293 0308 0309 0337 0340 0358

Flowers 0007 0444

Foliage 0142
Production 0136

Food enrichment 0254 0295 0348
Amino acids 0354 0355
Fermentation 0354

Food products 0032 0033 0226 0230 0233 0242 0278 0306 0323 0356 0385 0397

Forage 0050 0224 0247 0265 0414 0415

Fruits 0007 0008

Gaplek 0046
Production 0280
Trade 0439
Uses 0226 0280

Gaplek meal 0046 0439

Gari 0233 0242 0397
Composition 0226 0278
Detoxification 0278
Fermentation 0278 0356
HCN content 0278
Mechanization 0323
Nutritive value 0226
Processing 0356 0385

Gelatinization 0285 0288 0289 0329

Germination 0015
Cuttings 0106 0107 0110 0111 0444
Seed 0025 0026 0444
Timing 0025 0026 0106 0107 0110 0111 0140

Germplasm 0200 0206 0211 0217 0218 0219 0224 0383 0414 0415

Glomerella cingulata 0153

Glucose 0385

Grafting 0023 0104

Growth 0009 0012 0014 0015 0021 0022 0042 0076 0085 0117

Harvesting 0054 0061 0064 0118 0389 0399 0403 0411 0444
Agricultural equipment 0121
Timing 0057 0063 0065 0075 0078 0086 0097 0099 0200 0416 0441

HCN absorption 0254

HCN content 0044 0067 0086 0090 0107 0126 0199
Cassava chips 0276 0441
Cassava flour 0050 0276 0279 0415 0441

Cassava meal 0050
Cassava starch 0050 0441
Cortex 0035
Leaves 0028 0035 0047 0216 0278
Tubers 0028 0030 0031 0035 0084 0216 0237 0259 0278

Herbicides 0098 0367 0368

Hybrids 0023
Productivity 0026 0204
Resistance 0212
Selection 0026 0204 0205 0208
Tuber productivity 0204

Hydrolysis 0015
Cassava starch 0283

Illumination 0018

Income 0389

Industrial machinery 0290 0291 0293 0303 0311 0321 0330 0409

Industrial starches 0230 0284 0295 0298 0299 0300 0301 0318 0341 0419

Inflorescences 0007

Injurious insects 0061 0063 0067 0068 0173 0174 0175 0177 0178 0180 0181 0182 0184 0185 0187 0190 0192 0193 0196 0376 0377 0403 0413 0416 0439 0440
Anastrepha pickeli 0183
Aonidomytillus albus 0183
Bemisia 0183
Carpolonchaea chalybea 0183
Coelosternus granicollis 0183
Erinnyis alope 0197
Erinnyis ello 0179 0183 0188 0197 0367 0368
Eudiplosis brasiliensis 0183

Injurious mites 0174 0184 0186 0187 0416
Mononychellus tanajoa 0183 0191 0198
Tetranychus telarius 0183 0194 0195

Insecticides 0118 0197

Intercropping 0056 0118 0131 0158 0389 0424 0425 0427 0428 0429 0430 0432 0433 0441

Iodine 0244

Irrigation 0073 0090

Isolation 0237
Diseases and pathogens 0157

Kwashiorkor 0226

Labour 0105 0389 0391 0399 0408 0411 0424

Land preparation 0054 0068 0070 0112 0118 0389 0399 0411 0416
Mechanization 0403
Tuber productivity 0083 0087

Leaf area 0009 0014 0021 0179

Leaves 0005 0007 0017 0018 0021 0095 0152 0158 0166 0179 0186 0437 0444
Amino acids 0047 0238
Analysis 0011 0014 0029 0035 0042 0045 0047 0148 0231 0238 0265 0278
Animal nutrition 0248 0264 0265 0271
HCN content 0028 0035 0047 0216 0278
Mineral content 0148 0226
Nutritive value 0226 0238 0265
Production 0010
Protein content 0042 0047 0097 0226 0238
Rhodanese 0029
Vitamin content 0226

Legal aspects 0317 0324 0339 0380 0397

Linamarase 0254 0276

Linamarin 0254 0275 0276

Magnesium
Absorption 0045
Tuber productivity 0368

Malnutrition 0226

Manganese 0080

Manihot dichotoma 0212 0423

Manihot glaziovii 0169 0212

Manihot heptaphylla 0423

Manihot melanobasis 0212 0220

Manihot saxicola 0220

Marketing 0001 0004 0362 0381 0387 0388 0389 0402 0404 0439
Cassava chips 0375 0380 0385 0419 0441
Cassava flour 0385 0415 0419 0436 0437 0441
Cassava meal 0302 0339 0375 0385 0421
Cassava starch 0359 0374 0384 0385 0437 0441
Gari 0385
Pellets 0380 0441
Tapiocas 0359 0384 0436 0437 0441
Tubers 0437 0440

Mechanization 0121 0323 0325 0403

Methionine 0259

Mineral deficiencies 0080 0093

Mite control 0414
Acaricides 0194

Mononychellus tanajoa 0183

Tetranychus telarius 0183 0194

Mononychellus tanajoa 0183 0191 0198

Morphogenesis 0222

Moulds 0037

Mutation 0199 0202

Nitrogen 0028 0042 0046 0064 0066 0071 0077 0084 0086 0088 0089 0094 0108 0259 0368
Absorption 0079

Nematodes 0172 0368

Oidium 0145 0156 0444

Organoleptic examination 0237 0344

Packaging 0304 0333 0346 0384

Palatability 0237

Paper industry 0284
Cassava starch 0281 0287

Patents 0298 0299 0300 0301 0322

Peeling 0325 0333 0346

Pellets 0262 0380 0382
Industrial machinery 0290
Processing 0324 0441

Petioles 0010 0042 0444

pH 0074 0076 0092 0093
Cassava starch 0287

Phoma 0156

Phosphorus 0064 0066 0071 0076 0077 0081 0084 0085 0086 0088 0094 0368
Absorption 0045 0079 0080

Photoperiod 0014 0346

Photosynthesis 0011 0014 0017

Plant assimilation 0011 0014

Plant growth substances 0018 0022 0024 0106

Plant height 0074 0084 0117 0126 0139 0140

Plant physiological process 0009 0011 0012 0013 0014 0017 0018 0160 0199 0367 0368

Plant reproduction 0219

Plant respiration 0011 0160

Plant vascular system 0008 0444

Planting 0054 0068 0078 0101 0118 0120 0135 0137 0440 0444
Costs 0050 0389 0399 0411 0415 0416 0424 0441
Labour 0389 0399 0411 0424
Mechanization 0403
Spacing 0061 0066 0070 0075 0099 0102 0107 0113 0117 0368 0414 0415 0416 0424 0441
Tuber productivity 0050 0063 0097 0099 0102 0107 0115 0117 0119 0122 0368 0415 0441

Pollination 0219

Pressing 0346

Prices 0249 0339 0374 0380 0381 0382 0384 0387 0389 0404 0409

Processing 0050 0223 0230 0273 0280 0295 0310 0311 0316 0317 0321 0322 0324 0327 0336 0338 0342 0345 0381 0385 0406 0409 0416 0418 0435 0437 0441
- Centrifuging 0318 0333 0346
- Drying 0318 0333 0334 0344 0346
- Fermentation 0293 0308 0340 0351 0354 0356
- Gelatinization 0285 0288
- Peeling 0325 0333 0346
- Pressing 0346
- Rasping 0346
- Screening 0333 0346
- Washing 0333 0346

Propagation 0023 0096 0104 0106 0110 0114 0116 0164 0367 0444

Protein content 0032 0038 0252 0263 0329 0354 0358
- Leaves 0042 0047 0097 0226 0238
- Tubers 0042 0046 0099 0226 0237 0238 0259

Proteins 0136
- Amino acids 0354
- Analysis 0046 0231 0265 0352
- Dietary value 0239
- Food enrichment 0354
- Industrial microbiology 0351 0352 0354

Pruning 0112

Rasping 0346

Resistance 0074 0093 0134 0169 0195 0200 0206 0217 0218 0219 0221 0414 0415
- Diseases and pathogens 0107 0132 0133 0147 0148 0153 0157 0203 0211 0212
- Injurious insects 0179 0193 0368

Rhodanese 0029

Riboflavin 0229

Rooting 0106

Roots 0011 0045 0142
- Growth 0021
- Plant anatomy 0008 0444
- Plant physiology 0021

Rotational crops 0123 0416 0431

Sulphur 0085 0259

Seed 0116
- Germination 0025 0026 0444

Shoots 0024 0095 0106 0114

Silage 0259

Silba pendula 0178 0183 0367 0368

Soil analysis 0050 0081 0085 0088 0092 0093 0095 0097 0103 0118 0140

Soil fertility 0050 0079 0093 0108

Soil requirements 0054 0061 0063 0068 0074 0081 0088 0093 0367 0416 0440 0441 0444

Soil water 0414

Spacing 0061 0066 0070 0075 0087 0099 0100 0102 0103 0104 0107 0108 0113 0117 0218 0367 0368 0414 0415 0416 0424 0430 0441

Starch content 0034 0041 0043 0050 0067 0070 0078 0084 0086 0090 0099 0126 0148 0206 0237 0289 0348

Starch productivity
- Climatic requirements 0077
- Cultivars 0065 0077 0094 0134
- Fertilizers 0065 0077 0094
- Harvesting 0065 0097
- Timing 0065 0097

Stems 0005 0007 0008 0111 0116 0120 0142 0437 0444
- Analysis 0011 0045
- Plant development 0095 0166
- Production 0010

Stomata 0017

Storage 0025 0111 0116 0296 0304 0307 0326 0339 0344 0367 0368 0416 0440 0441

Superelongation 0145 0158 0367 0368

Swine 0251 0252 0253 0256 0258 0261
- Fattening 0249 0255 0257 0259 0266
- Finishing 0257 0259 0266
- Leaves 0271
- Tubers 0254 0259 0260 0271

Tapioca flakes 0384

Tapioca macaroni 0295

Tapioca pearls 0274 0333 0384

Tapiocas 0312 0359
- Analysis 0242 0274
- Dietary value 0235
- Digestibility 0235
- Industrialization 0437
- Legal aspects 0317 0324
- Nutritive value 0226 0274
- Processing 0280 0317 0324 0437 0441
- Storage 0441
- Trade 0384 0436 0437
- Uses 0226 0274 0280 0320 0436 0437 0441
- Vitamin content 0226
- Water content 0226

Tetranychus telarius 0183 0194 0195

Thiocyanates 0244 0259

Tissue culture 0024 0164

Toxicity 0241 0254 0259 0275 0443

Toxicology 0244 0275 0277

Trade 0001 0004 0439
- Cassava chips 0375 0379 0380
- Cassava flour 0415 0436 0437
- Cassava meal 0302 0375 0421
- Cassava starch 0374 0382 0384 0437
- Pellets 0380 0382
- Tapiocas 0384 0436 0437
- Tubers 0437

Tuber development 0009 0012 0014 0076 0216 0217

Tuber productivity 0009 0010 0022 0050 0052 0053 0062 0063 0064 0065 0071 0074 0077 0081 0083 0084 0085 0086 0087 0089 0090 0095 0097 0099 0100 0102 0104 0107 0108 0109 0115 0117 0119 0122 0124 0125 0126 0127 0128 0129 0131 0134 0138 0139 0140 0141 0148 0179 0211 0214 0368 0415 0430 0431 0441

Tubers 0005 0007 0010 0040 0062 0102 0166 0254 0260 0271 0325 0337 0430 0442 0444
- Analysis 0022 0030 0031 0034 0035 0036 0041 0042 0043 0046 0148 0238 0259 0274 0278 0289
- Deterioration 0144 0304 0367
- Dietary value 0233 0237 0259
- HCN content 0028 0030 0031 0035 0084 0216 0237 0259 0278
- Nutritive value 0036 0051 0226 0238 0274
- Packaging 0304
- Palatability 0237
- Silage 0259
- Starch content 0034 0041 0043 0084 0099 0148 0237 0289
- Storage 0304 0367 0440
- Trade 0437

Urea 0088

Uromyces manihotis 0156

Virus transmission 0146 0171
- Vectors 0167 0169

Viscosity 0329
- Cassava starch 0287 0288 0289

Vitamin content 0226 0229

Vitamin deficiencies 0243

Waste utilization 0261 0340

Water requirements (plant) 0017 0020 0057 0073 0088 0415 0431

Water content 0358
- Cassava chips 0348
- Cassava meal 0226
- Cassava starch 0348
- Gari 0226
- Leaves 0226
- Tapiocas 0226
- Tubers 0043 0226

Weeding 0068 0098 0105 0367 0368 0378 0389 0411 0440 0441

Weeds 0105 0217 0376 0377

Xanthomonas manihotis 0146 0148 0150 0156 0211 0437
Disease control 0145 0147 0151 0444

Etiology 0151 0444

Yeast production 0355

Zinc 0080