acts on CASSAVA

[*Manihot esculenta* Crantz]

Volume IV

Series 08EC-4
December, 1978

Cassava Information Center

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

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ABSTRACTS ON CASSAVA

(*Manihot esculenta* Crantz)

VOLUME IV

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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, as well as by CIAT's core budget. Special mention should be made, however, of the scientific and technical collaboration of CIAT scientists who work continuously in close collaboration with our documentalists and information processors.

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A00 BOTANY, TAXONOMY AND GEOGRAPHICAL DISTRIBUTION

0001-1489 COSTA A., A. **Notas taxonômicas e novos sinônimos em espécies de *Manihot* - I (Euphorbiaceae).** (*Taxonomic notes and new synonyms for species of Manihot. I. Euphorbiaceae*). Revista Brasilera de Biologia 37(4):825-835. 1977. Port., Sum. Engl., Port., 12 Refs., Illus.

Cassava. *Manihot*. Taxonomy.

Based on a review of taxonomic works on *Manihot* spp., the herbarium collections at the Universidade Federal do Rio Grande do Sul, Anchieta, Fundação Universitária de Brasilia and the private collection of Karner Hagelund were examined. The following species and reduction to synonymy are discussed: *M. hassleriana* Chodat (= *M. hunzikeriana* Martinez-Crovetto), *M. katharinae* Pax and *M. anysophylla* (Gris.) Müll. Arg. (= *M. grandistipula* Pax, *M. recognita* Pax, *M. guaranitica* Chodat & Hassler, *M. boliviana* Pax & Hoffm., *M. fiebrigii* Pax & Hoffm., *M. anisitsii* Pax & Hoffm.). (*Summary by T.B.*) A00

0002-4446 BAILLON, M.H. *Manihot. In* ——. Etude générale du groupe des Euphorbiacées. Paris, Masson, 1958. pp.305-307. Fr.

Cassava. *Manihot*. Taxonomy. Flowers. Inflorescences.

A detailed botanical description is given of the monoecious flowers and fruit of *Manihot* Plum.-Adans.-Pohl. The genus *Manihot* is some times confused with *Jatropha*, but the former is apetalous. A list is given of 12 species. (*Summary by T.B.*) A00

0003-7466 GRANT, W.F. **Cassava chemotaxonomic classification study; progress report, November, 1974.** Ste. Anne de Bellevue, Canada, MacDonald Campus of McGill University, Genetics Laboratory, 1974. 20p. Engl., Illus.

Cassava. *Manihot esculenta*. Taxonomy. Composition. Analysis. Germplasm. Cassava programs. Development research. *Manihot carthagenensis*. *Manihot glaziovii*.

The objectives of this chemotaxonomic classification are (1) to classify the CIAT cassava germplasm collection into groups of similar types in order to identify material and (2) to facilitate comparisons of material from different geographic areas where quarantine restrictions prevent free movement. Procedures, materials and methods are explained. To date, the chromatographic pattern has been obtained for at least one sample from all the collections of *Manihot esculenta*, *M. carthagenensis* and *M. glaziovii*. (*Summary by I.B.Z.*) A00 C03

0004-8768 NASSAR, N.M.A. **Conservation of genetic resources of cassava (mandioca), *Manihot esculenta* Crantz: determination of wild species localities with emphasis on cassava probable origin.** Ciência e Cultura 28(12):1486-1492. 1976. Engl , Sum. Engl., Port., 16 Refs., Illus.

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

Wild species of *Manihot*, the progenitors of cassava, constitute genetic reservoirs that can supply genes of new characters that are required. Data collected on trips made by the author in northeastern Brazil, together with recent reviews on the geographic distribution of wild *Manihot* species, are illustrated in map form. Central Brazil (southern Goiás and western Minas Gerais) has about 38 of the total 98 wild species recognized today. Southwestern Mexico has 17; northeastern Brazil, 18; and southwestern Mato Grosso and Bolivia, 6. Considering Vavilov's concept of centers of diversity based on Willis' hypothesis of age and area; Harlan's theory of introgression; and the history of Indian groups in pre-Colombian times, it is assumed that northern Amazonia is the 1st place where cassava was domesticated and Goiás, the primary center of diversity of *Manihot* spp. as a "biological group." (*Author's summary. Trans. by T.M.*) A00

0005-5344 NASSAR, N.M.A. **Wild *Manihot* species of Central Brazil for cassava breeding.** Canadian Journal of Plant Science 58:257-261. 1978. Engl , Sum Engl , Fr., 16 Refs., Illus.

Cassava. *Manihot*. Taxonomy. Identification. Plant anatomy. Plant breeding. Brazil.

Seven wild *Manihot* spp., native to Central Brazil, were collected from different localities, screened for root formation, HCN content and growth habit. The nature of their wild habitats is described. Several of the screened species have characters that appear to have a useful economic potential. (*Author's summary*) A00

0006-5030 PAX, F. **Euphorbiaceae-Adrianeae.** *In* Das Planzenreich, regni vegetabilis conspectus. Edited by A. Engler. Weinheim, Germany, Verlag von H.R. Engelmann, 1959. Germ., Latin, Illus.

Cassava. Euphorpiaceae. *Manihot*. Taxonomy. Plant anatomy. Geographical distribution.

A general botanic description is given of the anatomy and function of vegetative organs, flowers, fruit and seed, and the geographical distribution of the different genera. Relationships between genera and species within the Euphorbiaceae-Adrianeae are analyzed, and the phylogenesis of these 2 families is shown making a division into the genera *Cephalocroton* HOCHST, *Adenochlaena* BAILL., *Cephalocrotonopsis* PAX , *Symphyllia* BAILL., *Aphalomappa* BAILL., *Adriana* GAUDICH., *Manihot* ADANS. and *Pachystroma* MULL. ARG. Medicinal uses, foods, and latex production are mentioned. In subsequent sections, individual species of the 8 genera are described. The exact shape and size of vegetative and reproductive organs are given; the geographic distribution and importance in areas of the world are mentioned. There are drawings of many species showing aboveground parts of plants. The volume concludes with an index of names of plant collectors, countries where collections were carried out and species collected. (*Summary by D.L.*) A00

0007-8776 PITTIER, H. **Botanical notes on, and descriptions of, new and old species of Venezuelan plants. III. Old and new species of Euphorbiaceae: *Manihot flamentosa* Pittier, sp. nov.** Journal of the Washington Academy of Sciences 20(1):3-12. 1930. Engl., Latin

Manihot. **Taxonomy. Plant anatomy. Venezuela.**

Botanical descriptions are given for species of Euphorbiaceae found in Venezuela, among which is *Manihot filamentosa* Pittier, sp. nov. (*Summary by T.M.*) A00 B00

0008-1388 STURTEVANT, W.C. **History and ethnography of some West Indian starches: manioc.** *In* Research Seminar in Archaeology and Related Subjects, London University, 1968. The domestication and exploitation of plants and animals. Chicago, Illinois, Aldine, 1969. pp.177-183. Engl.

Cassava. History. Uses. Caribbean.

A brief examination is made of the shifting association of processing and utilization techniques with cassava in a restricted culture-area (the West Indies, especially the Greater Antilles), over a period of 450 yr. (*Summary by T.B.*) A00

0009-3906 ULE, E. **Beiträge zur Kenntnis der brasilianischen *Manihot*-Arten.** (*Contribution to the knowledge on the types of cassava in Brazil*). Beiblatt zu den Botanischen Jahrbüchern 50(114):1-12. 1914. Germ., Latin, 5 Refs.

Cassava. *Manihot*. Taxonomy. Plant anatomy. Geographical distribution. Brazil.

A description is given of 14 latex-producing *Manihot* species, collected by L. Zehntner in the state of Bahia, Brazil from 1911-13. Morphological details are provided (in Latin) and data on shape and size of vegetative parts, flowers and fruits are presented. Collection sites are described, and comments are made on the latex properties. The taxonomic ralationship with other *Manihot* species is discussed. (*Summary by D.L.*) A00

B00 PLANT ANATOMY AND MORPHOLOGY

0010-1172 CENOZ, H.M., HENAIN, A.E. and BERTINI, D.P. **Descripción de clones de mandioca (*Manihot esculenta* Crantz), cultivados en el nordeste argentino.** (*A description of cassava clones grown in northeastern Argentina*). Corrientes, Argentina, Universidad Nacional del Nordeste. Facultad de Agronomía y Veterinaria, 1969. 25p. Span., 10 Refs., Illus.

Cassava. Flowers. Fruits. Stems. Leaves. Tubers. Petioles. Clones. Cultivars. Identification. *Manihot esculenta.* **Argentina.**

A visit was made to the provinces of Misiones, Corrientes, Chaco and Formosa (Argentina) in 1960 to obtain propagation material of all the cassava var. cultivated there. The 86 clones collected were observed over a 6-yr period at the Facultad de Agronomía y Veterinaria in Corrientes. Based on 11 characters, it was concluded that there were only 12 different clones, proving that farmers often use different regional names for the same clone. Detailed information is given on these characters and the 12 clones; a key for identifying the clones is also included. (*Summary by T.B.*) B00

0011-9733 VERDE, J.F. **Características morfológicas y cuantitativas de veintiocho clones de yuca (*Manihot esculenta* Crantz).** (*Morphological and quantitative characteristics of 28 cassava varieties*). Tesis Ing. Agr. Jusepín, Venezuela, Universidad de Oriente. Escuela de Ingeniería Agronómica. Núcleo de Monagas, 1974. 139p. Span., Sum. Span., 44 Refs., Illus.

Cassava. Plant anatomy. Tubers. Leaves. Cortex. Stems. Sweet cassava. Bitter cassava. Cultivars. HCN content. Starch content. Tuber productivity. Venezuela.

A 1-yr evaluation was made of 28 cassava clones grown on a sandy loam soil at the experimental station of the Universidad de Oriente in Jusepín, Monagas (Venezuela), using a randomized block design. There was a wide range in yield; the outstanding clones were José María and Mantequilla, with yields > 27 t/ha. Of the clones studied, 71% had a starch content ranging from 80-93%. Based on Koch's (1933) classification of HCN content in fresh and peeled roots, it was concluded that of the 14 bitter clones in the study, only 2 should be considered bitter: José María (16.37 mg/100 g HCN; fresh wt basis) and Muerteña (5.23 g/100 g). Among the sweet clones, Ceiba Llanera was outstanding for its great no. of shoots and extensive branching, good characteristics for a forage var. (*Author's summary. Trans. by T.B.*) B00 D03 C03

See also 0007 0020 0212

C00 PLANT PHYSIOLOGY

0012-8755 ASLAM, M., LOWE, S.B. and HUNT, L.A. **Effect of leaf age on photosynthesis and transpiration of cassava (*Manihot esculenta*).** Canadian Journal of Botany 55(17):2288-2295. 1977. Engl., Sum. Engl., Fr., 27 Refs., Illus.

Cassava. *Manihot esculenta*. Leaves. Timing. Photosynthesis. Transpiration. Carbon dioxide. Laboratory experiments. Plant physiology. Canada.

The effect of plant and leaf age on CO_2-exchange rates (CER) and transpiration rates in 15 genotypes of cassava (*Manihot esculenta* Crantz) was measured in situ by infrared gas analysis. The plants were grown in a controlled-environment room with a 14-h photoperiod, day—night temp of 29-24°C and 60-70% RH. Plant age had no effect on leaf CER, whereas transpiration rates in 14-wk-old plants were significantly greater than those in 7-wk-old plants. Both CER and transpiration rates decreased with leaf age. The decline was negligible when measured at low photosynthetic photon flux density. At saturating light, however, both CER and transpiration rates decreased significantly in most of the genotypes. Significant genotypic differences were observed in the pattern of decline. Both stomatal (*rs*) and residual (*rr*) resistance to the diffusion of CO_2 increased with leaf age in all the genotypes The relative increase in *rr* was much greater than the increase in *rs*. In all the genotypes the ratio *rr*.*rs* was greater than unity, suggesting that *rr* is the major component of the total resistance to photosynthesis. Chlorophyll content and specific leaf wt also varied significantly among the genotypes. However, chlorophyll content decreased and specific leaf wt increased with leaf age. (*Author's summary*) C00

0013-9567 BARROS, R.S. **Fisiologia da mandioca (*Manihot esculenta* Crantz).** (*Cassava physiology*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brazil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.231-257. Port., 19 Refs., Illus.

Cassava. Plant physiology. Ecology. Tuber development. Photosynthesis. Plant physiological processes. Water requirements (plant). Leaves. Stems. Plant assimilation. Plant development. Leaf area. Spacing. Cultivars. Nutritional requirements.

A review is made of literature on the ecological requirements of cassava, photosynthesis and yield, physiology of the root and mineral nutrition. Some parameters used in the physiology of production are defined. (*Summary by T.M.*) C00

0014-9420 EKANDEM, M.J. **Technique for cassava hybridization and production of seedlings.** Ibadan, Nigeria. Federal Department of Agricultural Research. Memorandum no. 105. 1970. 4p. Engl., Sum. Engl.

Cassava. *Manihot esculenta.* Plant reproduction. Pollination. Seed. Germination. Timing. Laboratory experiments.

Detailed instructions are given on how to pollinate cassava, collect the seeds, pretreat them to improve germination in petri dishes, plant them in seed boxes and then transplant the seedlings in the field. (*Summary by T.M.*) C00

0015-7475 HUNT, L.A. **Growth physiology of *Manihot*; progress report no. 3, November 30, 1974.** Guelph, Canada, University of Guelph, Ontario Agricultural College, Crop Science Department, 1974. 66p. Engl.

Cassava. *Manihot esculenta.* Plant physiology. Plant physiological processes. Cassava programs. Developmental research. Plant development. Photosynthesis.

Information is given on the following studies from 3 different cooperating, cassava research groups: (1) A physiology project, studying the effects of nutrient level and temperature on the patterns of DM and major nutrient distribution during ontogeny. There are wide differences among cultivars in branching, rate of leaf appearance and leaf life, which should be taken into account when selecting parents to be used in a breeding program. A cultivar that produces leaves rapidly may be better able to replace damaged leaves, thus suffering less yield reduction than one that produces new ones more slowly. This should be considered when assessing the economic value of an insecticide or fungicide treatment. (2) Controlled environment studies on total DM productivity and distribution in Llanera plants. plant establishment, root thickening, development of roots and swollen roots, as well as shoots, and leaf canopy. (3) Leaf photosynthesis studies describing the effects of nutrient level and temperature on the photosynthetic rate of newly expanding and aging leaves at different stages of ontogeny. (*Summary by I.B.Z.*) C00

0016-9151 MAHON, J.D. *et al* **Environmental effects on photosynthesis and transpiration in attached leaves of cassava (*Manihot esculenta* Crantz).** Photosynthetica 11(2) 121-130. 1977. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. *Manihot esculenta.* Photosynthesis. Transpiration. Growth-chamber experiments. Leaves. Carbon dioxide. Analysis. Absorption. Temperature. Plant physiology.

Cassava plants were grown under controlled conditions, and the rates of photosynthetic CO_2 uptake and transpirational H_2O efflux were measured in attached leaf parts, exposed to a range of CO_2, irradiance and temp conditions. The effects of temp and nutrient supply during growth on the irradiance response of both young and old leaves were also determined. Photosynthesis and transpiration in the growth room were highest at 1200 h and decreased rapidly after 1600 h. The temp optimum for this maximum rate was 25°C in plants grown at 29/24°C. The high CO_2 compensation point (68 vpm), relatively low irradiance required for saturation (110 neinstein $cm^{-2}s^{-1}$) and high ratio of H_2O efflux/CO_2 uptake (109 to 138) are all indicative of the C_3 pattern of photosynthesis. The maximum rate of photosynthesis, at normal CO_2, of 20 to 24 mg CO_2 $dm^{-2}h^{-1}$ was not high compared to that of other C_3-species. The rate of photosynthesis was lower, especially at high irradiances, in older leaves than in young leaves. A lower rate of photosynthesis, associated with decreased transpiration, was also found in young leaves of plants grown at lower temp or under low nutrient conditions. Within this single genotype the rates of both photosynthesis and transpiration were reproducible when samples were grown and measured under standard conditions, and it may be easier to assess genotypic variability in such a controlled system than in the field. (*Author's summary*) C00

0017-8748 MAHON, J.D., LOWE, S.B. and HUNT, L.A. **Variation in the rate of photosynthetic CO uptake in cassava cultivars and related species of *Manihot*.** Photosynthetica 11(2):131-138. 1977. Engl., Sum. Engl., 18 Refs.

Cassava. *Manihot esculenta. Manihot*. Plant physiological processes. Photosynthesis. Carbon dioxide. Nutrient uptake. Leaves. Cultivars. Transpiration. Laboratory experiments.

The rates of photosynthetic CO_2 uptake and transpirational H_2O efflux by attached leaf parts of plants from 10 cultivars of cassava (*Manihot esculenta*) and 9 wild species of *Manihot* grown in controlled growth room were measured at 25°C, 350 vpm CO_2 and a range of irradiances. In addition, the ability of attached leaf parts to assimilate CO_2 in low CO_2 conditions was assessed. Among the species, the photosynthetic rates at maximum irradiance ranged from 29 mg CO_2 $dm^{-2}h^{-1}$ in *M. dichotoma* to 15 mg CO_2 $dm^{-2}h^{-1}$ in *M. quinquipartita*. Although the variability was less among the cultivars, the mean rates were the same for both the cultivars and the species. Among all genotypes tested there was a significant correlation between the rates of photosynthesis and transpiration. Since all of the genotypes showed a net CO_2 efflux when supplied with 45 vpm CO_2, it is unlikely that the C_4-type of photosynthetic metabolism was represented in this collection. However, under these conditions the species *M dichotoma, M. anomala* and *M. foetida*, as well as the cultivar M Col 22, had photosynthetic rates that were sufficiently greater than those of the other genotypes to merit further study. (*Author's summary*) C00

0018-1946 WILLIAMS, C.N. and SINCLAIR, R. **A sensitive porometer for field use.** Journal of Experimental Botany 20(63).81-83. 1969. Engl., 3 Refs., Illus

Cassava. Plant physiological processes. Plant physiology.

The instrument described is a modified sphygmomanometer. Data are given on stomatal movements in cassava as measured by this instrument. (*Summary by Field Crop Abstracts*) C00

See also 0003

C01 Plant Development

0019-1200 BRIEGER, F.G. and GRANER, E.A. **Polaridade e regeneracao nas estacas de mandioca.** (*Polarity and sprouting of cassava cuttings*). Revista de Agricultura (Piracicaba) 16(5/6):230-246. 1941. Port., Sum. Engl., 7 Refs., Illus.

Cassava. Cuttings. Planting. Rooting. Timing. Stems. Shoots. Laboratory experiments. Brazil.

A study was made of physiological factors controlling the development of roots and shoots of cassava cuttings. There was a decisive polarity with regard to root formation, which takes place only at the callus formed at the basal end of the cutting. After 30 days, roots are formed at the base of the new shoots, always at a depth of approx 5 cm. Shoot formation is governed mainly by the interaction polarity/gravity. Intensity of root and shoot formation depends mainly on the depth at which cuttings are planted; therefore, cuttings should be planted horizontally and not too deep. (*Author's summary*) C01 D02

0020-9805 GONZALEZ G., R. **Relaciones entre la morfología de las plantas y la radiación solar dentro de cultivos de maíz, yuca y plátano.** (*Relationships between plant morphology and solar radiation in maize, cassava and plantain*). Tesis Mag. Sc. Turrialba, Universidad de Costa Rica. Centro Agronómico Tropical de Investigación y Enseñanza, 1976. 102p. Span., Sum. Engl., Span., 60 Refs., Illus.

Cassava. Plant anatomy. Plan development. Inter-cropping. Plant height. Leaf area. Leaves. Stems. Tubers. Statistical analysis. Solar radiation. Costa Rica.

In multiple cropping systems it is important to evaluate radiation within the main crop, as well as the morphological characteristics of the plants that affect these conditions. The relationships of these factors were studied in maize (var. Tuxpeño), cassava (var. Valencia) and plantain (var. Pelipita), alone and in association with bean var. 27-R or cowpea var. V-44. A split plot design was used. The evaluation of solar radiation within and outside the crops was made with Gunn-Bellani's radiation mtegrator; precipitation, evaporation and external mean temp were also determined. Results showed that non intercepted solar radiation within the crops decreased progressively as the plant became older. Morphological characteristics correlating best with this microclimatic factor were plant height, leaf area and total biomass. There was no significant effect of the association of beans or cowpeas on maize; but this association had a significant influence on cassava plant height and a negative effect on plantain leaf area, canopy diameter and plant height. (*Author's summary*) C01 K01 B00

0021-8770 MAKANJUOLA, G.A., ONOCHIE, B.E. and FAPOHUNDA, H.O. **A study of some of the physical growth characteristics of cassava roots in relation to mechanical**

harvesting. Ile-Ife, Nigeria, University of Ife. Department of Agricultural Engineering, 1973. 17p Engl., Sum. Engl., 9 Refs.

Cassava. Developmental research. Tubers. Growth. Mechanization. Harvesting. Cultivars. Nigeria.

Results are given of the 1st in a series of research projects designed to develop a machine for harvesting cassava roots. Before the designer can arrive at a reliable functional design, he must understand the peculiarities of cassava root development. Physical parameters that can be used to describe this development are given. Based on a great number of measurements, regression equations were described to show the relationship between the depth of root growth, the radius of root spread and root weight. It was found that there is still a need to modify the root growth characteristics of cassava to make mechanical harvesting a more practical proposition. (*Author's summary*) C01 D02

0022-9712 MUMFORD, P.M. and GROUT, W.W. **Germination and liquid nitrogen storage of cassava seed.** Annals of Botany 42:255-257. 1978. Engl., 10 Refs., Illus.

Cassava. Seed. Germination. Storage. Temperature. Timing.

It has been found that cassava seeds do not conform to the behavior pattern of orthodox seeds under conventional storage conditions. % of germination was greatest when seeds were maintained at room temp and low moisture. The potential for long-term storage after freezing in liquid N was studied with 250 seeds placed in 30 x 5 mm aluminum foil packets (5 seeds each). Packets were immersed directly in liquid N for a min of 3 h or suspended horizontally 70 mm above the surface for 30 min prior to immersion. Seeds were thawed in water at 37°C for 45 s; thawed seeds were germinated at 30°C in the dark. There was a reduction in % of germination from 80 to 23% with rapid freezing, probably due to mechanical damage (seed shattering). Slower freezing had no adverse effect on seed structure or germination. (*Summary by T.M.*) C01

0023-4004 NAIR, T.V.R. and SINHA, S.K. **Photoperiodic effects on tuber development in *Manihot esculenta* Crantz.** Indian Journal of Experimental Biology 6:66. 1968. Engl., Sum. Engl., 5 Refs.

Cassava. Photoperiod. Light. Timing. Tuber development. Growth. India.

Formation of thickened roots in cassava was studied in plants exposed to different photoperiods (8, 12, 16, 20 and 24 h) for 5 or 10 days. Plants receiving 16 h light had the most roots (4.8), followed by the 12-h treatment (4 0). Only 3.0 roots were formed in the 8- and 24-h treatment. It is suggested that root formation is promoted by exposing plants to 12-16 h of light during initial stages of growth. (*Summary by T.B.*) C01

0024-1473 ONWUEME, I C. **Evaluation of the performance of cassava (*Manihot esculenta* Crantz) when grown from inverted stem cuttings.** Journal of Agricultural Sciences 90(1):149-156. 1978. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Plant development. Cuttings. Planting. Shoots. Growth. Timing. Rooting. Germination. Tuber development. Tuber productivity. Leaves. Leaf area. Field experiments. Laboratory experiments.

The characteristics of inverted cassava cuttings were studied in the glasshouse, planting 7-node cuttings upright or inverted; 4 nodes of each cutting were in the soil. They were observed every 2-3

days for 7 wk. Inverted cuttings sprouted less rapidly, but the % of cuttings that eventually sprouted did not decrease. Inverted cuttings produced more sprouts, and a greater % of these sprouts was produced below ground than for the upright cuttings. At 5 and 7 wk, total leaf area/cutting was less for the inverted cuttings; no. of leaves/cutting did not differ. In a field experiment, emergence and formation of thickened roots were slower in the inverted cuttings. Yield/plant and per unit area was significantly lower for the inverted cuttings. In the upright planting most of the roots originated at the lowest extremity of the cuttings, forming a compact bunch there. In the inverted planting, most of the roots arose from the shallower lying submerged nodes, but they did not form a compact bunch. The inverted planting had a lower % of roots lying along the ridge. In a few of the inverted plantings, but not in the upright, the bases of some stems became thickened roots. Treatments did not differ with respect to mean root length, radius of spread of the root tip and the no. of major stems/plant (*Author's summary*) C01 D02

0025- 1174 PARKE, D. **Tissue culture of cassava on chemically defined media.** Physiologia Plantarum 42:195-201. 1978. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Tissue culture. Culture media. Growth. Cultivars.

Defined media that promote the initiation and undifferentiated growth of callus derived from stem explants of 4 cassava cv. are described. Growth rates and yields of cassava callus after 4 wk of culture were comparable to those of callus of *Nicotiana tabacum* cv. Wisconsin no. 38. Nitrogen sources of ammonium nitrate or of ammonium chloride + succinate supported growth of all 4 cv. Sucrose was a better carbon source than glucose. The cassava cv. differed in their response to increasing concentrations of sucrose between 0.5% (w/v) and 3%, 2 of them increasing in DM with increasing concentrations of up to 3%. When cultured in the light on defined media that contained higher ratios of cytokinin to auxin, callus of the latter 2 cv. turned green. Roots but not shoots differentiated from the callus of all cv. The influence of hormone concentrations, sucrose level and N source on greening and root formation is summarized. (*Author's summary*) C01

0026- 4003 RIBEIRO, J.V. **Estudo de algumas caracteristicas da mandioca (*Manihot esculenta* Crantz) em relação a produção inicial de raizes.** (*Study of some characteristics of cassava in relation to initial root development*). Tese Mag. Sc. Lavras, Minas Gerais, Brasil, Escola Superior de Agricultura de Lavras, 1977. 56p. Port., Sum. Port., Engl., 24 Refs., Illus.

Cassava. Plant physiology. Developmental stages. Cuttings. Rooting. Tuber development. Roots. Cultivars. Timing. Harvesting. Plant anatomy. Brazil.

The behavior of 4 cassava cv. was studied with regard to the initial development of the root system, as well as some characteristics of the aerial part The experiment was conducted under greenhouse conditions at the Escola Superior de Agricultura de Lavras (Brazil) from Nov. 1976-Feb. 1977, using a completely randomized design in a 6 x 4 factorial scheme with 3 replications. The treatments consisted of 6 harvest periods and 4 cv. It was found that root origin was not differential feature as regards starch deposition, and behavior within the harvest periods was variable in relation to no. of roots arising from the callus region formed at the distal end of the cutting and roots from the cutting nodes. As for total no. of roots, all cv. except Riqueza were influenced by the harvest periods. A substancial increase in diameter in Sertaneja, noted in the final harvest, did not correspond to greater production during the period studied here. It was also found that root production was related to plant height, stem diameter, no. of roots and no. of leaves and that the relationship of root fresh wt/dry wt can be considered in the selection of cv. (*Author's summary*) C01

See also 0027 0042 0068 0153 0159 0391

C02 Cyanogenesis

0027-4301 NARTEY, F. *Manihot esculenta* (Cassava): cyanogenesis, ultrastructure and seed germination. Copenhagen, Denmark, Munksgaard, 1978. 262p. Engl., Sum. Engl., Dan., 305 Refs., Illus.

Cassava. *Manihot esculenta*. Cyanogenesis. Linamarin. Lotaustralin. Enzymes. Biochemistry. Seed. Germination. Linamarase. Plant physiology. Cyanides. Metabolism. HCN.

Manihot esculenta is cyanophoric, and its tissues release varying levels of HCN on crushing Noncyanophoric var. have not yet been discovered. Analyses indicate that although cyanogenesis is genetically determined, it is also influenced by various extrinsic and intrinsic factors such as soil moisture, climate, rates of synthesis, transport and degradation of cyanogenic materials. Variations in HCN values are often due to the volatility and highly reactive nature of HCN. The cyanogenic glycosides possess unusual chemical structures that make them ready derivatives of protein amino acids. Biochemical studies have fully established the precursor-product relationship between L-valine and linamarin, and L-isoleucine and lotaustralin in cassava. Cyanogenesis is due to the hydrolysis of linamarin and lotaustralin catalyzed by linamarase. The crude enzyme obtained from the peel, leaves and seedlings shows a preference for glycosides with aliphatic aglucones. The biosynthesis of linamarin and lotaustralin was established by feeding uniformly labeled L-valine-^{14}C and L-isoleucine-^{14}C to cassava and seedlings during the period of max glucoside biosynthesis. Cassava glucosides are metabolically active and capable of contributing part of their aglucone moieties for the biosynthesis of asparagine. Cassava not only has 2 major mechanisms for the detoxification of HCN by enzyme-catalyzed formation of asparagine and thiocyanate but also has an alternate cyanide-insensitive respiratory system that makes electron flow via a branch-off cytochrome b possible in the event of the intracellular release of high concentrations of HCN, exerting an inhibitory effect on its cytochrome oxidase system. The incorporation of cassava products in diets leads to constant or prolonged exposure to varying levels of HCN, causing chronic cyanide intoxication. This is correlated with high incidence of goiter, tropical ataxic neuropathy, cretinism and deficiencies in sulfur amino acids and vitamin B12, found in populations in Africa, Asia, the West Indies and South America. Cultivated cassava plants produce seeds freely in Africa, but viable seeds germinate with difficulty. It has been found that germination is stimulated by red light and appears to be controlled by phytochrome. Lipids and proteins form the major storage reserves of cassava seeds and may represent a nutritionally and economically useful asset to developing countries. Electron microscope studies show that the seed cells contain few, poorly defined cytoplasmic organelles. The activity of proteolytic enzymes increases during early germination and enhances protein degradation, making available high levels of valine and isoleucine for the biosynthesis of linamarin and lotaustralin. Seed lipid mobilization and utilization occur in the post germination period by enhanced lipase, isocitrate lyase and malate synthetase activity, resulting in an overall breakdown and conversion of fat to carbohydrate. Ultrastructure studies of various developmental stages show the gradual transition from a quiescent metabolically inactive state to a more organized state, initially in root cells where cyanogenesis is presumably initiated. (*Extracted from author's summary*) C02 C01

C03 Chemical Composition, Methodology and Analyses

0028-9735 **BERMEJO S., H.A. Componentes químicos de las raíces de trece clones de yuca amarga (*Manihot utilissima* Pohl.). (*Chemical composition of roots from thirteen bitter cassava varieties*).** Jusepín, Venezuela, Universidad de Oriente. Núcleo Monagas. Escuela de Ingeniería Agronómica, 1973. 40p. Span., Sum. Span., 41 Refs.

Cassava. Tubers. Cortex. HCN content. Starch content. Mineral content. Protein content. Ash content. Fibre content. Dry matter. Fat content. Venezuela.

A chemical-bromatological analysis was made of the peel and pulp of roots from 13 bitter cassava clones to obtain information on the possibility of their use in the starch industry and in feedstuffs. For determining HCN content, a method was developed that was found to be precise and reliable. Detailed results are given of DM, HCN, crude fat, fiber and protein contents. Significant differences were found between clones. José María had the highest yield and starch content. Detoxified meal from the pulp can be used in animal nutrition when supplemented with protein. Meal from the peel is relatively richer in fat, fiber, protein and ashes and in some minerals (Ca, Mg, P) and could be an important by-product in the starch industry. Its use in animal nutrition would have to be studied in digestibility trials and its toxic effect determined. (*Summary by T.B.*) C03

0029-1383 COOKE, R.D. **An enzymatic assay for the total cyanide content of cassava (*Manihot esculenta* Crantz).** Journal of the Science of Food and Agriculture 29.345-352 1978. Engl, Sum. Engl., 21 Refs., Illus.

Cassava. Tubers. Cortex. Cyanides. Composition. Analysis. Linamarase. Enzymes. Laboratory experiments.

An enzymatic assay for the cyanide contents of cassava parenchymal tissue (peeled root), cassava peel or cassava leaves is described. The material is homogenized in orthophosphoric acid, filtered through glass-fiber paper, and aliquots of the filtrate are neutralized and incubated with exogenous linamarase for 15 min. The cyanogenic glucosides present are hydrolyzed to free cyanide, which is estimated spectrophotometrically. The acid extraction solution inactivates endogenous linamarase, and assay of aliquots without enzyme treatment gives the free (nonglycosidic) cyanide contents of the extracts. The acid extracts are stable for at least 4 days at 4°C, and the steam-distillation/aspiration of earlier methods is unnecessary. The detection limit is $<$0.01 mg cyanide/100 g fresh wt of peeled root, and 40-50 samples/day can be handled easily. Analyses of 8 cv. indicated longitudinal and radial cyanide gradients in the roots. The problem of sampling bulky roots is discussed. (*Author's summary*) C03 H04

0030-1386 COOKE, R.D., BLAKE, G.G. and BATTERSHILL, J.M. **Purification of cassava linamarase.** Phytochemistry 17:381-383. 1978. Engl., Sum. Engl., 24 Refs., Illus.

Cassava. Linamarase. Enzymes. Laboratory experiments. Analysis. Biochemistry.

Linamarase was purified from parenchymal tissue of cassava by extraction with acetate buffer, fractional precipitation with ammonium sulfate, followed by column chromatography on DEAE-cellulose and Sepharose-6-B gel filtration. Specific activity was increased 350-fold with 35% recovery. The K_ms for linamarin and *p*-nitrophenyl-β-D-glucoside are 1.45×10^{-3} M and 0.46×10^{-3} M, respectively. The optimum pH in 50 mM NaPi is 6 and the specific activity, 26.5 nkat/mg. The enzyme can be prepared from cassava peel using the same procedure and has similar properties. (*Author's summary*) C03 H04

0031-8320 FAFUNSO, M. and BASSIR, O. **The dissapearance of cyanide from cassava leaves during leaf protein extraction.** West African Journal of Biological and Applied Chemistry 19(2):30-34. 1976. Engl., 40 Refs., Illus.

Cassava. Leaves. HCN content. Protein content. Detoxification. Laboratory experiments. Cultivars. Analysis.

The CN^-content of fresh cassava leaves (488-634 ppm, depending on the variety) gradually decreased in the pulp, juice, precipitated protein and dried protein during the manufacture of leaf protein concentrate by the method of M. Byers (1961) and N.W. Pirie (1953, 1959, 1970). However, the final product still contained traces of CN^-(viz., 11.7, 12 0, 12.4 and 141 ppm) after freeze-, sun-, room-temp and oven-drying, respectively. The fiber by-product contained 123-201 ppm CN^-below the toxic levels reported for ruminants. Fresh cassava leaf contained 18.7-23.2% crude protein on a DM basis. (*Summary by Chemical Abstracts*) C03 H04

0032-5575 GUIMARAES, F. **Contribuição ao estudo químico-industrial das mandiocas brasileiras.** (*Chemical-industrial study of Brazilian cassava varieties*). Revista de la Sociedad Brasileira de Química 6:160-172. 1937. Port., 1 Ref.

Cassava. Cultivars. Water content. Ash content. Protein content. Fibre content. Starch content. Tubers. Cassava flour. Brazil.

Five cassava var. were analyzed for their quality and yield of starch and flour for breadmaking purposes. The characteristics and chemical composition of the var. are given in table form. It is concluded that (1) the industrial yield of flour varies from 26.5-41.8%, depending on the var., chemical composition of the roots and process used; (2) up to 13% starch can be lost in the pressing; (3) this waste starch should be recovered and added to the flour to enrich it; and (4) yield of flour from dry chips can reach 39%. (*Summary by I.B.Z. Trans. by T.B.*) C03 H01

0033-1059 KURIAN, T. *et al.* **Regulation of the levels of cyanogenetic glucosides in cassava** (*Manihot esculenta* Crantz). Journal of Root Crops 2(2):39-43. 1976. Engl., Sum. Engl., 13 Refs

Cassava. HCN content. N. P. K. Dung. Molybdenum. Boron. Zn. Fertilizers. Plant-growth substances. Cultivars. Tubers. Timing. Organoleptic examination. India.

Pretreatment of cassava cuttings with growth regulators and fresh cow dung was not effective in reducing the glucoside content of mature cassava roots Basal application of dung increased bitterness and HCN, whereas ash improved root quality by reducing these factors. Foliar

application of micronutrients (B and Mo) did not reduce the cyanoglucosides, but Zn (500 ppm) was effective, especially during the 10th mo. Foliar application of growth regulators was useful in reducing root HCN content. Basal application of N or NP increased cyanoglucosides in roots whereas K or NPK reduced the content. (*Author's summary*) C03 D01

0034-8756 LIAN, D.M.S., TEIK, K.H. and SE, C.S. **Aminopeptidase isosymes of the Malaysian cassava, *Manihot esculenta* Crantz, varieties.** Proceedings of the Malaysian Biochemical Society 4:206-217. 1977. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. *Manihot esculenta*. Cultivars. Identification. Laboratory experiments. Biochemistry. Amino acids. Enzymes. Malaysia.

Three forms of aminopeptidase (Amp 1, Amp 2 and Amp 3) isozymes were found in cassava (*Manihot esculenta* Crantz) by polyacrylamide gel electrophoresis. The varieties studied were Bangkok 1, Bangkok 2, Thai, Fowlfat, Ham, Medan and Kekabu. Substrate specificity studies using 10 amino acid naphthylamides (glycine, leucine, alanine, arginine, lysine, histidine, phenylalanine, tyrosine, tryptophan and aspartine) as substrates showed that the aminopeptidases of cassava are not specific for leucine N-terminal residues. The Amp 1, Amp 2 and Amp 3 isozymes behaved quite differently with respect to substrate specificity. Bangkok 1 and Thai showed similar aminopeptidase isozyme patterns, but they differed from Bangkok 2 when L-leucyl-β-naphthylamide, L-alanine-β-naphthylamide, L-histidyl-β-naphthylamide and L-tyrosine-β-naphthylamide were used as substrates. The differences in the aminopeptidase bands between Medan and Kekabu when using L-phenylalanine-β-naphthylamide and L-tryptophan-β-naphthylamide were also observed. Fowlfat and Ham showed distinct differences in their aminopeptidase isozyme patterns in all the substrates used, except in the case of L-phenylalanine-β-naphthylamide and L-tryptophan-β-naphthylamide. No visible aspartyl aminopeptidase was found in any of the 7 varieties studied. Different methods of extraction using liquid nitrogen at 4°C were examined. The enzymes from the 30-min manual extraction showed no visible difference in the aminopeptidase isozyme patteerns when compared with those enzymes obtained from the 5-min extraction by mechanical means. However, when the time of extraction by the manual technique was reduced, the intensity of the isozyme bands was also affected. Similarly, comparison of the same varieties collected from different areas in Malaysia was also studied. Results showed that the aminopeptidase isozyme patterns were similar in each case regardless of geographical variations (*Author's summary*) C03

0035-9731 MARCANO M., J.R. **Componentes químicos de las raíces y hojas de veintisiete clones de yuca (*Manihot esculenta*, Crantz), cultivados en suelo de sabana de Monagas.** (*Chemical composition of the roots and leaves of 27 cassava varieties grown in the savanna of Monagas*). Tesis Ing. Agr. Jusepín, Venezuela, Universidad de Oriente. Escuela de Ingeniería Agronómica, 1974. 106p. Span., Sum. Span., 37 Refs.

Cassava. Tubers. Leaves. HCN content. Dry matter. Protein content. Fat content. Fibre content. Ash content. N. Mineral content. Analysis. Cultivars. Venezuela.

A randomized block experiment was conducted at the experimental station of Sabana and in the labs of the Universidad de Oriente in Jusepin (Venezuela) to determine yield, HCN content and chemical-bromatological composition of 27 cassava var. Based on the results obtained, the following conclusions were reached: (1) Except for crude fat content in the roots, analysis of variance indicated significant statistical differences for all components studied. (2) There was a wide range of variation in yield; Paridora, Teta de Indio, Caureña, Del Ministerio and Palo Verde all yielded > 30 t/ha. (3) Based on the correlation coefficient and regression analysis, a direct relationship was found between HCN content in the leaves and roots; there was up to 8 times

more HCN in the leaves than in the roots.(4) The leaves are rich in protein, ash, fat and minerals, making them of great nutritive value for feedstuffs, once they have been detoxified. (5) Chemical-bromatological composition and leaf production should be studied during the different stages of plant growth to determine the period of vegetative growth when there is greatest leaf production and quality and to determine whether there is an interaction between pruning and root yield (*Author's summary*) C03

0036-1486 NASSAR, N.M.A. and FICHTNER, S.S. **Hydrocyanic acid content in some wild *Manihot* (cassava) species.** Canadian Journal of Plant Science 58:577-578. 1978. Engl., 10 Refs.

Cassava. *Manihot*. Plant breeding. Tubers. HCN content. Brazil.

Roots of 5 wild *Manihot* spp. collected in Central Brazil were analyzed for their HCN content. *M. oligantha* subsp. *nesteli* had the lowest content (62.3 mg/kg in the unpeeled fresh root and 183.2 mg/kg on a dry basis) and may be useful in cassava breeding programs. (*Summary by T.B.*) C03 G01

0037-8754 SPLITTSTOESSER, W.E. **Protein quality and quantity of tropical roots and tubers.** HortScience 12(4):294-298. 1977. Engl., 39 Refs., Illus.

Cassava. Tubers. Protein content. Amino acids.

A review is made of the protein quality and quantity of tropical roots and tubers, among which cassava accounts for 57% of the total production. Although cassava roots have 1.5-5.2% protein on a dry wt basis and a considerable amount of nonprotein water-soluble amino acids, actual protein content ranges from 1.2-2.7% after roots have been treated to reduce HCN content. Cassava is deficient in many amino acids, particularly methionine, cysteine, tyrosine, isoleucine and tryptophan. Breeding for increased protein content has not been successful; only one protein-rich cultivar has been discovered. (*Summary by T.M.*) C03

0038-1471 YEOH, H.H. and CHEW, M.Y. **Free amino acids of cassava leaf.** Malaysian Agricultural Journal 50(4):435-441. 1976. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Leaves. Amino acids. Analysis.

The free amino acid pool in young cassava leaves ranged from 0.22-0.29 g/100 g fresh wt, constituting 2.6-3.4%, respectively of the total leaf amino acid. At least 10 ninhydrin-positive compounds were also detected but not identified. Asparagine, glutamine and serine were among the most abundant amino acids; tryptophan and proline were absent. Different methods of deproteinization of the leaf extract showed similar profiles of the free amino acids. (*Author's summary*) C03

0039-9040 YEOH, H.H. and CHEW, M.Y. **Electrophoretic patterns of the soluble protein from cassava (*Manihot esculenta* Crantz) leaf.** *In* Yeoh, H.H. and Khor, H.T., eds. Annual Conference of the Malaysian Biochemical Society, Kuala, Lumpur, Institute for Medical Research, 1977. Proceedings. Selangor, Malaysia, University of Malaysia, 1977. pp.184-191. Engl., Sum. Engl., 8 Refs., Illus.

Cassava. *Manihot esculenta*. Leaves. Proteins. Analysis. Protein content. Laboratory experiments.

Four soluble protein fractions (albumin, globulin, prolamin and glutelin) were isolated from young cassava leaves. These contituted only 40.6% of the total leaf protein. Starch gel and polyacrylamide gel electrophoresis (PAGE) showed that the protein fractions were electrophoretically heterogeneous, while SDS-PAGE indicated the relative sizes of the different molecular species in the protein fractions. Gel filtration with Sephadex G-200 again indicated the presence of different mol wt species in the protein fractions isolated. SDS-PAGE of the pooled-protein eluates from Sephadex revealed the existence of protein subunits. Glutelin, mol/wt 800,000 in gel filtration, could be dissociated into protein of mol wt 10,000 in SDS-PAGE. (*Author's summary*) C03

See also *0011* *0061* *0068* *0076* *0093* *0303* *0310* *0357*

D00 CULTIVATION

0040-8761 CORREA, H. **Cultura da mandioca; curso intensivo.** (*Cassava growing; intensive course*). Minas Gerais, Ministerio da Educação e Cultura Escola Superior de Agricultura de Lavras. Convênio INCRA-FAEPE, 1977. 86p. Port., 40 Refs., Illus.

Cassava. Cultivation. Climatic requirements. Soil requirements. Cuttings. Planting. Timing. Tuber productivity. Cultivars. Identification. N. P. K. Fertilizers. Minerals. Mechanization. Harvesting. Composition. Tubers. Injurious insects. Mycoses. Bacterioses. Insect control. Disease control. Weeding. Cultivation systems. Brazil.

Cassava has excellent potential in the state of Minas Gerais, where it can be grown in the Cerrado area An intensive cassava cultivation course was designed for this area. Aspects covered in this text include climatology, edaphology, preparation of the land, fertilization and liming, planting dates, varieties, preparation of stem cuttings and their storage, spacing, weed control, important pests and diseases, pruning, harvesting, intercropping and rotation. (*Summary by T.M.*) D00

0041-1177 DELGADO, A. and QUEVEDO, H. **Observaciones sobre el cultivo de la yuca en el Sur del Lago.** (*Cassava cultivation south of Lake Maracaibo, Venezuela*). Agro Información 3(2):5-8. 1977. Span , Illus.

Cassava. Cultivation. Venezuela.

Cultural practices are given for growing cassava south of Lake Maracaibo (Venezuela), where approx 10 sweet var. are grown. Data are given on climate, soils, preparation of the land, planting dates and distances, preparation and planting position of cuttings, spacing, weeding practices, fertilizers, pruning and harvesting. Recommendations are made for chemical control of the cassava hornworm *Erinnyis ello* and leaf-cutter ants (*Atta* sp., *Acromyrmex* sp.). The most common diseases are blight (*Xanthomonas* sp.) and mosaic. (*Summary by T.B.*) D00

0042-8759 GALLEGOS P., R.R. **Evaluación de producción agronómica y biomasa en sistemas de producción que incluyen yuca** (*Manihot esculenta* **Crantz**). (*Evaluation of agronomic production and biomass in production systems that include cassava*). Tesis Mag. Sc Turrialba, Universidad de Costa Rica, Centro Agronómico Tropical de Investigacion y Enseñanza, 1976. 122p. Span., Sum. Span., Engl., 62 Refs., Illus.

Cassava. *Manihot esculenta.* **Cultivation. Inter-cropping. Maize. Beans. Sweet-potatoes. Stems. Leaves. Petioles. Tubers. Plant development. Productivity. Field experiments. Costa Rica.**

This research formed part of experiments conducted by the Dept. of Tropical Crops and Soils at CATIE in Turrialba (Costa Rica) from Nov. 1974-Oct. 1975. Objectives were to evaluate the performance of cassava in different cropping systems and to select cropping systems and technologies for obtaining a significant increase in edible root production. Experiments were conducted on a soil of the normal phase of the Instituto Clay series (Inceptisol, Typic Dystropepts) using cassava var. Valencia, sweet potatoes var. C-15, maize var. Tuxpeño-1 and beans var. CATIE-1. Treatments covered 5 production systems: (a) cassava as monocrop, (b) cassava + sweet potatoes planted at the same time with a 2nd crop of sweet potatoes, (c) cassava + maize planted at the same time, followed by maize, (d) cassava + beans planted at the same time, followed by maize, and (e) cassava + maize + beans planted at the same time, followed by sweet potatoes. Ninety-m^2 plots were arranged in a randomized complete block design with 4 replications. For cassava alone, the following physiological and morphological growth variables were recorded every 2 mo as long as plants remained in the field: total, leaf, stem, petiole and swollen root biomass. Stem height and circumference, leaf no., leaf area and LAI were also determined. Storage root production was measured at the end of each production system cycle. Production from all associations was totaled and expressed as Land Equivalent Ratio (LER). It is concluded that best total biomass production in cassava was obtained in treatments (a) and (d). Cassava was much more efficient in storage root production when grown as a monoculture; production was greatly reduced when it grew in association with other crops. Av yields were higher in high-technology than in low-technology systems. According to the LER, the polycultural systems were agronomically more efficient than cassava monoculture as far as food production is concerned. (*Author's summary*) D00 C01 K01

0043-9571 **GONZALEZ, J.A. El cultivo de la yuca. (*Cassava cultivation*). Maracay, Venezuela. Centro Nacional de Investigaciones Agropecuarias. Serie de Cultivos no. 1. 1976. 18p. Span., Illus.**

Cassava. Land preparation. Cuttings. Planting. Cultivars. Timing. Weeding. Harvesting. Insect control. Disease control. Costs. Venezuela.

This manual for cassava farmers gives practical instructions on adequate soils, land preparation, fertilization, selection and planting of cuttings, the best sweet and bitter varieties for the 3 main zones in Venezuela, planting dates, control of weeds, diseases and pests, and harvesting. Approx production costs for commercial operations are also given. (*Summary by T.M.*) D00

0044-1206 **KOLTE, V.R. and NAPHADE, D.F. The tapioca as food crop.** Nagpur College of Agriculture Magazine 47:16. 1974/75. Engl.

Cassava. Cultivation. India.

The cultivation of cassava is being recommended in Maharashtra (India) in an attempt to increase food production to make the state self-sufficient. Basic information is given on how to grow cassava; recommended var. are H 97, H 165, H 226 and M4. When properly fertilized, yields of 40-50 t/ha are obtained. (*Summary by T.B.*) D00

0045-9334 **MANDIOCA REQUER técnica. (*Cassava cultivation*). Dirigente Rural 1(11):18, 20. 1962. Port., Illus.**

Cassava. Cultivation. Brazil.

The cultural practices used in cassava cultivation in Araras, São Paulo (Brazil) are presented. With var. Branca de Sta. Catarina yields of 12.4-18.6 t roots/ha are obtained. The initial soil pH of 4-4.5 is corrected by liming 5-6 mo before planting. At planting 289 kg P and 62 kg K/ha are

applied; and at 3 mo, 124 kg N. Every 2 cycles of cassava, N fertilization is complemented by planting the legume *Styzolobium* sp., which is cut and plowed under. The only pest of importance is the hornworm *Erinnyis ello*, which is controlled chemically. (*Summary by I.R.Z. Trans. by T.M.*) D00

0046-9333 SASIDHAR, V.K. and SADANANDAN, N. **Tapioca after cowpea gives higher yield.** Indian Farming 26(6):23. 1976. Engl., Illus.

Cassava. Cultivation systems. Cowpea. Tuber productivity. India.

In trials on a red loam acid soil (pH 5.8), cassava cv. Malayan-4, followed by cowpea cv. New Era gave yields of 25.45 t roots and 580 kg seed/ha, respectively, in 1971-72 and 29.02 t and 423 kg, respectively, on the same plots in 1972-73. This cropping sequence was more profitable than other sequences involving cassava. (*Summary by Field Crop Abstracts*) D00

0047-1213 **SISTEMAS DE produção para a cultura da mandioca.** (*Cassava production systems*). Brasilia, Empresa Brasilera de Pesquisas Agropecuárias. Circular no. 133. 1976. 26p. Port.

Cassava. Cassava programs. Cultivation. Land preparation. Fertilizers. Planting. Harvesting. Timing. Brazil.

In order to make viable recommendations on cassava production systems, they must be in accordance with the production systems and conditions of a given region. Technological packages are given for (1) large mechanized operations, (2) intermediate producers using animals or rented machinery to prepare the land and (3) small farmers (up to 3 ha) in the upper and lower regions of the Taquari River in the state of Rio Grande do Sul (Brazil). (*Summary by T.B.*) D00

See also 0410

D01 Soil, Water, Climate and Fertilization

0048-4024 ALMEIDA, F.C.G. and ALBUQUERQUE, J.J.L. **Efeitos da adubação mineral e espaçamento na produção da mandioca** (*Manihot utilissima* Pohl). (*Effects of fertilization and spacing on cassava production*). Ciência Agronômica 4(1/2):7-10. 1974. Port., Sum. Engl., 5 Refs

Cassava. Field experiments. Fertilizers. N. P. K. Spacing. Tuber productivity. Brazil.

A field trial was conducted to determine the influence of 3 within-row spacings (0.5, 0.75 and 1.0 m) and 2 levels of NPK fertilization (30-40-30 and 60-80-60 kg/ha) on cassava yield, using a completely randomized block design with 4 replications. The 1.0-m spacing and the 60-80-60 NPK treatment gave the best yields (18 and 17.4 t/ha, respectively). (*Author's summary*) D01 D02 D03

0049-2581 BOLAÑOS M., F.J. **Respuesta de la yuca** (*Manihot esculenta* Crantz) **a la aplicación de fertilizantes, en la región de Santágueda.** (*Response of cassava to fertilization in the region of Santágueda*). Tesis Ing. Agr. Manizales, Universidad de Caldas, 1972. 109p. Span., Sum. Span., 20 Refs., Illus.

Cassava. Field experiments. Fertilizers. N. P. K. Plant height. Tuber development. Starch content. Mineral content. Analysis. Timing. Dry matter. Productivity. Colombia.

The response of Llanera, a high-yielding, well-adapted cassava variety, to major nutrients was studied on a soil with a pH of 4.8 at Santágueda (Colombia). A 2 x 2 x 2 completely confounded factorial design with 9 treatments each and 4 replications was used. The NPK treatment consisted of 60 kg ammonium sulfate/ha (21% N), 100 kg triple superphosphate/ha (45% P) and 130 kg potassium sulfate/ha (52% K). The addition of P significantly increased yield, plant height, root length, diameter and starch content. Further studies with different levels of P, liming and methods of application are recommended. (*Summary by I.B.Z.*) D01

0050-7410 CAMPOS, H. DOS R., CARMO, G.F. DO and CONCEIÇÃO, A.J. DA **Estudo dos fatores climáticos.** (*Effect of climatic factors on cassava*) *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.41-45. Port.

Cassava. Cultivation. Climatic requirements. Brazil.

A report is given of a phenological study in Bahia (Brazil) using a late-maturing cassava var. (Graveto) and an early-maturing one (Aipim Maragogipe). The var. were planted at a distance of

1.00 x 0.60 m every 30 days, beginning in Aug. 1972. A randomized block design with 12 treatments and 4 replications was used. The 2 methods of fertilization and different sources of NPK used are explained. Preliminary results showed that germination of the cuttings varied according to season and that the early-maturing var. did better than the late-maturing one. (*Summary by I.B Z. Trans. by T.B.*) D01

0051- 9552 CARVALHO, J.E.B. DE. Nutrição mineral de mandioca. (*Mineral nutrition of cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.209-217. Port., 15 Refs.

Cassava. Minerals. Nutritional requirements. Fertilizers. N. P. K. Ca. Mg.

Different aspects of the mineral requirements of cassava are discussed on the basis of data compiled from a literature review. (*Summary by T.B.*) D01

0052- 1387 CHEW, W.Y., JOSEPH, K.T. and RAMILI, K. **Influence of soil-applied micronutrients on cassava (*Manihot esculenta*) in Malaysian tropical oligotrophic peat.** Experimental Agriculture 14(2):105-111. 1978. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Nutritional requirements. Soil analysis. Field experiments. Copper. Zn. Manganese. Iron. Tuber productivity. Starch productivity. Nutrient uptake. Mineral deficiencies. Malaysia.

Two experiments were conducted to determine micronutrient requirements of cassava var. Black Twig on Malaysian peat soil. Cu was found to be the only essential micronutrient. Fertilizing with 20 kg/ha of copper sulfate approx tripled root DM, starch and Cu uptake, but applying 10 kg gave the same results. Each crop absorbed only ca. 2% of the applied Cu, giving a leaf content of about 14 ppm, compared with ca. 7 ppm in Cu-deficient plants. Cu deficiency symptoms were invariably observed in Cu-deficient plots. (*Author's summary*) D01 D03

0053- 8354 DIAZ, R.O., HOWELER, R. and VARON, V. **Descripción de los suelos utilizados para el cultivo de la yuca.** (*Description of soils in cassava-growing areas*). *In*____.and Pinstrup-Andersen, P., eds. Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 9p. Span., Sum. Span.

Cassava. Soil requirements. Soil fertility. Soil analysis. Minerals. Productivity. Colombia.

An analysis of soils in 5 different cassava-growing zones in Colombia showed that there were intermediate levels of organic matter in most soils of farms visited. P and K levels and degree of soil acidity (pH) had a considerable effect on cassava yield. Apparently, Al was not important. Soil Ca/Mg ratios should be higher than the unit to avoid problems of Mg toxicity or Ca deficiency. Few problems of salinity were found. (*Author's summary. Trans. by I.B.Z.*) D01

0054- 9227 DIAZ D., R.O., HOWELER, R. and VARON R., U. **Evaluacion de los análisis de suelos de las zonas productoras de yuca en Colombia.** (*Evaluation of soil analyses in cassava-growing zones of Colombia*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 47p. Span., Illus

Cassava. Soil requirements. Soil analysis. Fertilizers. N. P. K. Aluminium. Mg. Ca. Productivity. Colombia.

The results are given of physicochemical analyses of soils and estimated cassava yields for five production zones in Colombia. There was little correlation between yield and the factors studied. Yields tended to increase as P increased; and there was a positive response to K in 2 zones and Ca/Mg in 2 others. However, there were contradictory results with K and pH in three of the zones. Other factors affecting yield should be studied to find the reasons for this discrepancy. (*Summary by T.M.*) D01

0055-9564 EVENSON, J.P. and KEATING, B. **The potential of cassava (*Manihot esculenta* Crantz.) as a harvester of solar energy.** *In* Conference on Alcohol Fuels, Sydney, New South Wales, 1978. Proceedings Sydney, Australia, Institution of Chemical Engineers. New South Wales Group. 1978. pp.7-1 - 7-5. Engl., Sum Engl., 7 Refs

Cassava. Climatic requirements. Soil requirements. Temperature. Rainfall data. Photoperiod. Tuber productivity. Adaptation. Cassava programs. Cultivars. Selection. Australia.

Because of cassava's potential as a source of energy, research work on this crop was begun by the U. of Queensland in 1970. Preliminary screening of 22 native cv. resulted in the selection of M. Aus 7, which gave good performance over a wide range of environments. Data are given on meteorological factors affecting the cassava growing season in different parts of Queensland, yield and yield potential, and possible insect pests. Aspects requiring further study are outlined. (*Summary by T.B.*) D01 D03

0056-3043 FIGUEROA F., R. and RAMIREZ P., C. **Comportamiento agronómico de cuatro variedades introducidas de yuca (*Manihot esculenta* Crantz) y dos nativas (Provincia de Ricaurte).** (*Agronomic evaluation of four introduced and two native varieties in the region of Ricaurte, Colombia*). Tesis Ing Agr. Tunja, Universidad Pedagógica y Tecnológica de Colombia, 1976. 128p. Span., Sum Span., 19 Refs., Illus.

Cassava. Field experiments. Cultivars. Adaptation. Soil analysis. Soil requirements. Fertilizers. N. P. K. Timing. Experiment design. Tuber productivity. Colombia.

Two experiments were conducted at 2 different sites in the state of Boyacá (Moniquirá and Santana), Colombia to evaluate time of fertilizer application (2 and 4 mo after planting) and adaptability of 4 cassava cv introduced from Palmira, as compared to 2 local var. (Caspuda and Sata). Climatological and edaphic data are given in detail. A split plot design was used with 2 replications for each period of fertilizer application. Each plot measured 15 x 2 m, and there were 20 plants/plot. Because of the sloping terrain, oxen were used to prepare the land. NPK was applied in a proportion of 10-30-10, using 150 g/plant. Weeding was done at the time of fertilizer application. The cv. CMC 40 was severely attacked by CBB and had to be eradicated. The following statistical analyses were made: analysis of variance, the Duncan and T tests. Best production was obtained at Santana, where climatic and soil conditions were more favorable. Best results (highly significant) as to time of fertilizer application were obtained at 2 mo at both sites. CMC 57 was the best yielder at both sites. (*Summary by T.B.*) D01

0057-1377 FORNO, D.A. **The mineral nutrition of cassava (*Manihot esculenta* Crantz) with particular reference to nitrogen.** Ph.D. Thesis. Brisbane, University of Queensland. Department of Agriculture, 1977. 175p. Engl., Sum. Engl., 203 Refs , Illus.

Cassava. Nutritional requirements. Minerals. N. Boron. Ca. Nutrient uptake. Propagation. Growth-chamber experiments. Roots. Growth. Temperature. Mineral deficiencies. Toxicity. Mineral content. Analysis. pH. Shoots. Cultivars. Australia.

The mineral nutrition of cassava was studied, with emphasis on physiological variability among cv. in their response to N. Naturalized Australian clones and cv. introduced from Puerto Rico, Fiji and Indonesia were used. A mist propagation technique was developed to multiply the material. There was a root disorder due to Ca deficiency so further experiments were conducted to optimize levels of Ca, root temp and incident radiation for propagating cuttings. In general high light intensities, a root temp of ca. 25°C and a Ca concentration of ca. 150 uM were satisfactory. To determine optimum growing conditions, effects of nutrient solution, temp, pH and Ca supply were studied in a series of solution culture experiments with rooted cuttings. Root temp of ca. 20°C were found best while low temp (ca. 19°) induced B deficiency due to reduced rates of B uptake at low temp. Critical concentrations were 1.6 µmol g^{-1} for deficiency and 12 µmol g^{-1} for toxicity. Substrate Ca levels for optimum growth ranged from 100-350µM, depending on the cv; optimum pH in flowing culture ranged from 5.5-7.5. Effects of substrate nitrate and ammonium concentrations on growth of selected cassava cv., cotton, maize, sorghum, sunflower and ginger were studied in further flowing culture experiments. Large differences were apparent between cv., but in general cassava was not better than most of the other crops in ability to take up N from low nitrate or ammonium concentrations. Ginger had the lowest critical substrate N concentrations for growth; however, even when cassava growth was greatly retarded by low N supply, severe deficiency symptoms did not develop and young leaves contained twice the N concentration found in similar tissues of the other species, except ginger. Data are consistent with the hypothesis that the ability of cassava to grow better than most crops on low-fertility soils is due, in part, to its superior ability to regulate its growth rate according to the rate of nutrient supply. Ammonium and/or nitrate substrates were equally effective sources of N for most cassava cv. Generally, max growth rates and N uptake were observed between pH 5.6-6.8, although there was considerable variability between cv. in their responses outside this pH range. Differences in rate of N uptake accounted for much of the difference. At pH 5.9 and below, ammonium toxicity affected growth of sunflower and some cassava cv. grown on substrates containing 120-500µM ammonium. However, addition of a small amount of nitrate to the culture solution was effective in preventing ammonium toxicity in all cases. Results suggest that variation in the responses of individual cassava cv. to various nutritional factors is sufficient to warrant investigation of the possibility of breeding cv. for particular nutrient environments. (*Author's summary*) D01

0058-9551 GOEDERT, W.J. Pesquisa em fertilidade do solo. (*Study on soil fertility*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.218-222. Port., 9 Refs.

Cassava. Soil requirements. Soil fertility. Brazil.

A literature review showed conflicting data for fertilizing and liming cassava, probably because a few basic rules had not been followed in experimentation. These points are discussed briefly, and the types of experiments that should be conducted to determine nutrient requirements are given. (*Summary by T.B.*) D01

0059-9239 INSTITUTO DE PESQUISAS E EXPERIMENTACAO AGROPECUARIAS DO LESTE (BRAZIL). Tabuleiros terciários do Recôncavo. Mandioca. (*Tablelands in the Recôncavo region of Bahia. Cassava*). *In*____. Contribuição ao estudo das plantas alimentares no estado da Bahia. Cruz das Almas, Brasil, Convênio IPEAL/SUDENE, 1970. pp.49-57, 90-93. Port.

Cassava. Field experiments. Cultivars. Planting. Spacing. N. P. K. Fertilizers. Timing. Tuber productivity. Statistical analysis. Brazil.

The production of different agricultural commodities (peanuts, sweet potatoes, beans, yams, maize, sorghum and cassava) were studied on the basis of 3 ecological zones in the state of Bahia.

This section deals with the tablelands of the Recôncavo, a vast and fertile coastal region of the state. As for cassava, data are given in table form for varietal competition, planting dates and spacing at Cruz das Almas and NPK fertilization at São Gonçalo dos Campos. (*Summary by T.M.*) D01 D02

0060-4424 JACQUES, C. **Le manioc et l'épuisement du sol.** (*Cassava and soil depletion*). Revue Agricole de la Nouvelle Calédonie 1937:2581-2584. 1937. Fr.

Cassava. Soil impoverishment.

Soil is depleted by cassava when it is grown without good cultural practices, above all little or no crop rotation. The reason for this is that 1 t of roots removes from the soil an av of 6.5 kg lime, 7.7 kg K, 4.7 kg phosphoric acid, 2 kg Mg and 0.7 kg N. (*Summary by I.B.Z. Trans. by T.M.*) D01

0061-9798 KAILASAM, C. *et al.* **Influence of soil moisture regimes under different fertilizer treatments on the HCN content of tapioca.** Madras Agricultural Journal 64(6).399-401. 1977. Engl., 6 Refs.

Cassava. Soil moisture. Irrigation. Fertilizers. N. P. K. HCN content. Tubers. Leaves. Stems. Field experiments. India.

Field trials were conducted on sandy loam soil to determine the effect of 7 moisture regimes and 3 fertilizer treatments on the HCN content in the root, peel, stem bark and leaf of the cassava plant. HCN content of all parts of the plant increased with decreasing soil moisture; however, the increase was only significant in the stem bark. The highest HCN content (800 ppm) was observed in the stem bark of those plants irrigated 15 days after reaching zero % available soil moisture. NPK, NK and N fertilization had no effect on HCN content in contrast to previously reported work. The mean contents of HCN in peel, stem bark, leaf, and root were 651, 529, 134 and 42 ppm, respectively. (*Summary by Chemical Abstracts*) D01 C03

0062-8720 KANAPATHY, K. **Fertiliser requirement on peat soils.** Malaysian Agricultural Journal 50(3):292-313. 1976. Engl., Sum. Engl , 20 Refs., Illus.

Cassava. *Manihot esculenta*. Soil requirements. Soil fertility. Nutritional requirements. N. P. K. Fertilizers. Tuber productivity. Malaysia.

Many attempts have been made to grow crops on peat; these were unsuccessful except when intensive burning was used. This method is, however, very labor intensive and subject to weather conditions. Since 1965 several pot and field tests have been carried out to study fertilizer requirements of different crops. As regards cassava, it appeared to require considerable amounts of major nutrients, particularly potash. It was found that liming tended to depress P and K uptake whereas burning enhanced their uptake. Peat was most deficient in K; there was little difference in peat from shallow and deep peat areas. It is concluded that peat can be exploited for growing annual crops such as cassava, peanuts, soybeans and tomatoes, in addition to pineapples. (*Summary by T.M.*) D01

0063-8721 KANG, B.T. and MOORMANN, F.R. **Effect of some biological factors on soil variability in the tropics. I. Effect of pre-clearing vegetation.** Plant and Soil 47(2):441-449. 1977. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Soil fertility. Soil analysis. Cultivation systems. pH. Shifting cultivation. Fallowing. N. P. K. Fertilizers. Nigeria.

Field observations were carried out on an Egbeda soil series in western Nigeria to study the degree of soil-nutrient variability within and between plots due to preclearing vegetation. The soil showed lower soil pH, organic C, exchangeable K and Ca contents following cassava grown by traditional methods than following secondary forest vegetation or thicket regrowth. Except for exchangeable K, the degree of variability of the above parameters was observed to be in the following order: secondary forest vegetation > thicket regrowth > cassava plots. The available P status was generally low and showed little relation to preclearing vegetation. The implications of soil variability due to preclearing vegetation on soil sampling and in field experimentation are discussed. (*Author's summary*) D01

0064-8780 LOPEZ Z., M. and DOROFEEV, I. **Estudio de distintas combinaciones de N-P-K en el cultivo de la yuca en 2 variedades de diferentes ciclos.** (*Different NPK combinations for two cassava varieties with different maturity cycles*). *In* Facultad de Ciencias Agropecuarias. Memoria Anual 1968-1969. Las Villas, Cuba, 1970. pp.110-127. Span., Sum. Span., Engl., 6 Refs., Illus.

Cassava. Nutritional requirements. Field experiments. Fertilizers. N. P. K. Nutrient uptake. Leaves. Stems. Tubers. Tuber productivity. Cultivars. Timing. Cuba.

A study was conducted at the Universidad Central in Cuba to determine the vegetative growth period in 2 cassava varieties with different cycles and morphological characters, as well as yield response to different combinations of NPK fertilizer Señora Blanca has a long cycle (12 mo), is a tall, branching type and yields more than Señorita, a short-cycle variety (10 mo). In relation to foliage growth, the vegetative period was 6 mo for the short-cycle and 8 mo for the long-cycle variety. Roots matured between the 8th and 10th mo and the 10th and 12th mo for the 2 varieties, respectively. From the 4th mo on, nutrient uptake and growth rate increased suddenly; nitrogen uptake increased 90%. In the short-cycle variety, approx 400 kg K_2O, 150 kg N and 80 kg P_2O_5, ha were taken up whereas in the long-cycle variety these figures were 1400. 223 and 265 kg/ha, respectively. Best results were obtained when complete NPK fertilization was used. For the Santa Clara soils of this experiment, the following NPK ratios should be used: 5-2-10 for long-cycle varieties and 1-1-6 for short-cycle varieties. Cassava has a critical water-requirement period at 4-6 mo of growth, when it should be irrigated (*Author's summary*) D01 D03

0065-8753 OBIGBESAN, G.O. **Investigations on Nigerian root and tuber crops: effect of potassium on starch yields, HCN content and nutrient uptake of cassava cultivars** (*Manihot esculenta*). Journal of Agricultural Science 89.29-34. 1977. Engl., Sum. Engl., 22 Refs.

Cassava. *Manihot esculenta.* **Field experiments. K. Starch productivity. HCN content. Nutrient uptake. Mineral content. Tubers. Cultivars. Nigeria.**

Field experiments were made in the rain forest zone of western Nigeria over 3 cropping seasons on the effects of K fertilizer of one local cassava cultivar 53101 and two improved cultivars 60506 and 60447, which were F_1 hybrids of the former. The results showed that K fertilizer increased starch yields only slightly. Cultivar 60506 produced significantly higher starch yields ($P<0.01$) than the local strain 53101 whereas cv. 60447 gave lower starch recovery than the local cultivar. A definite influence of K application on the HCN content of the swollen roots could not be established. The peeled roots of the improved cultivars contained much less HCN than those of the local 53101 strain ($P<0.01$). Potassium had the highest (0.72-1.28% dry wt basis) while P had the lowest concentration (0.06-0.12%) in the peeled root. Owing to its higher yielding capability, the unfertilized 60506 removed larger amounts of potash (av 110.9 kg K_2O/ha) from the soil than unfertilized 53101 (av 82.2 kg K_2O/ha). (*Author's summary*) D01 D03

0066-8749 OBIGBESAN, G.O. **Investigations on Nigerian root and tuber crops: response of cassava cultivars to potassium fertilizer in Western Nigeria.** Journal of Agricultural Science 89.23-27. 1977. Engl., Sum. Engl., 14 Refs.

Cassava. *Manihot esculenta*. Field experiments. K. Soil analysis. Growth. Tuber productivity. Dry matter. Timing. Cultivars. Nigeria.

The response of 3 cassava cultivars to K fertilizer was studied in field experiments from 1972-76. They included the local cv. 53101 and improved cv. 60506 and 60447 which were F_1 hybrids involving the local strain (53101) and cv. 42074. In locations known to be low in K, the cultivars showed only low response to K fertilizer with optimum performance at about 60 kg K_2O/ha, but the local cv. 53101 had apparently not reached its maximum root production even at 120 kg K_2O/ha. This cultivar gave higher root yield increases (10-18 kg dried root/kg K_2O) than cv. 60506 (6-10 kg dried root/kg K_2O) whereas cv. 60447 produced about 18 kg/kg K_2O. Unfertilized 60506 produced av yields equivalent to those obtained from the heavily fertilized 53101. Cultivar 60506 gave the highest DM content. The improved cultivars retained more leaves than the local strain. K fertilizer enhanced the utilization index (storage root/top ratio) of the cultivars. (*Author's summary*) D01 D03

0067-8731 PREMA, L., THOMAS, E.J. and AIYER, R.S. **The usefulness of sensory methods of analysis by a taste panel in differentiating the quality of cassava tubers under different manurial treatments.** Agricultural Research Journal of Kerala 13(2):141-145. 1975. Engl., Sum. Engl., Hindi., 6 Refs.

Cassava. Field experiments. N. P. K. Fertilizers. Dry matter. Starch content. HCN content. Protein content. Tubers. Organoleptic examination. India.

Rural farmers and consumers claim that the taste of cooked cassava roots is significantly affected by fertilization treatment. Therefore, an experiment was conducted in which 5 kg of cooked roots from 4 treatments (2 extreme levels of N and P) in a fertilizer experiment conducted at Vellayani (0-75-150 kg N/ha and 0-50-100 kg P_2O_5/ha) were submitted to an organoleptic evaluation by a panel of 30 rural women. Taste was measured on a 5-point scale. The fresh roots were analyzed for their DM, starch, protein and HCN content. Root quality was found to be significantly influenced by levels of N, higher levels reducing quality. Higher levels of P significantly enhanced quality. A balanced application of N and P_2O_5 at a ratio of 3:2 had no deleterious effect on quality. Results of chemical analysis of quality factors of the fresh roots closely parallel the organoleptic assessment. The usefulness of this method for comparing quality of varieties is discussed. (*Author's summary*) D01 H01

0068-1400 PUSHPADAS, M.V., VIJAYAN, M.R. and AIYER, R.S. **Nutritional studies on cassava (*Manihot esculenta* Crantz). III. Nutrient inter-relationships at different stages of growth.** Journal of Root Crops 2(2):23-33. 1976. Engl., Sum. Engl., 14 Refs.

Cassava. Nutritional requirements. N. P. K. Ca. Magnesium. Petioles. Analysis. Timing. Mineral content. Field experiments. Cultivars. Growth. India.

The interrelationships of N, P, K, Ca and Mg were studied in cassava in 2 separate field experiments laid out in a split plot, randomized block design. The major treatments were factorial combinations of 3 levels each of N and P in one experiment and K and Ca in the other, with var. M4 and H-105 as the minor treatments. Samples of petioles from the middle 1/3 of the total leaves were collected at 62, 136 and 203 days after planting and analyzed for content. N, P and K content increased with application of N, P and K; but N, P and Mg decreased with the application of K. Liming increased Ca content only during the 1st stage of sampling whereas N, P and K had no influence on Ca content. It was also found that H-105 was superior to M4 in K content on all 3 sampling dates. (*Author's summary*) D01 C01 C03

0069-1092 RAJENDRAN, N., NAIR, P.G. and MOHAN KUMAR, B. **Potassium fertilization of cassava in acid laterite soils.** Journal of Root Crops 2(2):35-38. 1976. Engl., Sum. Engl., 7 Refs.

Cassava. K. N. Nutrient uptake. Field experiments. Tuber productivity. Cultivars. Tubers. Mineral content. Potash. India.

Because of its role in photosynthesis and translocation of carbohydrates, K is very important for tuber crops in general, especially cassava. Field experiments conducted from 1967-73 in acid lateritic soils showed that 100 kg K_2O/ha was optimum and that further application resulted in "luxury consumption." It was also found that the soil-available K level could be maintained at this rate of application. With increasing rates of N, increased K uptake was found. There was a significant, positive correlation between root yield and NK uptake. (*Author's summary*) D01 D03

0070-8764 SHANMUGAM, A. and SRINIVASAN, C. **Influence of potassium on tapioca and sweet potato.** Potash Newsletter 8(4).21-23. 1973. Engl., 7 Refs.

Cassava. Minerals. K. Tuber productivity. India.

Cassava and sweet potatoes are major root and tuber crops in India. The influence of K fertilization (in the presence of N) on yield is discussed, citing results of experiments at the Central Tuber Crop Research Institute, Trivandrum, where 100 kg each N and K/ha increased yields from 17.7 to 33 t/ha; and at Tamil Nadu Agricultural University, where 50:50:150 kg NPK/ha increased yields 116%. (*Summary by T.M.*) D01

0071-9800 SILVA, L.G. **Adubação NPK na cultura da mandioca em Tabuleiró Costeiro no estado da Paraiba.** (*NPK fertilization of cassava in Paraiba*). Pesquisas Agropecuárias no Nordeste 2(1):73-75. 1970. Port., Illus.

Cassava. Field experiments. Fertilizers. N. P. K. Tuber productivity. Brazil.

A factorial design was used to evaluate 3 rates of NPK at all combinations on cassava production in a low-fertility soil at Santa Rica, Paraiba (Brazil). The var. Nove Folhas was planted at a spacing of 1 x 0.5 m and harvested at 14 mo. Ammonium sulfate (20% N), superphosphate (20% P_2O_5) and potassium chloride (60% K_2O) were applied at the following rates: 0, 400, 800; 0, 300, 600, and 0, 100, 200 kg/ha, respectively. N was applied in 3 parts (14 days, 2 and 5 mo after planting); P and K, at planting. The 800-600-600 kg NPK/ha treatment gave a yield 444% better than the control; P gave better yields than N and K. (*Summary by J.S. Trans. by T.B.*) D01 D03

0072-8763 SOBRAL, L.F. *et al.* **Efeitos de macro e micronutrientes na produção da mandioca,** (*Manihot esculenta* Crantz). (*Effects of macro- and micronutrients on cassava production*). Sergipe, Brasil. Empresa Brasileira de Pesquisa Agropecuária. Comunicado Tecnico no. 1. 1976. 13p. Port., Sum. Port., Engl., 8 Refs., Illus.

Cassava. *Manihot esculenta.* **Field experiments. N. P. K. Boron. Molybdenum. Copper. Zn. S. Fertilizers. Ca. Tuber productivity. Brazil.**

Three 3^3 factorial fertilizer trials using a confounded design were conducted in 3 municipalities of the state of Sergipe (Brazil) to study the effect of 0-60-120 kg/ha of N, P_2O_5 and K_2O on cassava production. Sulfur and the micronutrients Zn, Cu, B and Mo were applied uniformly in all treatments. Additional treatments using a randomized complete block design studied the effects of liming, S, the foregoing micronutrients and organic matter (castor bean meal used as a partial or total substitution of urea). P increased production significantly at all sites; there were no significant effects for the other nutrients, except K at one site. (*Author's summary*) D01

0073-8781 SOUZA, L. DA S. **Características do solo para a cultura da mandioca.** (*Characteristics of soils for growing cassava*). *In* Curso Intensivo Nacional de Mandioca, 2o., Cruz das Almas, Bahia, 1977. Cruz das Almas, Brasil, Empresa Brasileira de Pesquisa Agropecuaria Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1977. 14p. Port., 23 Refs., Illus.

Cassava. Soil requirements. Soil analysis. Fertilizers. Minerals. Irrigation. pH. Aluminium. N. P. K. Brazil.

The influence of soil characteristics on chemical, physiological and biological aspects of vegetative growth is discussed. Soils adequate for growing cassava are defined. (*Summary by I.B.Z. Trans. by T.M.*) D01

0074-9233 SUDARSANAM, S. *et al.* **Preliminary studies on the effect of pre-treatment of tapioca setts in potassium chloride solution.** Farm Science 4(5):21-22 1977? Engl

Cassava. Cuttings. Potassium chloride. Tuber productivity. Irrigation. India.

Because of the role of K in imparting drought resistance in plants, the treatment of cassava cuttings with 2.5% KCl solution was evaluated, with and without irrigation, to determine whether cassava could be grown profitably as a rainfed crop. Yields of unirrigated plants from treated cuttings averaged 47.22 t/ha, an increase of 3.8% over yield of plants from nontreated cuttings When irrigated, yields of plants from treated cuttings increased 20% (*Summary by T M.*) D01

0075-1589 TARAZONA, C., MARIN, G. and LEON, A. **Respuesta de la yuca (*Manihot esculenta* Crantz) a la fertilización en parcelas demostrativas.** (*Response of cassava to fertilization in demonstration plots*). Bogotá, Instituto Colombiano Agropecuario, 1973. 38p. Span., Sum. Span., 15 Refs., Illus.

Cassava. Nutritional requirements. Fertilizers. Field experiments. N. P. K. Tuber productivity. Soil requirements. Colombia.

In order to determine the response of cassava to different levels of NPK fertilization, 23 on-farm trials were conducted in different parts of Colombia. Response was compared to soil analyses for organic matter, P and K. For P-deficient soils (< 15ppm) the use of 1000 kg of 4-24-8 fertilizer and 100-150 kg urea (applied about 4 mo after planting) is tentatively recommended. Due to the instability of cassava prices, it was not possible to determine optimal economic levels of application. Until better information is obtained from other areas, the only reasonable guide for fertilizer recommendations is that tentatively made by the ICA Soil Program, based on soil analyses. (*Author's summary. Trans. by T.B.*) D01

0076-4789 UKRA, O. **A study of calcium, magnesium and sulfur deficiency symptoms of cassava by controlled sand culture.** Bankgkok, Thailand, Kasetsart University. Agronomy Department, 1966. 2p. Engl.

Cassava. Ca. Magnesium. S. Deficiencies. Laboratory experiments. Plant development. Thailand.

Young cassava cuttings with 2-3 shoots were planted in sand-filled pots and given 1 of 4 nutrient solutions (complete with micronutrients or deficient in Ca, Mg and S). It was found that (1) plants deficient in S were the most stunted (78.8 cm); stems and leaves were yellowish. (2) At 7½ mo, Ca-deficient plants averaged 94.5 cm. There was some chlorosis but not as much as in (1). Lower

leaves dried up; young leaves were wrinkled and turned upwards. Roots grew well but there were few thickened ones. (3) Mg deficiency had no effect on height. Leaves and stems were pale green, and there were a great no. of chlorotic spots between the veins. Petioles turned pale purple. Leaf fall was extreme in the later stage of growth, leading to death. (*Summary by T.M.*) D01 C03

See also *0033* *0113* *0391*

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

0077-9425 BADILLO-FELICIANO, J. and LUGO-LOPEZ, M.A. **Effect of planting system and partial removal of the epidermis of cassava cuttings on growth yields and root development.** Journal of Agriculture of the University of Puerto Rico 60(4) 606-611 1976. Engl., Sum. Engl., Span.

Cassava. Cuttings. Planting. Plant development Growth. Tuber development. Tuber productivity. Field experiments. Propagation. Puerto Rico.

A field experiment was conducted on a Coto clay oxisol to compare the effect of planting cassava cuttings vertically with a section aboveground or horizontally underground and of removing the epidermis (ringing) of the cuttings at the basal, terminal or middle section, and combinations of these treatments. The experiment followed a randomized complete block design with 8 treatments and 4 replications. Data obtained from an 8-month-old cassava crop revealed no significant differences in edible root yields when planted either vertically with a section aboveground or horizontally underground. Removing rings of the epidermis did not affect yields significantly. Mean height of plants from cuttings planted vertically without rings was significantly higher than that of plants from cuttings set horizontally with rings at both ends. No significant differences in top-to-root ratios were attributable to treatment. Counts and observations of cuttings grown on sand beds under greenhouse conditions indicate that, contrary to the generally accepted belief, roots are produced more abundantly from calluses formed at the basal area where the incision is made at cutting than at nodes below ground level. Irrespective of treatments, overall yields were more than twice those obtained in subsistence and commercial farming. This can be attributed to the use of a high-yielding cultivar and sound soil and crop management practices. (*Author's summary*) D02

0078-6045 BRAWIJAYA UNIVERSITY. FACULTY OF AGRICULTURE. CASSAVA RESEARCH PROJECT. **Progress report I (October 1973-April 1974).** Malang, Indonesia, 1974. 16p. Engl., Illus.

Cassava. Cassava programs. Propagation. Grafting. Propagation materials. Land preparation. Planting. Timing. Tuber productivity. N. Fertilizers. Manures. Field experiments. Indonesia.

The objectives of the cooperative project between IDRC and the Faculty of Agriculture at Brawijaya University are to develop a cassava production system for small farmers; to study the potentials of the Mukibat system using *Manihot esculenta* and *M. glaziovii;* to link Indonesia with the CIAT cassava research network; and to provide practical training for the university's staff and graduate students. Field experiments were set up on nonirrigated land in 8 regencies of East Java. During the 1st year the main objective was to obtain information on the productivity of

the Mukibat system under different conditions. A progress report is given on land preparation, application of organic matter and fertilizers, preparation of planting material, planting and replanting, and maintenance of the crop. Three problems encountered have been delayed planting, low %s of successful grafts and damage caused by heavy winds. (*Summary by T.B.*) D02 J00

0079-6115 BRAWIJAYA UNIVERSITY. FACULTY OF AGRICULTURE. CASSAVA RESEARCH PROJECT. **Survey on Mukibat cassava in East Java.** Malang, Indonesia, 1976. 25p. Engl., Illus.

Cassava. Grafting. Cuttings. Planting. Spacing. Land preparation. Irrigation. Weeding. Harvesting. Inter-cropping. Tuber productivity. Gaplek. Cassava starch. Indonesia.

A survey on Mukibat cassava was made among 292 small farmers (< 1 ha) in 24 districts of 12 regencies in East Java. Data suggest that Mukibat performed better than normal cassava, especially in yards (probably because of organic fertilizer). The av farmer had 440 Mukibat plants which produced 5-6 t plus 1637 normal cassava plants which yielded 3.3 t. Aspects of land preparation planting on ridges or hills, use of organic matter and fertilizers, most commonly used var., preparation of planting material, planting distances and depth, weeding, irrigation, intercropping, harvesting and the relationship between plant treatment and production are discussed on the basis of survey results. Reasons for making gaplek or not are discussed for the Mukibat and normal cassava farmers. Only 20% of the farmers sampled made starch; 51% of the normal cassava is consumed fresh. Many of the farmers consume young leaves for food; they are also given to animals. Input/output and net profits of Mukibat and normal cassava are compared. (*Summary by T.B.*) D02 J00

0080-5595 BRUNO, A. **La mandioca.** (*Cassava*). Rivista di Fisica, Matematica e Scienze Naturali 1932:7-17. 1932. It.

Cassava. Cultivation. Geographical distribution.

Some morphological characteristics, as well as toxic factors and antidotes, are given for *Manihot esculenta* (=*M. palmata, M. utilissima, M. dulcis*). The difference between sweet and bitter varieties is explained. The origin and geographic distribution of cassava are also dealt with. Some cultural practices and factors affecting yield are discussed, with emphasis on the good cassava-growing conditions in Brazil (300-500 quintals roots/ha; 20-25% starch). (*Summary by I B Z Trans. by T.M.*) D02

0081-9563 CARDENAS, J., FRANCO, O. and DOLL, J. **Equipamento de aspersão.** (*Spraying equipment*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.303-312. Port

Cassava. Weeding. Herbicides. Timing.

Aspects of weed control in general are discussed, with emphasis on the use of herbicides (selectivity, mixtures of products, hormonal herbicides, time and rates of application) Recommendations are given for the chemical control (products, rates and time of application) of weeds in cassava. (*Summary by J S. Trans. by T.B.*) D02

0082-9797 CHALOT, C. **De la culture et des différentes préparations du manioc.** (*Cultivation of cassava and its uses*). Revue des Cultures Coloniales 3:75-79. 1898. Fr., Sum. Fr.

Cassava. Cultivation. Cassava products. Uses. Africa.

The following aspects of cassava cultivation by natives in Equatorial Africa and in a great part of the tropics are discussed briefly: distribution, morphological description, cultural practices (preparation of the land, cuttings, spacing). Av yields are 40-60,000 kg/ha. The roots are used to make flour, chips, tapioca, starch and alcohol. (*Summary by I.B.Z. Trans. by T.B.*) D02

0083-8723 CHEW, W.Y., CHEW, H.J. and ABDUL RAZAK, H.A.H. **Pre-emergence weed control on peat. I. Screening of some herbicides for tapioca and soya bean.** Malaysian Agricultural Journal 50(3):411-415. 1976. Engl., Sum. Engl., 14 Refs.

Cassava. Herbicides. Weeding. Weeds. Tuber productivity. Field experiments. Malaysia.

Two field experiments were conducted to screen 7 preemergence herbicides including atrazine and ametryne, both at the rate of 3.36 kg a.i./ha; simazine, diuron and BAS 2013H (isononuron) at the rate of 5 kg a.i./ha; CP 50144 (alachlor) at 2.4 kg. a.i./ha; and nitralin at 5 kg a.i./ha. Nitralin was not included as a treatment in the cassava experiment. Each herbicide was applied as a spray using about 1123 liters of water/ha a day after planting. The control and hand weeding plots were sprayed with the same amount of water. Highest yields in both crops were obtained with hand weeding, followed by CP 50144 and diuron. Both herbicides gave highest weed control as well. (*Summary by Abstracts on Tropical Agricultural*) D02 D03

0084-9561 CONCEICAO, A.J. DA **Colheita da mandioca.** (*Harvesting cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976 Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.435-440. Port., 7 Refs.

Cassava. Harvesting. Timing. Brazil.

Commercial harvesting operations are facilitated when cassava cuttings are planted horizontally at 10 cm in furrows. Planting on ridges also gives good results and weeds are less of a problem. Harvesting dates and systems are discussed briefly. Roots should be processed within 24 h since they are difficult to store, or they can be made into chips which are easily dried to a moisture content of 10-12%, making it possible to store them for a long time. Stems can be used for propagation material and leaves and green stems of for forage. (*Summary by T.M.*) D02

0085-8353 DIAZ, R.O., TORO, J.C. and VARON, U. **Características de la producción y sistemas de siembra.** (*Characteristics of production and planting systems*) *In*_____and Pinstrup-Andersen, P., eds. Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 20p Span., Illus.

Cassava. Cultivation. Inter-cropping. Planting. Spacing. Timing. Land preparation. Irrigation. Statistical analysis. Weeding. Drainage. Colombia.

The cultural practices used by farmers in 5 cassava-growing zones of Colombia were determined. Most farmers planted cassava alone although intercropping (principally with maize but also with beans, plantains, coffee, etc.) was found in all zones. Most farmers prepared the land with machinery; but in one zone oxen were used or land was superficially cleaned with machetes. Only 4% planted on ridges, usually on lots of < 10 ha. On the av, a density of 10,000 plants/ha was used. Cuttings were planted vertically in only one zone, but this zone also had to do the most replanting. Most farmers weeded 3 times (during the 1st 2 mo and between 4-6 mo). Irrigation was

practiced in only one zone; all zones used drainage. It is concluded that the dissemination of simple, inexpensive techniques is necessary to close the gaps among the different zones. (*Summary by A.J. Trans. by T.M.*) D02 K01

0086-8357 DOLL, J., PINSTRUP-ANDERSEN, P. and DIAZ, R.O. **Las malezas y las prácticas de control en yuca.** (*Weeds and their control in cassava*). *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. 16p. Span., Sum. Span., 5 Refs.

Cassava. Weeds. Weeding. Colombia.

In a survey made of weeds in cassava plantations in 5 different zones of Colombia (3 visits), 62-65% of the weeds found were broad-leaved species Surprisingly, the most common weed was *Pteridium aquilinum, Bidens pilosa* and *Cyperus rotundus* cause serious problems. Significant zone variations were found with regard to the relative frequency of the different species although some weeds were common to many areas. Highest weed populations did not coincide with the most common species . Most annual weeds were susceptible to common herbicides, but more research is needed on perennials such as *P. aquilinum* and *Sida* spp. Most weeding is done manually; only 3% of the farmers used chemical control. The av no. of weedings/crop was 3.3. The nonuse of herbicides is due to their high price, lack of information and capital, as well as the unavailability of the right herbicides and small-sized containers. (*Author's summary. Trans. by I.B.Z.*) D02

0087-4997 DRUMMOND, O.DE A., CASTRO, J.F. DE and CRUZ, J.M. DE A. **Trabalhos experimentais com mandioca.** (*Experiments with cassava*). Boletim de Agricultura do Departamento de Produção Vegetal 3(3/4).67-74. 1954. Port.

Cassava. Field experiments. Cuttings. Spacing. Tuber productivity. Insect control. Disease control. Planting. Pruning. Cultivars. Brazil.

Results are given in table form of 6 experiments conducted by different federal institutes in different parts of Minas Gerais (Brazil) from 1951-53. The experiments studied (1) the effect of planting date on yield at Lavras and the experimental station of Patos de Minas; (2) chemical control of the lace bug (*Vatiga manihotae*), shoot flies and cassava ash at Belo Horizonte, (3) planting on ridges vs. hills, with and without pruning; and (4) evaluation of 25 var. at Lavras and 6 at Belo Horizonte. (*Summary by T.B.*) D02 F01

0088-9730 GONZALEZ CH., F.J. **Estudio sobre el tamaño y la posición de la estaca de yuca** (*Manihot esculenta* Crantz) **utilizadas en la plantación.** (*Size and planting position of cassava cuttings*). Tesis. Jusepín, Venezuela, Universidad de Oriente. Escuela de Ingeniería Agronómica, 1973. 29p. Span., Sum. Span., 20 Refs.

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

A 2-yr experiment was conducted at the experimental station of the Universidad de Oriente, Jusepín (Venezuela) to determine the effect of planting position and length of cassava cuttings on yield. It was found that cutting size had a positive influence on yield, which increased as length increased.Av yields were 23.1, 20.5 and 18.2 t/ha for cuttings of 40, 30 and 20 cm, respectively. With regard to planting position, results were contradictory; but in general the horizontal and slanted positions were best (differences not significant), with av yields of 19.9 and 17.9 t/ha, respectively. (*Summary by T.B.*) D02

0089-1176 HRISHI, N., RAJENDRAN, P.G. and KAMALAN, P. **Acceleration of cassava production through Mukibat system.** Journal of Root Crops 2(2):7-9. 1976. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Propagation. Grafting. Cuttings. Plant development. Tuber productivity. Plant height. India.

A higher % of success in graft union was observed when the F_1 of *M. esculenta* x *M. glaziovii* was used as the scion instead of *M. glaziovii*. The different root stocks also showed different degrees of graft compatibility, H-2304 being the most compatible. The Mukibat plants showed enhanced vigor for both morphological attributes and yield. Mean yield/plant in the Mukibat system showed a 3-fold increase over the controls; they were also found to tolerate drought and adverse soil conditions and showed higher photosynthetic efficiency and sink capacity as compared to the cv. used as root stocks. (*Author's summary*) D02

0090-9556 LORENZI, J.O. **Competição de cultivares de mandioca.** (*Evaluating cassava cultivars*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.176-179. Port., 3 Refs.

Cassava. Cultivars. Field evaluation. Selection. Cultivation. Brazil.

The procedures to be carried out when evaluating cassava germplasm are outlined: multiplication and selection of varieties, planting date and site, preparation of the cuttings, planting, choice of experimental design, analyses to be made during the experiment and characters to be evaluated at harvest. (*Summary by T.B.*) D02

0091-8128 LOZANO, J.C. *et al.* **Production of cassava planting material.** Cali, Colombia Centro Internacional de Agricultura Tropical. Series GE-17. 1977. 28p. Engl., Sum. Engl., 27 Refs , Illus.

Also in Spanish and Portuguese.

Cassava. Propagation materials. Cuttings. Viroses. Mycoses. Bacterioses. Mycoplasmoses. Injurious insects. Storage. Timing. Temperature. Production. Colombia.

Quality cassava "seed" production depends on several factors, including type of material used, sanitary conditions and storage. The quality of the seed per se is determined by stem age, no. of nodes/cutting, thickness of the cutting, varietal differences in germination, and the extent of mechanical damage that the cutting may suffer when it is being prepared, transported and planted Seed quality can be reduced by the presence of systemic, localized or soil-borne pathogens, as well as by attack of mites and insects found on the surface of the stem cutting, within the stem, and/or in the soil. Storage generally reduces germination of cuttings as a result of dehydration or attack by pathogens and other pests during the storage period. Those problems related to cassava planting material are discussed fully and illustrated by color plates; practical recommendations are made, whereby it is possible to store cuttings for periods of more than 30 days. (*Author's summary*) D02

0092-9418 MAKANJUOLA, G.A. **The semi-automatic device for planting cassava stem cuttings on ridges.** Appropriate Technology 2(4):24-25 1975. Engl., Sum. Engl , 7 Refs , Illus.

Cassava. Cuttings. Planting. Mechanization. Agricultural equipment. Nigeria.

A description is given of a mechanical device for planting cassava stem cuttings on freshly made ridges. The machine consists of a disc ridge and a semiautomatic planter For a multirow operation, there will be as many units of the planting device as there are no. of ridges. The machine can be manufactured locally, with the exception of the ridger discs and bearings. (*Author's summary*) D02

0093-9729 MARTINEZ M., V. **Efectos fitotóxicos en yuca (*Manihot utilissima* Pohl) inducidos por ocho herbicidas aplicados a un suelo de sabana.** (*Phytotoxic effects in cassava due to herbicides applied in a savanna soil*). Jusepín, Venezuela, Universidad de Oriente Escuela de Ingeniería Agronómica, 1967. 32p. Span., Sum. Span., 2 Refs., Illus.

Cassava. Herbicides. Toxicity. Analysis. Leaves. Chlorosis. Venezuela.

A study was made of the physiological and phytotoxic effects of 8 herbicides on cassava cv. 2001, grown in pots, with a total of 64 treatments and 3 replications. Photos were taken at different stages of plant growth. A mathematical evaluation was made by means of nonparametric observations using an arbitrary phytotoxic scale. Diuron, linuron and atrazine were the most toxic, producing death of plants at 8 kg/ha and severe effects at lesser concentrations These 3 herbicides are readily absorbed and symptoms were 1st noted in the apical parts of mature leaves. Since diuron did not produce toxic effects until 2 kg/ha (a rate frequently used in weed control), it may be considered a promising treatment for cassava. Premerge and pentachlorphenol did not produce noticeable harmful effects except at high rates; however, the former had no residual effect because it is easily lixiviated. 2,4-D, amino triazole and trichloroacetic acid had little effect on cassava growth. Further work is being done to make specific recommendations for using these herbicides on cassava. (*Summary by T.M.*) D02 C03

0094-1195 NORMANHA, E.S. and PEREIRA, A.S. **Resultados experimentais sobre épocas de plantio da mandioca.** (*Experimental results of planting dates for cassava*). Revista de Agricultura (Piracicaba) 22(4/6)·135-142. 1947. Port.

Cassava. Field experiments. Planting. Timing. Tuber productivity. Starch productivity. Brazil.

Planting dates for cassava in the state of São Paulo (Brazil) were determined after 2 yr of experiments at Campinas. Planting was done the 15th of each month from June-Oct. during the 1st yr and from May-Oct., the 2nd yr. Sprouting of cuttings took 102, 72, 41 and 10-20 days, respectively, the 1st yr. Best yield was obtained in the July planting (55 t/24,200 m²), followed by June and Aug. (51.1 and 48.7 t, respectively). Sprouting was much faster the 2nd yr since rainfall was greater in June than the yr before. Yields were also better: 90.5 t for July and 75 t/24 200 m² for Aug. It is concluded that cassava should be planted during the harvest period (May-July), which would also solve the problem of storing the branches for planting material; production and starch content are also increased. (*Summary by J S. Trans. by T.B.*) D02 D03

0095-9554 NORMANHA, E.S. **O plantio da mandioca.** (*Planting cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.190-197. Port.

Cassava. Cuttings. Planting. Timing. Spacing. Brazil.

The following aspects of planting cassava are discussed: selection of stems for cuttings, preparation of the land, planting depth and position, planting dates in several regions of Brazil and spacing. (*Summary by T.B.*) D02

0096-3556 NUNES, W. DE O. *et al.* **Espaçamento para mandioca (*Manihot esculenta*) em solos fluminenses de baixa fertilidade. (*Spacing for cassava in low-fertility soils*).** Pesquisa Agropecuaria Brasileira. Serie Agronomia 11:59-64. 1976. Port., Sum. Port., Engl., 8 Refs.

Cassava. Field experiments. Spacing. Tuber productivity. Brazil.

An evaluation was made of between-row (1.0, 1.2 and 1.4 m) and in-row spacing (0.5, 0.7 and 0.9 m) in low-fertility soils of 3 counties in the main cassava-producing area of the state of Rio de Janeiro (Brazil). There was no significant difference in between-row spacing with regard to total root production, independent of location, obtaining approx yields of 15,400 kg/ha. A spacing of 0.50 m between plants gave the highest yield (16,184 kg/ha); there was a difference of approx 765 kg/ha between this and the other 2 treatments. For commercial (20-40 cm long) and industrial (30-50 cm long) roots, best between-row spacing was 1.4 m, increasing production 6.2 and 7.8%, respectively, as compared to the 1-m spacing. For in-row spacing, 0,9 m was best, giving yield increases of 3 and 5.1% for commercial roots and 5.1 and 7.6% for industrial roots, in comparison to the 0.7 and 0,5 m treatments, respectively. (*Author's summary*) D02 D03

0097-9553 SAMPAIO, C.V. **Densidade de plantio. (*Planting density*).** *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.198-200. Port., 10 Refs.

Cassava. Spacing. Brazil.

A short literature review is made of planting densities for cassava. In the state of Bahia (Brazil), a spacing of 1.00 x 0.60 x 0.50 m is optimum since it permits rapid soil coverage and thus economizes on weeding. For early-maturing or leafy var. (for forage) or mechanized planting, different spacing would be necessary. (*Summary by T.B.*) D02

0098-9555 SEIXAS, B.L.S. **Preparo do solos. (*Land preparation*).** *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.183-199. Port.

Cassava. Land preparation. Ploughing. Tuber productivity. Brazil.

Preparation of the land depends on type of vegetative covering, soil type, topography and rainfall. Plowing and grading are essential; in some cases, furrowing is also required. Results are given in table form of soil analyses in different regions of Bahia to determine resistance to plow penetration. Traction powers required are also given. Results are given of experiments evaluating the effect of plowing depth (0.10, 0.15 and 0.20 cm) on yield of 2 cassava cv. (*Summary by T.B.*) D02

0099-9423 SILVA, A.A. DA. **Experimento fatorial de posição de plantio e tamanho da estaca de mandioca. (*Factorial evaluation of planting position and size of cassava cuttings*).** *In* Reunião de Investigação Agronômica do Nordeste, 1a., Recife, Brasil, 1958. Anais. Recife, 1958. p.127. Port.

Cassava. Cuttings. Planting. Field experiments. Brazil.

A table is given showing results of 2 experiments evaluating cassava cutting size (10-20 cm) and planting position (horizontal, vertical, slanted). Highest av yields were obtained with cuttings

planted at an angle: 23.6 t/ha for 20-cm and 22.4 t for 10-cm cuttings. There was no significant difference between planting at an angle and vertically, but there was between slanted and horizontal positions. (*Summary by T.M.*) D02

0100-4127 VALLES P., C.R. **Comparativo de herbicidas para el control de malezas en yuca (*Manihot esculenta* Crantz) en Tarapoto. (*Evaluation of herbicides for weed control in cassava grown at Tarapoto*). Tarapoto, Perú. Centro Regional de Investigaciones Agropecuarias del Oriente.** Avances en Investigación 1(1):15-18. 1977. Esp., 8 Refs.

Cassava. Field experiments. Weeds. Weeding. Herbicides. Tuber productivity. Peru.

A completely randomized block design with 11 treatments and 4 replications was used to evaluate preemergence herbicides for controlling weeds (*Digitaria sanguinalis, Cassia occidentalis, Euphorbia hirta, Ipomoea purpurea, Leptochloa filiformis, Momordica charantia, Malvastrum americanum, Portulaca oleracea, Chloris radiata*) in cassava grown at the experiment station in Tarapoto (Peru). The early-maturing var. Auqina Amarilla was used (av yield 24 t roots/ha). Floumeturon (Cotoran 80 WP) at 3.9 kg a.i./ha gave the best results (27.3 t roots), which was not significantly different from the continuously weeded control (23.6 t). At 2.4 kg a.i., this product also gave good results, comparable to the other herbicides (15-16 t roots/ha), except for atrazine (Gesaprim WP) which gave poor results (5.4-7.9 t roots). The yield of the unweeded control was 0.15 t. (*Summary by T.B.*) D02

0101-9426 WAHAB, A.H., ROBINSON, P.F. and HASSAN, I. **Mechanized planting of cassava (*Manihot esculenta* Crantz) stem cuttings on Guyana's light peats and peaty clays.** Turrialba 27(2):137-141. 1977. Engl., Sum. Engl., Span , 1 Ref., Illus.

Cassava. Cuttings. Planting. Timing. Mechanization. Labour. Costs. Agricultural equipment. Field experiments. Guyana.

Cassava is changing its status in Guyana from a traditional minor crop to a commercial one. Efforts to mechanize this operation resulted in the design, construction and trial of a cassava stem-cutting machine and a 3-row planter. Comparative field studies were conducted in manual vs. mechanized operations in flat and ridged fields Irrespective of soils, type of field preparation and planting method, overall plot stands at 52 days ranged from 86-105% of the expected standard density. There was no significant difference in overall fresh root yield at 12 mo (18-5 t/ha using an unimproved local variety), irrespective of planting method and field layout Machine specifications are given. Costs and economic comparisons are discussed (*Author's summary*) D02

See also 0019 0021 0024 0048 0059 0112 0391 0402

D03 Energy Productivity and Yields

0102-4023 ALMEIDA, F.C.G. and PAIVA, J.B. **Competição de variedades de mandioca** *Manihot utilissima*, Pohl. (*Evaluation of cassava varieties*). Ciência Agronômica 1(1):27-29. 1971. Port., Sum. Engl., 6 Refs., Illus.

Cassava. Field experiments. Cultivars. Tuber productivity. Brazil.

An evaluation was made of 10 cassava var. on an alluvial soil at the experimental farm in Pentecoste (Ceará, Brazil). The sweet cassava var. Aciolina yielded best (26.6 t/ha, 64% more than the control). (*Author's summary*) D03

0103-9717 CASTRO, J.F. DE **Mandioca: competição de variedades.** (*Regional cassava varietal trials*). Boletim de Agricultura 3(11/12):77-78. 1954. Port.

Cassava. Field experiments. Cultivars. Tuber productivity. Spacing. *Xanthomonas manihotis*. **Brazil.**

Results are given in table form of an evaluation of 46 cassava var. for yield and resistance to CBB, conducted at the Lavras experimental research station (Brazil) from 1946-54. The effect of planting distance was evaluated with Vassourinha 523 in Lavras and with Jatobá in Patos de Minas. Best yields (12,776 and 17,852 kg/ha) were obtained at 80 x 20 and 100 x 20 cm, respectively. (*Summary by T.M.*) D03

0104-7361 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. SECTEUR DU DAHOMEY. **Manioc.** (*Cassava*). *In*____. Rapport du Campagne 1972. Porto Mono, Dahomey, 1973. pp.111-117. Fr.

Cassava. Cultivars. Identification. Tuber productivity. Cassava mosaic virus. Resistance. Starch productivity. Dahomey.

Results are given in table form of experiments on cassava conducted by the Institut de Recherches Agronomique Tropicales et des Cultures Vivrières at Dahomey in 1972. Local as well as imported (Madagascar) varieties were evaluated on the basis of no. and wt of roots/plant, starch content, cortex and pulp color, taste and resistance to cassava mosaic. Results at 11, 15 and 18 mo are also given of breeding trials with local and foreign varieties, which were studied on the basis of the same aspects, except for cortex and pulp color. (*Summary by S.S. de S. Trans. by I.B.Z.*) D03

0105-8737 MACHADO, E.L. **Cultivares de mandioca (*Manihot utilissima*) para obtenção de massa verde. (*Cassava varieties for forage production*).** Agronomia Sulriograndense 11(1):69-73. 1975. Port., Sum. Port., Engl., 6 Refs.

Cassava. *Manihot esculenta*. Leaves. Stems. Production. Cultivars. Field experiments. Productivity. Forage. Brazil.

Four experiments were conducted during the 1st growth cycle and 3 in the 1st and 2nd growth cycles of 17 cassava cultivars from the collection of the experimental station at Taquari, Rio Grande do Sul (Brazil) to evaluate them for forage production. The most productive cultivars were S6-118, bitter Pernambucana P-11 and the sweet Taquara R 13. It was found that 150% more foliage was produced during the 2nd than in the 1st growth cycle. (*Author's summary*) D03

0106-8362 PINSTRUP-ANDERSEN, P. and DIAZ, R.O. **Estimación de pérdidas en la producción de yuca debidas al efecto de diferentes factores. (*Estimate of losses in cassava production due to different factors*).** *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. 7p. Span., Sum. Span.

Cassava. Productivity. Soil requirements. Mineral deficiencies. Diseases and pathogens. Injurious insects. Cultivation systems. Colombia.

Results of the analysis of a multiple regression model showed that potential yield-limiting factors for all cassava growers in Colombia are adverse rains when the crop is 0-4 mo old, ants, the percentage of the plantation affected by CBB, *Phoma* sp. and superelongation; intercropping; soil texture, P content and acidity. It is calculated that total yields could be increased 8% if these factors were controlled. (*Author's summary. Trans. by T.M.*) D03

See also 0011 0048 0052 0055 0064 0065 0066 0069 0071 0083 0094 0096 0210 0212 0214 0215 0313 0389 0391 0395

E01 General Descriptive Studies

0107-1207 LOZANO, J.C. El peligro de introducir enfermedades y plagas de la yuca (*Manihot esculenta* Crantz) por medio de material vegetativo de propagación. (*The threat of introducing diseases and pests on cassava planting material*). Fitopatología Colombiana 6(2):93-100. 1977. Span., Sum. Engl., Span., 30 Refs.

Cassava. Disease transmission. Disease control. Cassava programs. Bacterioses. Mycoses. Viroses. Colombia.

Cassava pathogens and pests are still found in limited geographical areas; however, as cassava is propagated vegetatively, the distribution of planting material among continents, countries or even geographical regions is a threat for cassava cultivation because of the risk of disseminating diseases and pests. After discussing these risks, preventive control measures are suggested. (*Summary by T.B.*) E01

0108-9850 LOZANO, J.C. General considerations on cassava pathology. *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.17-27. Engl., Sum. Engl., 58 Refs.

Cassava. Viroses. Bacterioses. Mycoses. Mycoplasmoses. Disease control.

The increase in the area planted to cassava has increased the pathological and entomological problems of this crop. Emphasis is placed on the little research that has been undertaken in the field of cassava pathology, as well as the lead that the international centers have now taken in this respect. At the national level, special programs have already been established in Brazil, Mexico, Thailand, the Philippines, Malaysia and India. At present, more than 30 diseases of cassava induced by viruses, mycoplasmas, viruslike causal agents, bacteria and fungi have been reported. The principal characteristics of the causal agents are summarized in table form. The special characteristics of cassava that should be taken into consideration by plant protection specialists when designing research programs are discussed. The following methods of control are recommended: (1) establishment of quarantine regulations for imported planting material and formation of centers to produce certified cassava seed; (2) cultural control methods — host eradication, crop rotation, sanitary measures, improvement of growing conditions, preventive measures against high soil moisture and the use of tissue culture techniques to produce AMV - and CBB-free plants; (3) biological control; (4) physical control methods — microwave, ultraviolet and heat treatments; and (5) chemical control. The major problems that may be encountered by plant pathologists during the screening and evaluation of varieties are discussed briefly.(*Summary by S.S. de S. Trans. by I.B.Z.*) E01

0109-9257 MATHAR, A.S., FERNANDO, X.S. and RAMU, N. **Preliminary studies on the control of vascular streaking in the tubers of tapioca.** Farm Science 4(5) 5-8. 1977?. Engl., Sum. Engl., 8 Refs.

Cassava. Tubers. Storage. Deterioration. Disease control. India.

Studies on the control of vascular streaking and storage life of cassava roots indicated that wax coating and Bavistin 0.1% treatment were effective in controlling vascular streaking, giving a storage lige up to 30 days. Hypochlorite 10 0% and Captan 0 1% were also effective, but with a storage life up to only 15 and 21 days, respectively. (*Author's summary*) E01

110-1201 PERSLEY, G.J. **Report on cassava disease survey in Tanzania, 9-28 January, 1978.** -Ibadan, Nigeria, International Institute of Tropical Agriculture, 1978. 12p. Engl.

Cassava. ***Xanthomonas manihotis. Cercospora henningsii. Cercospora caribaea. Cercospora vicosae. Mononychellus tanajoa.*** **Pest damage. Maps. Tanzania.**

A trip was made to 45 farms and 5 experiment stations in Tanzania from 9-29 Jan. 1978 to survey the distribution and severity of cassava diseases. The following diseases were found: CBB (*Xanthomonas manihotis*), African cassava mosaic, anthracnose (*Glomerella manihotis*) and leaf spots caused by *Cercospora* spp. The green cassava mite *Mononychellus tanajoa* was also recorded. Based on findings, a few recommendations are given. (*Summary by T.B.*) E01 F01

0111-6820 TERRY, E.R. and OYEKAN, J.O. **Cassava diseases in Africa reviewed.** Span. Progress in Agriculture 19(3).116-118. 1976. Engl., 21 Refs., Illus.

Cassava. *Manihot esculenta.* **Cassava brown streak virus.** *Xanthomonas manihotis Glomerella cingulata Cercospora henningsii. Cercospora caribaea. Cercospora vicosae. Phytophthora. Fomes lignosus.* **Cassava African mosaic virus. Disease control. Africa.**

The geographic distribution in Africa, symptoms and control methods are presented for the major diseases of cassava caused by viruses, bacteria and fungi Discussed are African mosaic, brown streak, bacterial blight, anthracnose, Cercospora leaf spots and root rots caused by *Phytophthora* spp. and *Rigidoporous (Fomes) lignosus.* (*Summary by T.M.*) E01

0112-3104 ZARATE R., R.D. and PRADA S., F.L. **Métodos terapéuticos en cangres de yuca** (*Manihot esculenta* Crantz): **Efecto en la germinación e inactivación de algunos agentes patogénicos transmitidos** por semilla asexual. (*Therapeutic methods in cassava cuttings: effects on germination and inactivation of several pathogenic agents borne by asexual seed*). Tesis Ing. Agr. Palmira, Universidad Nacional de Colombia. Facultad de Ciencias Agropecuarias, 1977. 51p. Span., Sum. Span., Engl., 27 Refs., Illus.

Cassava. Cuttings. Propagation materials. Disease control. Germination. Hot water treatments. Mycoses. Bacterioses. Colombia.

An experiment was conducted to determine the effects of 3 physical-therapeutic methods (hot water, microwave and UV light treatments) on the germination of cassava cuttings and their possible use as inactivating agents of several pathogens causing diseases in this plant. Results indicated that optimum points of tolerance were 52°C for 30 min for hot water and 90 s for the microwave treatment. Up to 7 h exposure to UV light had no effect on cutting germination. The hot water and microwave treatments at their optimum values controlled *Botryodiplodia* sp. and *Glomerella* sp., both causing necrosis of the cutting, and the causal agent of superelongation;

however, they were not effective in controlling CBB. In in vitro tests CBB was inactivated by hot water at 58°C in 40 min and in 45 s by microwave treatment. *Botryodiplodia* sp. and *Glomerella* sp., which were found in association, were inactivated at 57°C in 60 min (spore suspensions) or 30 s microwave treatment for mycelial cultures. UV light had no inactivating effects on any of these pathogens. (*Author's summary*) E01 D02

See also 0205

E02 Bacterioses

0113-9422 ADENIJI, M.O. and OBIGBESAN, G.O. **The effect of potassium nutrition on the bacterial wilt of cassava.** Nigerian Journal of Plant Protection 2:1-3. 1976. Engl , Sum. Engl., 8 Refs.

Cassava. *Xanthomonas manihotis.* **K. Minerals. Field experiments. Tuber productivity. Nigeria.**

The reaction of a susceptible and a tolerant cassava cv. to infection by cassava bacterial blight was studied under 4 levels of K nutrition (0-60-90-120 kg K_2O/ha). At 0 and 60 kg K, wilt was 74.4 and 70.5 and 56.2 and 44.4% in susceptible and tolerant cv., respectively. Significant reduction in wilt was obtained at 90 kg K in both cv. Highest fresh root yields were also recorded at this level of K. (*Author's summary*) E02 D01

0114-1475 ARENE, O B **Influence of shade and intercropping on the incidence of cassava bacterial blight.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. pp.28-29. Engl., 2 Refs., Illus.

Cassava. *Xanthomonas manihotis.* **Inter-cropping. Shading. Nigeria.**

Results are given of 2 experiments conducted to determine the effect of shading and intercropping on CBB incidence Soil infestation per se was not significant in contributing to no. of diseased shoots, but shading significantly affected disease incidence, CBB being higher in unshaded pots. Highest incidence (22.8%) was found in cassava planted alone; this was significantly higher than in any of the 3 intercropping treatments. The reasons for this are discussed briefly. (*Summary by T.B.*) E02 K01

0115-1467 DOKU, E.V. and LAMPTEY, P. **Control of cassava bacterial blight in Ghana.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. p.22. Engl.

Cassava. *Xanthomonas manihotis.* **Disease control. Ghana.**

CBB was 1st reported in Ghana in 1975. Preventive and eradicant control measures are outlined. (*Summary by T.B.*) E02

0116-1474 EZELIO, W.N.O. **Control of cassava bacterial blight in Nigeria.** *In* Persley, G., Terry, R.E. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa. Canada, International Development Research Centre. IDRC-096e. 1977. pp.15-17. Engl., 4 Refs.

Cassava. Cassava programs. *Xanthomonas manihotis*. Disease control. Resistance. Cultivars. Nigeria.

CBB was 1st reported in Nigeria in 1972, and by 1973 estimated yield losses were 75%. Preliminary control measures recommended by the Federal Agricultural Research & Training Stations, Umudike are listed. The objectives and strategies for achieving these objectives including cultural practices of the Cassava Program of the National Accelerated Food Production Project are discussed briefly. (*Summary by T.B.*) E02

0117-1185 EZUMAH, H.C. and SEBASIGARI, K. **Control of cassava bacterial blight in Zaire.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. pp.20-21. Engl., 7 Refs.

Cassava. *Xanthomonas manihotis*. Disease control. Clones. Resistance. Selection. Cassava programs. Zaire.

CBB was 1st reported in Zaire in 1970 and has since spread to many parts of the country, seriously affecting the supply of vegetable protein. Screening work being done by the Programme National Manioc to find field-resistant clones is discussed briefly. Preliminary data suggest that there is a correlation between CBB severity and soil fertility. (*Summary by T.B.*) E02

0118-4533 GONÇALVES, R.D. **A bacteriose da mandioca no vale do Paraiba.** (*Cassava bacterial blight in the Valley of Paraiba*). Biológico 5(6):117-118. 1939. Port

Cassava. *Xanthomonas manihotis*. Disease control. Brazil.

The importance of cassava bacterial blight in the central region of the state of São Paulo and surrounding areas is discussed. The main symptoms of the disease are described and control measures recommended. Planting the var. Vassourinha is recommended since it is resistant (*Summary by T.M.*) E02

0119-1409 HAHN, S.K. and HOWLAND, A.K. **Breeding for resistance to cassava bacterial blight.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre IDRC-096e 1977. p.23. Engl.

Cassava. Cassava programs. Plant breeding. *Xanthomonas manihotis*. Resistance. Nigeria.

From 1972-76 top priority was given by the Root & Tuber Improvement Program at IITA to breeding for resistance to CBB. The most outstanding clones have already been made available to farmers (*Summary by T.B.*) E02 G01

0120-1476 HEYS, G. **Cassava improvement in the Niger Delta of Nigeria.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976.

Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. pp.18-19. Engl.

Cassava. Cassava programs. *Xanthomonas manihotis*. Disease control. Cultivars. Selection. Resistance. Nigeria.

The Shell-BP Petroleum Development Company's activities in the Niger Delta (Nigeria) are discussed briefly with regard to the screening of cassava clones for CBB resistance and high yield potential. This work is being done in cooperation with IITA and the Ministry of Agriculture. (*Summary by T.B.*) E02

0121-3181 IKOTUN, B. **Cassava bacterial blight disease caused by *Xanthomonas manihotis* (Arthaud-Berthet y Bondar) Starr (CBB). Ph.D. Thesis. University of London. Imperial College of Science and Technology, 1975. 242p. Engl., Sum. Engl., 304 Refs., Illus.**

Cassava. *Xanthomonas manihotis*. Etiology. Laboratory experiments. Disease control. Disease transmission. Analysis. Field experiments. Colombia.

Several strains of the cassava blight bacterium from Africa, South America and Asia were compared. The isolates were sufficiently similar to be regarded as strains of one species, different from *Xanthomonas cassavae* in several respects and now placed in *X. manihotis*. Although *X. manihotis* did not survive long in soil, it survived better in neutral than in acid soils. Below 10^4 cells/g of soil, infection was not obtained through soil splash. The pathogen survived > 24 mo in field-collected exudates and for > 30 mo in artificially inoculated stems. Burning of infected material is recommended Disease dissemination by insects was greater in attractant-treated than in insecticide-treated and control plots. Controlling insects delayed but did not prevent disease spread; therefore, field sanitation rather than insect control is recommended to decrease its spread. *X. manihotis* and *X. cassavae* multiplied in intercellular spaces of plant tissue where enzymatic degradation of pectic substances commenced. Cells were separated but cellulose microfibrils were not degraded. Plasmalemmae of adjacent cells were removed from cell walls and cytoplasm was plasmolyzed. Cell contents were dispersed by *X. manihotis* and brought together by *X cassavae*. Both are parenchyma rather than vascular pathogens as *X. manihotis* has been regarded previously. Enzymes involved in cell wall degradation, cell separation and tissue disintegration were probably polygalacturonase/polytranseliminase, with an optimum pH of 9. The role of extracellular bacterial polysaccharide produced by *X. manihotis* in pathogenesis is still unclear. It is likely that a toxin is involved in the production of yellow chlorotic haloes surrounding the leaf spots caused by *X. cassavae* but not by *X. manihotis*. (*Author's summary*) E02

0122-1407 IKOTUN, T. **Survival of *Xanthomonas manihotis*, the cassava bacterial blight pathogen.** *In* Persley, G., Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. pp.24-27. Engl., 14 Refs., Illus.

Cassava. *Xanthomonas manihotis*.

Results are given of experiments studying the survival of the CBB pathogen in the soil and in infected cassava stems. Comparison of survival times of *X. manihotis* in bacterial exudate and host tissues indicated that the soil is not a favorable niche for survival. Because of the long periods of survival in exudates and plant material, it is important to remove and burn infected plant parts to prevent disease carry-over. Disease-free planting material should be used to prevent the establishment of CBB in new plantations. (*Summary by T.B.*) E02

0123-3120 MATTOS C., L.L. **Bacteriosis del tallo de la yuca (*Manihot esculenta* Crantz). (*Cassava stem bacteriosis*).** Tesis Mag. Sc. Lima, Perú, Universidad Nacional Agraria La Molina, 1977. 83p. Span., Sum. Span., 40 Refs., Illus.

Cassava. Stems. *Erwinia*. Etiology. Epidemiology. *Anastrepha pickeli*. Disease transmission. Colombia.

A detailed description is given of a bacterial disease causing stem rot in cassava. The disease is characterized by total maceration of the young (green) stem tissue, in the mature (lignified) stem parts the disease is localized in the medular tissue, which becomes necrosed, turning reddish to dark brown in color. The causal agent belongs to the group *Erwinia*, possibly in the *E. carotovora* var *carotovora* group. It has previously been described as *E. cassavae;* differences in symptomatology and certain taxonomic characteristics are discussed With regard to etiology, the cultural, morphological, biological, physiological, biochemical, nutritional and serological characteristics of this Gram-negative, rod-shaped, peritrichous organism are dealt with in detail. The disease is severest during the rainy season. The pathogen is capable of multiplying on the host under conditions of high RH; it later penetrates host tissue via wounds caused by fruit flies (*Anastrepha* spp.). Means of dissemination are discussed. The disease affects the viability of planting material, causing a loss in germination as well as in production Since the insect/pathogen relationship is decisive in the incidence of the disease, the best method of control would be the use of var. resistant to the insect or direct control of the insect itself (*Summary by T B*) E02

0124-1477 MOREIRA, L.C., TAKATSU, A. and CALDAS, L.S **Recuperação de plantas de mandioca livres de *Xanthomonas manihotis* através da cultura de meristemas. (*Obtaining cassava plants free from Xanthomonas manihotis using meristem culture*).** Fitopatologia Brasileira 2(3).217-223. 1977. Port., Sum. Port., Engl., 12 Refs., Illus.

Cassava. Plant tissues. Growth-chamber experiments. Plant-growth substances. *Xanthomonas manihotis*. Tissue culture. Disease control. Brazil.

Using Kartha & Gamborg's method (1975) with some modifications, a high % of the meristem cultures obtained from stems severely infected with *Xanthomonas manihotis* developed into healthy plants and could be transplanted to pots. Modifications of the nutrient medium were the substitution of kinetin (0.1 mg/liter) for benzyladenine and the use of gibberellic acid at 5×10^{-7} M. (*Author's summary*) E02

0125-8729 PAILY, P.V., REMA DEVI, L. and MENON, M.R **Bacterial wilt of cassava (*Manihot esculenta* Crantz) in Kerala.** Agricultural Research Journal of Kerala 13(1).107-109. 1975. Engl., Sum. Hindi., 4 Refs

Cassava. *Manihot esculenta*. *Xanthomonas manihotis*. India.

A report is given of a bacterial wilt of cassava in Kerala (India), the symptoms of which are described. Of the different inoculation methods tested, leaf inoculation without injury was the most successful. Varietal differences were found: Malayan-4 showed leaf spotting only, H-165, wilting and bacterial exudation from petioles; other susceptible varieties, wilting alone. Although symptoms are not in complete agreement with those reported for CBB, it appears that the causal agent is *Xanthomonas manihotis* since symptomatology depends on varietal reaction and environmental conditions. (*Summary by T.M.*) E02

0126-1202 PERSLEY, G.J. **Report on visit to Togo and Ghana, 15-22 December, 1975.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1975. 8p. Engl., 5 Refs.

Cassava. *Xanthomonas manihotis*. Cassava programs. Ghana. Togo.

A trip was made to Togo and Ghana in Dec. 1975 to confirm the presence of CBB in these countries. At present its distribution appears limited so it may be possible to restrict its spread by controlling the movement of diseased planting material. Possible cooperative activities with IITA are discussed. (*Summary by T.B.*) E02

0127-1406 PERSLEY, G.J. Distribution and importance of cassava bacterial blight in Africa. *In*_____. Terry, E.R. and MacIntyre, R., eds. Workshop on Cassava Bacterial Blight, Ibadan, Nigeria, 1976. Report. Ottawa, Canada, International Development Research Centre. IDRC-096e. 1977. pp 9-14 Engl, 14 Refs., Illus.

Cassava. *Xanthomonas manihotis*. Maps. Africa.

Information is given on the geographic distribution of CBB in Africa, based on surveys in Benin, Cameroon, Ghana, Nigeria and Togo. The possible origin and recent changes in disease severity are also discussed. (*Summary by T.B.*) E02

0128-1203 PERSLEY, G.J. Technical report on IDRC cassava bacterial blight project. Ibadan, Nigeria, International Institute of Tropical Agriculture, 1977. 21p. Engl., Illus.

Cassava. Cassava programs. *Xanthomonas manihotis*. Ecology. Disease transmission. Epidemiology. Resistance. Maps. Africa

The aim of this IDRC-sponsored project is to find control methods for CBB (*Xanthomonas manihotis*) in Africa. The following aspects are discussed: distribution in Africa, ecology (seed transmission, sources of inoculum, epiphytic populations), epidemiology (effects of environmental factors and NPK on disease development, time of planting), biology (bacteriophages, variation in pathogenicity, inoculation methods), resistance (screening in the greenhouse). (*Summary by T.B.*) E02

0129-1204 PERSLEY, G.J. Report on cassava disease survey in Kenya. Ibadan, Nigeria, International Institute of Tropical Agriculture, 1978. 18p. Engl.

Cassava. *Xanthomonas manihotis*. Epidemiology. Maps. Kenya.

A survey was made of cassava diseases on local farms and 4 experiment stations in western Kenya in Feb. 1978 to determine whether CBB (*Xanthomonas manihotis*) and a bacterial leaf spot (*X. cassavae*) occurred and to assess damage caused. The frequency and severity of CBB, African cassava mosaic, anthracnose (*Glomerella manihotis*) and Cercospora leaf spots were noted. The green mite *Mononychellus tanajoa* was also recorded High CBB incidence was reported with severe damage on both farms and experiment stations. The existence of *X cassavae* was not confirmed; it may be a yellow variant of *X. manihotis*. Recommendations are made on the basis of findings (*Summary by T.B.*) E02

0130-8938 ROBBS, C.F. *et al.* Variações em *Xanthomonas manihotis* (Arthand Berthet) Starr. (*Variations in Xanthomonas manihotis*). Revista da Sociedade Brasileira de Fitopatologia 5.67-75. 1972. Port., Sum. Engl., 8 Refs., Illus.

Cassava. *Xanthomonas manihotis*. Brazil.

A bacterium identified as *Xantomonas manihotis* was isolated from cassava plants showing necrotic leaf spots in the state of Guanabara (Brazil). Inoculation tests using 2 local cassava varieties (Saracura and Rosa) revealed that the organism was unable to induce systemic wilting symptoms. Studies were perfomed comparing the new strain with typical isolates of *X. manihotis* known to cause both necrotic and systemic symptoms, and with the African cassava leaf spot organism *X. cassava*, obtained from England (NCPPB-101). No significant differences were detected in morphological, cultural and biochemical characteristics of the isolates studied, except for the yellow pigment present in the cultures of NCPPB-101. Differences were obvious with respect to the type of symptoms produced on inoculated cassava plants. The Guanabara isolate (ENA-300) and the African pathogen (NCPPB-101) caused only necrotic, angular leaf spots, very similar in aspect and size. Even when the inoculum was placed on the stems following the removal of petioles, these isolates were incapable of inducing wilt. On the other hand, the 3 other Brazilian isolates of *X. manihotis* included in the study (ENA-693, ENA-828 and ENA-858) produced the typical wilting symptoms as a result of both leaf and stem inoculations. When leaves were inoculated, the resulting spots enlarged rapidly, causing a progressive yellowing of the adjacent tissues followed by a wilting of the petioles. Based on these results, it is suggested that *X. cassava* may be considered as a synonym of *X. manihotis* and simply referred as a yellow variant of the latter. (*Author's summary*) E02

0131-9548 TAKATSU, A. **Doenças causadas por bactérias.** (*Diseases caused by bacteria*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.417-425. Port., 19 Refs.

Cassava. *Xanthomonas manihotis*. **Etiology. Epidemiology. Bacterioses. Disease control. Brazil.**

The following aspects of CBB (*Xanthomonas manihotis*) are discussed briefly: geographic distribution, symptomatology, etiology, epidemiology, infection and manifestation of symptoms, survival in the soil, the obtention of disease-free material. Mention is made of *Erwinia cassavae* and the genera *Bacillus*, *Corynebacterium* and *Pseudomonas*. (*Summary by T.B.*) E02

0132-9842 TERRY, E R. **Cassava bacterial diseases.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.75-84. Engl., Sum Engl., 41 Refs., Illus.

Cassava. *Xanthomonas manihotis*. *Erwinia*. **Disease transmission. Vectors. Etiology. Disease control. Maps. Africa.**

Bacterial diseases of cassava — leaf spots, stem rot and blight — are discussed, with emphasis on cassava bacterial blight (*Xanthomonas manihotis*) in Africa. The following aspects are dealt with in detail: distribution in Africa, factors contributing to the pattern of CBB development (cultivation systems, rainfall and soil conditions), economic importance, etiology and symptomatology, factors influencing dissemination of the disease (propagating material, vectors, rainfall, soil conditions, sources of inoculum) and integrated control. Yield losses range from 14-100%, depending on variety, locality, time of year and cultivation system. CBB also reduces starch content and availability of planting material and foliage as a source of protein. (*Summary by A.J. Trans. by T.M.*) E02

0133-9719 VALE H., H. **La bacteriosis de la yuca: enemigo potencial del cultivo de la yuca en la cuenca del Lago de Maracaibo.** (*Cassava bacterial blight: potential threat in the Maracaibo Lake region*). Agro Información 2(5):17-20. 1977. Span., Illus.

Cassava. *Xanthomonas manihotis.* **Disease transmission. Disease control. Venezuela.**

Symptoms of CBB are illustrated, and ways in which it is disseminated are discussed. It is recommended that propagation material should not be brought from the eastern part of Venezuela, where CBB is presently found; quarantine measures should also be passed to prevent the introduction of new diseases and pests. The establishment of centers for propagating cassava is highly recommended to guarantee disease-free material for farmers. (*Summary by T.M.*) E02

See also *0207* *0391* *0414*

E03 Mycoses

0134-9837 BOOTH, R.H. A review of root rot diseases in cassava. *In* Brekelbaum, T., Bellotti, A and Lozano, J C, eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical Series CE-14. 1978. pp.121-133. Engl., Sum Engl., 84 Refs.

Cassava. Physiological disorders (plant). Deterioration. Mycoses.

Diseases of young, swollen and harvested roots are reviewed. Pathogenic rots and some physiological disorders are discussed. The need for further research on all aspects of these diseases, particularly the role of microorganisms in causing early root damage, the nature of primary root deterioration and the development of integrated control systems appropriate for the various production and utilization situations, is stressed. (*Author's summary*) E03

0135-7414 CONCEICAO, A J DA Estudo das moléstias. (*Some pests of cassava*). *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.15-18. Port.

Cassava. *Cercospora henningsii. Cercospora caribaea. Uromyces manihotis. Phyllosticta. Rosellinia. Diplodia.* Cassava programs. Brazil.

A report is given of the diseases found in the germplasm bank at the Universidade Federal da Bahia (Brazil) and in trials carried out in different regions of the state. Leaf diseases (*Cercospora henningsii, C. caribaea, Phyllosticta* sp.), rust (*Uromyces manihotis*) and root rots (*Rosellinia* spp., *Diplodia* sp.) were found; but none was of sufficient importance to require chemical control. A parasitic fungus (*Darluca* sp.) was found in association with rust. The use of self-fertilized seeds is recommended rather than the introduction of planting material from other regions to prevent the dissemination of localized diseases such as CBB. (*Summary by T.B.*) E03

0136-9840 KRAUSZ, J.P., LOZANO, J.C. and THURSTON, H.D. Superelongation: a *Sphaceloma* disease of cassava. *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.95-99. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Cassava superelongation. *Sphaceloma manihoticola.* Etiology. Epidemiology.

A new and serious disease of cassava (*Manihot esculenta*) was first reported to be causing serious epidemics in Colombia in 1972 and has since been found in Central America, Brazil and

Venezuela. The causal organism was identified as a fungus of the species *Sphaceloma*, probably *S. manihoticola*. The disease results in extensive elongation of the internodes of infected plants and causes serious yield loss. Artificial inoculation of young cassava plants was achieved in a mist chamber, and free water was found to be necessary for conidial germination. Pathogen dissemination appears to be associated with wind-blown spores and, more extensively, with infected stem cuttings used for propagation. The pathogen also attacks *Manihot glaziovii*. Resistant germplasm within *M. esculenta* has been identified. (*Author's summary*) E03

0137-9154 LABERRY S., R. Estudio etiológico de la roya (*Uromyces* spp.) en yuca (*Manihot esculenta* Crantz) en Colombia. [*Etiology of rust (Uromyces spp) on cassava in Colombia*]. Tesis Mag Sc. Bogotá, Universidad Nacional de Colombia-Instituto Colombiano Agropecuario, 1976. 84p. Span., Sum. Span., Engl., 44 Refs., Illus.

Cassava. *Manihot esculenta*. *Uromyces manihotis*. Mycoses. Etiology. Epidemiology. Cultivars. Resistance. Maps. Colombia.

Taxonomic studies indicated that *Uromyces manihotis* is present in Brazil, Bolivia, Colombia, Costa Rica, Cuba, Ecuador, Jamaica, Dominican Republic, Trinidad and Tobago, Venezuela and Puerto Rico; *U. jatrophae* in Cuba, Mexico and Trinidad and Tobago; *U. carthagenensis* in Argentina and Brazil; and *U. manihotis -catingae*, *U. tolerandus* and *U. manihoticola* in Brazil only. Of these, only *U. manihotis* and *U. jatrophae* have been reported attacking cassava. *U. manihotis* uredospores have an optimum temp range of 20-25°C for germination after 36.h of exposure. At 1° and 35°C, there was no germination. Av spore germination was lower in the presence of light than in the dark At 81% RH or less, there was no germination; at 95 and 100% RH, germination was 18 and 68%, respectively. Infection was higher than 33% when inoculated plants were kept in a humidity chamber for 12 h or more. The period of incubation ranged from 12-15 days. The highest spore inoculum level was 25 mg diluted in 40 cc water + Tween 20 at 1%. The infection index was higher in one-mo-old plants than in plants 2- to 4-mo old. Of 72 promising cassava cultivars in the CIAT germplasm collection evaluated for resistance to *U. manihotis*, 92% were found to be resistant. Under field conditions, a high incidence of fungal parasitism by *Darluca filum* was observed on *U. manihotis* pustules. (*Author's summary*) E03

0138-9427 LARIOS C., J.F. and MORENO M , R A. **Epidemiología de algunas enfermedades foliares de la yuca en diferentes sistemas de cultivo. II. Roya y muerte descendente.** (*Epidemiology of some leaf diseases of cassava in different cultivation systems. II. Rust and dieback*). Turrialba 27(2) 151-156. 1977. Span , Sum. Engl., Span , 18 Refs., Illus .

Cassava. *Manihot esculenta*. Uromyces. *Glomerella cingulata* Epidemiology. Field experiments. Inter-cropping. Cultivation systems. Costa Rica.

The incidence and severity of cassava rust (*Uromyces* sp.) were studied in 5 different cropping patterns during the 1974-75 growing season at Turrialba (Costa Rica). The cropping patterns studied were cassava alone and associated with maize and/or beans, and sweet potatoes. The incidence and severity of dieback (*Glomerella cingulata*) was also studied in cassava alone and associated with maize and/or beans Each of these last 3 cropping patterns was studied at 2 management levels, differing primarily in amount of fertilizers and weeding frequency. Maximum severity and incidence values for rust were 2.8 and 67.7%, respectively No statistical differences were found among treatments. In every treatment the infection rate was less than 10 units/day. Dieback was more intense in cassava monoculture under a low management level. This disease was less intense in the cropping patterns including more crops and a high level of management. (*Author's summary*) E03

0139- 9838 LEU, L.S. **Concentric-ring leaf spot (*Phoma* sp.) of cassava.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977.

Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.117-120. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. *Phoma*. Etiology. Resistance. Productivity. Cultivars. Colombia.

Concentric-ring leaf spot (*Phoma* sp.) is found attacking cassava in cooler areas and in the subtropics during the rainy season. A severe attack causes defoliation and dieback, resulting in heavy yield losses. Aspects of symptomatology, etiology, economic losses and varietal resistance are discussed. Results are given of trials conducted by CIAT evaluating more than 1000 cultivars for resistance to *Phoma* sp.; only 1.7% were found to be resistant and 12.9%, tolerant. The most effective control method is using resistant cultivars. (*Summary by T.M.*) E03

0140-1484 PONTE, J.J. DA *et al.* **Podridão-seca das manivas: comportamento de estacas de dez variedades de mandioca.** (*Reaction of ten cassava varieties to stem dry rot*). Fitopatologia Brasileira 2:193-198. 1977. Port., Sum. Port., Engl., 2 Refs., Illus.

Cassava. Cultivars. Resistance. *Diplodia*. Cuttings. Laboratory experiments. Brazil.

The reaction of 10 cassava var. to the fungus *Diplodia manihoti*, causal agent of stem dry rot, was studied under laboratory conditions at the Universidade Federal do Ceará (Brazil). None of the var. was resistant. Salangó, Mamao, Olho-verde, Urubu, Aipim-mansa and Amarelinha were higly susceptible and Pipoca, Agua-morna, Aipim-brava and Manipeba, susceptible. (*Author's summary*) E03

0141-9705 PUNITHALINGAM, E. **The ascigerous state of *Phomopsis manihotis* Swarup, Chauhan & Tripathi.** Kavaka 3:29-31. 1975. Engl., Latin, Sum. Engl., 3 Refs., Illus.

Cassava. *Manihot esculenta*. *Phomopsis manihotis*. Colombia.

A fungus isolated from stem lesions of a sample of *Manihot esculenta* collected in Colombia is described as a new species, *Diaporthe manihotis* sp. nov. with a *Phomopsis* state. The *Phomopsis* state is shown to be idential to *P. manihotis* Swarup, Chauhan & Tripathi described from India. The connection between *P. manihot* Chevaugeon known from Africa and the *Phomopsis* state of *Diaporthe manihotis* is also discussed. (*Author's summary*) E03

0142-8404 ROY, A.K. **Additions to the fungus flora of Assam-I.** Indian Phytopathology 18(4):327-334. 1965. Engl.

Cassava. Mycoses. India.

As regards cassava pests, a report is given of a new species of fungus, *Periconia shyamala* A.K. Roy, found on the leaves in Assam (India). Descriptions are also given of *Cochliobolus cynodontis* Nelson (imperfect state), recorded for the 1st time in India, and *Cornynespora cassiicola* (Berk. and Curt.) Wei, a new host record; both fungi were found on the leaves (*Summary by A.J. Trans. by T.M.*) E03

0143-9714 ROY, A.K. **Some studies on *Epicoccum nigrum* on tapioca.** Science and Culture 34(9):406-407. 1968. Engl., 5 Refs.

Cassava. *Manihot esculenta*. *Epicoccum nigrum*. Mycoses. India.

A report is given of a leaf spot on cassava in India, caused by *Epicoccum nigrum*. Data are given on alternate hosts, disease symptomatology, morphological characteristics of the fungus, pathogenicity, growth on different media at several pHs, and germination of spores under different conditions. (*Summary by T.M.*) E03

0144-9041 SIVAPRAKASAM, K., KRISHNAMOHAN, G., and KANDASWAMY, T.K. **Evaluation of fungicides for the control of sett rot of tapioca caused by** *Diplodia natalensis*. Madras Agricultural Journal 63(5-7):424-425. 1976. Engl., 1 Ref.

Cassava. Cuttings. *Diplodia*. **Disease control. Laboratory experiments. India.**

An in vitro evaluation was made at Tamil Nadu Agricultural University (India) of 13 fungicides for controlling rot of cassava cuttings caused by *Diplodia natalensis*. Dipping cuttings for 15 min in solutions containing 0.1% Vitavax, Bavistin or Benlate, or 0.2% thiram reduced disease incidence and is recommended before storing planting material. (*Summary by T.M.*) E03

0145-4025 SUDO, S. and NUNES, W.O. **Comportamento de nove variedades de mandioca** (*Manihot utilissima* **Pohl), em relação á "antracnose"** (*Colletotrichum gloeosporioides* **f. sp,** *manihotis*), **no estado do Rio de Janeiro .** (*Reaction of nine cassava varieties to anthracnose*). Agronomia (Brasil) 31:39-43. 1973. Port., Sum. Port., Engl., 4 Refs.

Cassava. Field experiments. Cultivars. Resistance. *Glomerella cingulata*. **Brazil.**

Results are given of a field trial evaluating the reactions of 9 cassava var. to anthracnose caused by *Glomerella cingulata* (= *C. gloeosporioides*) in the state of Rio de Janeiro (Brazil). None of the var. was immune, but Santa Catarina and Goiana 822 seemed to be much more tolerant than the others. (*Author's summary*) E03

0146-8399 SWARUP, J., CHAUHAN, L.S. and TRIPATHI, R.C. **Two new** *Phomopsis* **spp. from India.** Mycopathologia et Mycologia Applicata 28(4):345-347. 1966. Engl., Illus.

Cassava. *Manihot esculenta*. **Mycoses. India.**

A morphological description is given of 2 new fungi (*Phomopsis* spp.) in India. *P. manihotis* Swarup, Chauhan & Tripathi causes severe leaf spotting of cassava. (*Summary by T.M.*) E03

0147-9839 TERI, J.M., THURSTON, H.D. and LOZANO, J.C. **The Cercospora leaf diseases** of cassava. *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977, Proceedings Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.101-116. Engl., Sum. Engl., 47 Refs., Illus.

Cassava. *Cercospora caribaea*. *Cercospora henningsii*. *Cercospora viscosae*. *Cercospora manihobae*. **Tuber productivity. Disease control. Resistance. Etiology. Epidemiology.**

A review is presented on the leaf diseases of cassava caused by *Cercospora* spp., with the purpose of determining the present state of knowledge on these diseases, as well as on-going research in this area. The following aspects of brown leaf spot (*C. henningsii*), white leaf spot (*C. caribaea*), blight leaf spot (*C. viscosae*) and dark leaf spot (*C. manihobae*) are discussed: geographic distribution, host range, etiology, epidemiology, symptomatology, economic importance and control measures including exclusion, eradication, chemical protection and varietal resistance

(HCN content, anthocyanins and genetic mechanisms). Greenhouse and field-screening techniques for evaluating resistance are also dealt with. (*Summary by A.J. Trans. by T.M.*) E03

0148-1143 TERI, J.M. **Brown leaf spot and Cercospora leaf blight of cassava: epidemiology and importance.** Ph.D. Thesis. Ithaca, N.Y., Cornell University, 1978. 101p. Engl., Sum. Engl., 87 Refs., Illus.

Cassava. *Cercospora henningsii. Cercospora caribaea. Cercospora vicosae. Cercospora manihobae.* **Epidemiology. Starch productivity. Cultivars. Resistance. Field experiments. Tuber productivity. Disease control. Defoliation. Dry matter. HCN content. Colombia.**

The economic importance of Cercospora or Cercospora-like diseases of cassava was studied. Symptomatological, morphological and cultural characteristics of *C. henningsii, C. vicosae, C. caribaea* and *C. manihobae* are given, with emphasis on the 1st 2, which cause brown leaf spot and leaf blight spot, respectively. Epidemiology was studied in 2 important cassava-growing regions of Colombia. These diseases are typically compound-interest diseases, with a long lag stage and a comparatively short logarithmic stage. The general effect is premature defoliation, which becomes apparent when plants are 4-5 mo old. Fresh and DM yields and quality of susceptible cv. and hybrids were significantly reduced by an av of 18 and 17%, respectively, by brown leaf spot and 23 and 21% by leaf blight spot. Starch yields were reduced an av of 13% by brown leaf spot and 24% by leaf blight spot; however, the effect on root starch content was not great. The tolerant var. Chiroza suffered no apparent loss in yield or quality when the disease was severe. Possible reasons for not finding reports in literature of these diseases being of economic importance on cassava are discussed. Breeding for comprehensive resistance to these diseases is recommended. Planting should be scheduled so that the most susceptible stage of the plant coincides with the onset of the dry season Early-maturing var. and those with high LAIs should be more tolerant to the diseases. (*Summary by T.B*) E03

0149-1194 VIEGAS, A.P. **Môfo dos afídeos e aleirodídeos.** (*Leaf mold in association with aphids and white-flies*). Revista de Agricultura (Piracicaba) 15:475-485. 1940. Port., 7 Refs., Illus.

Cassava. Leaves. Mycoses. Injurious insects. **Brazil.**

The symptomatology and development of the fungus *Cladosporium herbarum* on sugary secretions of aphids and aleyrodids (*Aleurothrixus aepim*) on cassava leaves are described and illustrated. This sooty mold is not of economic importance in Sao Paulo (Brazil), but it is considered beneficial since it affects *A. aepim.* Shade and high RH favor its development. Germination of the conidia, mycelia (hyphae) and conidiophores is described. (*Summary by J.S. - Trans. by T.B.*) E03 F01

0150-8735 VYAS, S.C. and JOSHI, L.K. **Die-back of cassava** (*Manihot esculenta* **Crantz=** *Manihot utilissima* **Pohl)— a new disease caused by** *Colletotrichum gloeosporioides* **Penz.** Science and Culture 42(3):171-172. 1976. Engl , 3 Refs.

Cassava. *Manihot esculenta. Glomerella cingulata.* **India.**

A reports is made of a new disease causing dieback of cassava stems in Jabalpur (India). The causal agent was identified as the fungus *Colletotrichum gloeosporioides.* (*Summary by T.M.*) E03

See also 0163 0391

E04 Viroses

0151- 9848 BOCK, K.R. and GUTHRIE, E.J. **African mosaic disease in Kenya.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.41-44. Engl., Sum. Engl., 5 Refs.

Cassava. Cassava African mosaic virus. Productivity. Resistance. Disease transmission. Kenya.

Results of field observations and experiments suggest that African mosaic can be controlled in Kenya by the use of mosaic-free planting material. The low rate of spread of mosaic into mosaic-free plots (2.2% in 12-14 mo) and also within plots (12.9%) indicates that whiteflies are comparatively inefficient vectors and that man is the principal vector in his indiscriminate use of infected cuttings as propagation material. A reappraisal of locally adapted cassava in relation to hybrids seems necessary in view of these results; they also suggest that susceptibility to mosaic might not be a factor limiting the usefulness of high-yielding varieties being developed by breeders. (*Author's summary*) E04

0152- 3649 COSTA, A.S. and KITAJIMA, E.W. **Studies on virus and mycoplasma diseases of the cassava plant in Brazil.** *In* Cassava Mosaic Workshop, Ibadan, Nigeria, 1972. Proceedings. Ibadan, International Institute of Tropical Agriculture, 1972. pp.18-36. Engl., 17 Refs., Illus.

Cassava. Cassava common mosaic virus. Cassava vein mosaic virus. Mycoplasmoses. Disease control. Disease transmission.

Information is given on history, geographic distribution, economic importance, host range and control of 2 different types of mosaic in Brazil caused by viruses with morphological differences: (1) Common cassava mosaic, which differs from African mosaic, may have symptoms similar to those of golden or leaf vein mosaic on certain varieties. The disease is apparently not transmitted by seed, but by mechanical inoculation through grafts made on healthy cuttings. No vectors were found; it seems that dissemination occurs when infected and healthy cuttings are planted simultaneously. (2) Cassava leaf vein mosaic is, at present, of no economic importance. Symptoms are evident only on mature leaves; chlorotic areas are limited to the veins. A vector of the virus has not been found. The disease is not so easily transmitted as common mosaic. Three types of witches'-broom (old, Pernambuco and Santa Barbara) have been found associated with mycoplasma diseases. They are of little economic importance because of their limited distribution. Transmission is not vector associated. (*Summary by A.B. Trans. by S.S. de S.*) E04 E05

0153-9716 DOKU, E.V. **Soil volume, sink size and expression of cassava mosaic virus disease (CMVD) symptoms.** Acta Horticulturae 53:257-261. 1977. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Cassava mosaic virus. Plant development. Tuber development. Leaves. Timing. Laboratory experiments. Plant height. Ghana.

Nine- to 12-inch long cuttings taken from the base of plants of cassava var. Ankrah were planted in 3 soil vol (40 cm^2 x 10, 20 or 40 cm) at the University of Ghana. All plants from which cuttings were taken showed severe African mosaic symptoms. Root (sink) size was directly related to soil vol, as were growth (indicated by stem elongation), increase in leaf no. and severity of AMD symptoms (i.e., the larger the vol of soil and hence root size, the severer the disease expression). Possible physiological reasons for this apparently anomalous association of high root yields with severe disease symptoms are given. (*Author's summary*) E04 C01

0154-1173 HARRISON, B.D. *et al.* **Plant viruses with circular single-stranded DNA.** Nature 270(22/29):760-762 1977. Engl., 18 Refs., Illus.

Cassava. Viroses. Laboratory experiments.

The DNA of maize streak and cassava latent viruses was single stranded and was composed of both small circular and linear mols. The linear mols varied in size up to the length of the circular mols, suggesting that they were formed by nicking and partial degradation of the latter. Circular DNA of cassava latent and maize streak viruses had mol wt of 0 80 x 10^6 and 0.71 x 10^6, respectively. Polyacrylamide electrophoresis of DNA from both viruses showed the presence of 2 components, circular and linear DNA mols corresponded to the slower and faster migrating components, respectively. (*Summary by Chemical Abstracts*) E04

0155-9841 MARTINEZ L., G. **American virus and mycoplasma diseases of cassava.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.85-93. Engl., Sum. Engl., 26 Refs., Illus.

Cassava. Cassava common mosaic virus. Mycoplasmoses. Cassava vein mosaic virus. Cassava latent virus. Disease transmission. Disease control. Colombia.

The following aspects of virus or mycoplasma diseases in cassava (common mosaic virus, leaf vein mosaic, latent virus, witches' - broom and frog skin) are presented: geographic distribution, economic importance, strains, host range and symptomatology, transmission, serology, stability, purification and properties of particles. Aspects requiring further research are discussed (*Summary by T.M.*) E04 E05

0156-9270 NARASIMHAN, V. and ARJUNAN, G. **Reaction of different varieties of cassava to cassava mosaic virus.** Indian Journal of Mycology and Plant Pathology 5(2).182-183 1975. Engl., 4 Refs.

Cassava. Field experiments. Cassava mosaic virus. Resistance. Cultivars. India.

The reactions (1971-74) of 29 cassava cultivars and selections to natural infection by African mosaic virus in the field are tabulated Three remained disease free and 4 had only moderate infection (*Summary by Review of Plant Pathology*) E04

0157-9718 NARASIMHAN, V. and ARJUNAN, G. **Effect of plant density and cultivation method on the incidence of mosaic disease of cassava.** Indian Journal of Mycology and Plant Pathology 6(2):189-190. 1976. Engl., 6 Refs.

Cassava. Planting. Spacing. Cassava African mosaic virus. Field experiments. India.

The effect of spacing (75 x 75, 75 x 90 and 90 x 90 cm) and planting on ridges or beds on AMD incidence was studied at the Tapioca Research Center, Salem, Tamil Nadu (India), using the erect cassava var. Local Burma. With this nonbranching var., the possibility of secondary spread of AMD was min at 90 x 90 cm; thus wider spacing should be adopted in areas where cassava is attacked by AMD. There was no significant difference between planting on ridges or beds. (*Summary by T.M.*) E04

0158-9706 NARASIMHAN, V. and ARJUNAN, G. **Whitefly population in relation to the incidence of mosaic in cassava varieties at Salem (Tamil Nadu).** Indian Journal of Mycology and Plant Pathology 6(2):187-188. 1976. Engl., 4 Refs.

Cassava. Injurious insects. *Bemisia*. Cassava mosaic virus. Cultivars. Resistance. Field experiments. India.

A highly significant correlation was found between whitefly populations and AMD incidence in 18 var. from the germplasm collection at the Tapioca Research Station, Salem, Tamil Nadu (India). In resistant S. 2371, S. 1310 and H 165 whitefly populations were very low whereas on highly susceptible var (62.5-93.7% AMD), there were > 50 whiteflies/5 plants. (*Summary by T.M*) E04

0159-1095 THANKAPPAN, M. and CHACKO, C.I. **Effect of cassava mosaic on the different plant parts and tuber yield in cassava.** Journal of Root Crops 2(2):45-47. 1976. Engl , Sum. Engl., 9 Refs.

Cassava. Cassava mosaic virus. Plant anatomy. Tuber productivity. Stems. Leaves. Plant height. India.

In studies with 5 cassava cv. it was found that infection by cassava mosaic significantly reduced stem girth, plant height, petiole length, middle leaflet length and width of all cv. tested. Yield was also reduced from 19.5-26%. (*Author's summary*) E04 C01

See also 0182 0207 0391

E05 Mycoplasmal Diseases

0160-9417 GONCALVES, R.D., NORMANHA, E.S. and BOOCK, O.J. O "superbrotamento" ou "envassouramento" da mandioca. (*Cassava witches'-broom*). São Paulo, Brasil. Secretaria da Agricultura, Indústria e Comércio, 1942. 13p. Port., Illus.

Cassava. Mycoplasmoses. Disease control. Brazil.

Witches'-broom of cassava was 1st reported in Vicosa, Minas Gerais in 1939; an account is made of its dissemination to northeastern Sao Paulo in 1942. Its economic importance, symptomatology, possible causes and preventive measures are discussed. (*Summary by T.B.*) E05

See also 0155

E06 Nematodes

0161-9845 DICKSON, D.W. **Nematode problems on cassava.** *In* Brekelbaum, T , Bellotti, A. and Lozano, J.C., eds Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.59-63. Engl., Sum. Engl., 22 Refs.

Cassava. Nematodes. Productivity. Pest control.

Although nematodes can attack cassava alone or interact with soil-borne microorganisms and may cause losses of economic importance, information on the subject is scarce. This article reviews the geographic distribution, biological and ecological aspects of the following nematode parasites of cassava: *Meloidogyne* spp., *Pratylenchus brachyrus, Rotylenchulus* spp., *Helicotylenchus* spp., *Rotylenchus* spp. and *Criconemoides* spp. As more cassava production moves into monoculture and as new high-yielding varieties are released, nematodes have the potential to cause severe reductions in root yield and quality. Various control measures are discussed, and areas that need to be investigated are outlined (*Summary by S.S. de S. Trans by M.O.H.*) E06

F01 Injurious Insects and their Control

0162-9150 AMEZQUITA DE QUIÑONES, M C. **Metodología parcial de análisis proyecto "desarrollo del gusano cachón en la yuca".** (*Partial methodology of analysis applied to the project on the development of the hornworm on cassava*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 19p Span., 4 Refs.

Also in English.

Cassava. *Erinnyis ello.* **Entomology. Insect agents. Cassava programs. Statistical analysis. Biological control. Colombia.**

Part of the methodology of the analysis applied to the project of the hornworm (*Erinnyis ello*) on cassava is presented The project studies the hornworm life cycle and population dynamics and the economic impact on cassava production under 2 conditions (1) in cages with controlled ideal conditions for development and (2) under field conditions on 19 farms with biological control by the egg parasite *Trichogramma* sp. and predation by *Polistes erythocephalus* (on 10 farms only) The theoretical structure of the Markov and semi-Markov stochastis processes is given, the models used are based on the latter. (*Summary by T.M.*) F01

0163-9702 BAYER DE COLOMBIA S.A. **Problemas fitosanitarios en el cultivo de la yuca.** (*Phytosanitary problems in cassava*). Agrobayer. Información Técnica. Circular no. 82. 1976. 5p. Span., Illus.

Cassava. Injurious insects. Mycoses. Insecticides. Insect control. Disease control. Injurious mites. Mite control. Colombia.

The main pests and diseases of cassava in Colombia are discussed with regard to morphological characters, type of damage caused and control measures. Illustrations are given of the hornworm, shoot flies, whiteflies, cutworms, lace bugs and mealybugs. As for diseases, leaf spots caused by *Cercospora* spp. and *Phyllosticta* sp. are important. (*Summary by T.B.*) F01 E03

0164-9822 BELLOTTI, A. and ARIAS, B. **Biology, ecology and biological control of the cassava hornworm (*Erinnyis ello*).** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical, Series CE-14. 1978. pp.227-232. Engl., Sum. Engl., 16 Refs., Illus.

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

The hornworm, one of the most important pests of cassava in the Americas, can defoliate plantations rapidly. More than 90 larvae/plant have been observed in Colombia. When populations reach this magnitude, they can consume up to 100% of the foliage; they also attack tender stem parts and lateral buds, killing young plants. Yields losses after a single attack can reach 20%; starch content can also be reduced. The 5 larval instars are described as well as the ecological factors that influence population fluctuations. Biological control is preferable to chemical control because pesticide application is costly and affects the equilibrium between parasites and pests. CIAT is conducting a biological control program to evaluate parasitism of eggs by *Trichogramma minutum* and *Telenomus dilophonotae*, parasitism of larvae by *Apanteles congregatus* and *A. americanus*, larval predation by *Polistes canadiensis* and *P.erythocephalus*, and a bacterial disease of larvae caused by *Bacillus thuringiensis*. Data related to these experiments are presented in tables. (*Summary by S.S. de S. Trans. by T.M.*) F01

0165-8948 BELLOTTI, A. **Control biológico del gusano cachón** (*Erinnyis ello*). (*Biological control of the cassava hornworm, Erinnyis ello*). Cali, Colombia, Centro Internacional de Agricultura Tropical, Serie Seminarios Internos SE-02-78. 1978. 11p. Span., Sum. Span., 16 Refs.

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

A program of biological control of the cassava hornworm appears feasible. The following biological control agents have been found to reduce hornworm populations effectively: *Trichogramma* spp. (egg parasites), *Apanteles* spp. (larval parasites), *Polistes* spp. (larval predators) and *Bacillus thuringiensis* (pathogenic to larvae). Further studies are required to develop the program better and test it at a commercial level. (*Author's summary. Trans. by T.M.*) F01

0166-9821 BELLOTTI, A. and SCHOONHOVEN, A. VAN **Miscellaneous pests of cassava.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.233-238. Engl., Sum. Engl., 37 Refs.

Cassava. Injurious insects. Entomology.

A description is given of several pests that may on occasion cause serious damage to cassava. Aspects dealt with include their biology and ecology, type of damage and control methods. Insects attacking planting material or young plants during the establishment phase include white grubs (*Phyllophaga* sp., *Leucopholis rorida*), cutworms (*Prodenia litura, P. eridania, Agrotis ipsilon*) and termites (*Coptotermes* spp.).Pests attacking foliage include leaf-cutter ants (*Atta* spp., *Acromyrmex* spp.), gall midges (*Jatrophobia brasiliensis*) and lace bugs (*Vatiga manihotae*). Among insects attacting stems and branches are the stemborers (*Coelosternus* spp., *Lagochirus* sp.). (*Summary by T.M.*) F01

0167-9849 BELLOTTI, A.C. **An overview of cassava entomology.** *In* Brekelbaum, T , Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.29-39. Engl , Sum. Engl., 39 Refs.

Cassava. Entomology. Injurious mites. Injurious insects. Insect control. Biological control. Mite control. Productivity.

Research on mites and insects that attack cassava has shown that they are factors that limit yield. Furthermore, the decrease in genetic variability due to the development of genetically uniform

varieties tends to increase the incidence of epidemics and epiphytotics. The mite *Tetranychus urticae*, crickets, termites, leaf-cutter ants, grubs, cutworms and the scale insect *A. albus* are considered as universal pests of cassava since they are found in almost all cassava-growing areas. Insects that attack cassava over a prolonged period cause more damage than those that attack the plant only at certain times. The degree of damage depends on various factors; but under conditions at CIAT, it was greatest from the 2nd-6th mo of growth. Insects that attack cassava can be divided into 3 categories: (1) those that attack vegetative planting material (fruit flies, stemborers, scale insects, grubs and cutworms); (2) those that attack the growing plant; foliage consumers, sap-sucking pests, leaf deformers, and bud and stem borers; and (3) those that attack stored cassava planting material and dried products (more than 38 insects, mostly Coleoptera). The status of entomological research on cassava is indicated and the areas where further research is recommended are given. The factors that should be taken into account when establishing a pest management program are presented. Biological control and host plant resistance are described in detail because of their vital importance to integrated control programs that should also include the careful selection of planting material, use of sound cultural practices, resistant varieties as well as the use of phermones, attractants and growth regulators. It is concluded that studies on resistance to diseases in cassava should aim at the development of horizontal resistance since it is stable and involves less risk in the development of biotypes. Since major characters are inherited in an additive manner, this can be an effective tool in increasing resistance in genotypes that have low levels of resistance. A table is presented on the mite and insect complex, giving data on alternate hosts, yield losses, areas where they are found, and types of damage caused. (*Summary by S.S. de S. Trans. by M.O.H.*) F01

0168-9826 BELLOTTI, A. and PEÑA, J.E. **Studies on the cassava fruit fly *Anastrepha* spp.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.203-208. Engl., Sum. Engl., 4 Refs.

Cassava. *Anastrepha pickeli* Pest damage. Ecology. Entomology. Germination. Productivity. Insect control. Insecticides. Colombia.

Two species of fruit flies have been identified as attacking cassava in Colombia: *Anastrepha pickeli* in the Valle del Cauca (altitude 1000 m) and *A. manihoti* in the coffee-growing regions (1200 m) When this insect attacks the fruit of cassava, it does not cause economic losses; but when it attacks the stem, it bores tunnels where a bacterial pathogen *Erwinia carotovora* var. *carotovora* can be found causing severe stem rot. When environmental conditions are favorable, the cassava plants can recover rapidly from this damage even when growing terminals have rotted or died. Severest fruit fly damage is observed in planting material; the use of infested cuttings results in losses in germination as well as yield. Environmental conditions favorable to fruit fly development and aspects of its biology are discussed. *Opius* sp. is a parasite of larvae in the cassava fruit but has not been observed in the stems. The use of systemic insecticides is discussed, and results are given of field experiments designed to determine which baits or attractants would trap fruit flies or increase the effectiveness of insecticides. (*Summary by S.S. de S. Trans. by T.M.*) F01

0169-9829 BENNETT, F D. and GREATHEAD, D.J. **Biological control of the cassava mealybug (*Phenacoccus manihoti* Matile-Ferrero): prospects and necessity.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C. eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.181-194. Engl., Sum. Engl., 15 Refs.

Cassava. *Phenacoccus manihoti*. Biological control. Insect control. Insect agents. Entomology.

Results are given of preliminary research on the biological control of the cassava mealybug *Phenacoccus manihoti* in the Neotropics and West Africa. Propagation of *Phenacoccus* spp. was

successful on a potato medium. A survey was made of natural enemies in West Africa, only two predators (*Spalgis lemolea* and *Acalypha* sp.) were found. Because of the scarcity of predators and possible absence of parasites, it will be necessary to introduce them from the Neotropics. To determine optimal techniques for shipping these natural enemies from the Neotropics, an evaluation was made of longevity of adult *Aenisus phenacocci, Hyperaspis onerata* and *Nephus* sp. on different diets. It was found that adults fed a honey diet could survive a 10-day shipping period, provided temp did not greatly exceed 30°C. An appendix table summarizes known biological control attempts against mealybugs. (*Summary by A.J. Trans. by T.M.*) F01

0170-9335 BERNAYS, E.A. *et al* **The relationship of *Zonocerus variegatus* (L.) (Acridoidea: Pyrgomorphidae) with cassava (*Manihot esculenta*).** Bulletin of Entomological Research 67:391-404. 1977. Engl., Sum. Engl., 21 Refs , Illus.

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

Field and laboratory studies at Ibadan, Nigeria showed that the young nymphs of *Zonocerus variegatus* normally reject cassava after biting it and die if they are confined on growing leaves Later instars will eat cassava, especially when deprived of food for some time, but the adults progressively lose wt when restricted to feeding on growing cassava On cut cassava, on the other hand, extensive feeding occurs and normal growth is maintained. The change from unpalatability to acceptability occurs within about one h of cutting and is apparently associated with wilting. Cassava produces latex, but this was not distasteful to *Zonocerus*. The readiness to feed on growing cassava was associated with low levels of HCN production by the leaves; wilted leaves still produced HCN, but at a lower rate than turgid, growing leaves. In the area around Ibadan, *Zonocerus* regularly defoliates cassava in the latter part of the dry season, probably because a shortage of attractive foods forces the insect to feed on it. (*Author's summary*) F01

0171-9810 COSTA, A.S and RUSSELL, L.M. **Failure of *Bemisia tabaci* to breed on cassava plants in Brazil (Homoptera: Aleyrodidae).** Ciencia ê Cultura 27(4):388-390. 1975. Port., Sum. Port., Engl., 7 Refs.

Cassava. *Bemisia* Entomology. Cultivars. Field experiments. Laboratory experiments. Brazil.

Bemisia tabaci is not known to breed on cassava in Brazil or elsewhere in the New World, either under natural or experimental conditions. Cassava did not become infested when placed in compartments among other plants with heavy *B. tabaci* populations or when fertilized females from other hosts were confined to caged cassava plants. The fact that *B. tabaci* apparently does not breed on cassava in the New World may be an alternative explanation for the nonexistence of a whitefly-transmitted type of cassava mosaic in Brazil, where diseases transmitted by this insect are common on a wide range of plants including other Euphorbiaceae. (*Author's summary*) F01

0172-7412 COSTA, J.M. DA **Estudo das pragas. (*Study of cassava pests*). *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.8-14. Port.

Cassava. Cassava programs. *Mononychellus tanajoa. Silba pendula.* Injurious insects. Insect control. Mite control. Brazil.

A progress report is given of studies being conducted at the Universidade Federal da Bahia on the biology and chemical control of the leaf-cutter ants *Atta* spp. and *Acromyrmex* spp. and control of the mite *Mononychellus tanajoa*. A list is given of the insecticides being evaluated in the control of the hornworm and the shoot fly *Silba pendula*. A 5-yr study is being made of pest incidence

during the different planting periods. Var. are also being evaluated for resistance to different pests. (*Summary by T.B.*) F01

0173-9550 COSTA, J.M. DA Insetos nocivos a mandioca (*Manihot esculenta* Crantz). (*Insect pests of cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976 Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.315-323. Port., 20 Refs.

Cassava. *Erinnyis ello. Erinnyis alope. Mononychellus tanajoa. Tetranychus cinnabarinus. Silba pendula. Teleocoma crassipes. Anastrepha pickeli. Eudiplosis brasiliensis. Scirtothrips manihoti.* **Insect control. Mite control. Biological control. Brazil.**

More than 80 species of insects have been found attacking cassava. The following Brazilian pests and control measures are discussed briefly; the hornworms *Erinnyis ello* and *E. alope;* the mites *Mononychellus tanajoa* and *Tetranychus cinnabarinus;* the fruit flies *Silba pendula, Anastrepha pickeli* and *Teleocoma crassipes;* the stemborers *Coelosternus* spp.; the gall midge *Jatrophobia brasiliensis;* the leaf-cutter ants *Atta* spp. and *Acromyrmex* spp.; and the thrips *Scirtothrips manihoti.* (*Summary by T.B.*) F01

0174-9833 DORESTE S., E, ARIAS, C. and BELLOTTI, A. **Field evaluations of cassava cultivars for resistance to tetranychid mites.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978 pp.161-164. Engl., Sum. Engl., 3 Refs.

Also in Spanish.

Cassava. Injurious mites. Field experiments. Resistance. Cultivars. Venezuela.

The results are given of two field trials evaluating resistance of cassava cultivars to tetranychid mites. The cultivars were selected at CIAT (Colombia) and planted at the experimental farm of CENIAP (Venezuela). Using an injury scale of 0-5 for terminal buds and leaves, av damage and standard deviations were determined. A list is given of 19 cultivars with different degrees of resistance. (*Summary by T.M.*) F01

0175-9835 FLECHTMANN, C.H.W. **The cassava mite complex: taxonomy and identification.** *In* Brekelbaum, T., Bellotti, A. and Lozaho, J.C., eds Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978 pp.143-153. Engl., Sum. Engl., 29 Refs., Illus.

Cassava. Entomology. Injurious mites. *Mononychellus tanajoa. Tetranychus urticae Tetranychus cinnabarinus.* **Identification.**

A taxonomic key is presented for classifying the mites that attack *Manihot* spp Methodology (sampling and slide preparations) is explained, and morphologic characters important in their identification are given and illustrated Data are given on geographic distribution, host plants and damage caused by *Eutetranychus banski, E. enodes, E. orientalis, Allonychus reisi, Mononychellus caribbeanae, M. tanajoa, M. mcgregori, M. bondari, Oligonychus coffeae, O peruvianus, O. gossypii, Tetranychus yusti, T. tumidus, T. mexicanus, T sayedi, T. truncatus, T neocaledonicus, T. amicus, T. lombardini, T. kanzawai, T. urticae* and *T. cinnabarinus* (*Summary by T.M.*) F01

0176-4205 FRANCO, J.F. *et al.* **Ensaio de campo de combate à "brôca dos brotos da mandioca"** *Silba pendula* **(Bezzi, 1919).** (*Field evaluation of chemical control of shoot fly larvae*). Anais da Sociedade Entomologica da Brasil 5(2):209-215. 1976. Port., Sum Port., Engl., 7 Refs., Illus.

Cassava. *Silba pendula.* **Insect control. Insecticides. Field experiments. Brazil.**

A field evaluation was made of 5 insecticides for controlling larvae of the shoot fly *Silba pendula* on cassava plants in Piracicaba (São Paulo, Brazil). Treatments were as follows 380 g a i./ha prothoate, 700 g endosulfan, 800 g methidathion, 1000 g ethion and 1000 g fenthion. Three spray applications were made of all products, none of which was effective. Methidathion and fenthion damaged the leaves. In addition, after the last spray, a heavy mite (*Tetranychus urticae*) infestation was observed. (*Author's summary*) F01

0177-1180 GHESQUIERE, J. **Un calliceratide (Hym. Proct.) nouveau du Congo belge.** (*A new Calliceratidae from the Belgian Congo*). Annales de la Société Royale Zoologique de Belgique 65:59-62. 1935. Fr., 4 Refs., Illus.

Cassava. Insect agents. Entomology. *Bemisia* **Zaire.**

A taxonomic description is given of the female *Allomicrops bemisiae* sp. n., a Ceraphronidae (Calliceratidae) from the Belgian Congo (Zaire). It is reported as a parasite or hyperparasite of *Bemisia gossypiperda* since high populations have been found on this pest of cassava. (*Summary by T.B.*) F01

0178-3110 GIRALDO V., H. and VELOSA A., B. **Algunas consideraciones sobre la biología, morfología y enemigos naturales de la escama blanca** (*Aonidomytilus albus* Cockerell) **y el pioho harinoso** (*Phenacoccus gossypii* Townsend y Cockerell) **de la yuca** (*Manihot esculenta* Crantz). (*Aspectos of the biology, morphology and natural enemies of the white scale and the cassava mealybug*). Tesis Ing. Agr. Palmira, Universidad Nacional de Colombia. Facultad de Ciencias Agropecuarias, 1977. 108p. Span., Sum. Span., Engl., 34 Refs., Illus.

Cassava. *Aonidomytilus albus. Phenacoccus.* **Entomology. Insect agents. Colombia.**

Aspects of the biology, morphology and natural enemies of the white scale (*Aonidomytilus albus*) and the cassava mealybug (*Phenacoccus gossypii*) were studied at CIAT (Palmira, Colombia), alt 1006 m, av annual temp 24°C, annual rainfall 1000 mm and RH 78%. The study was conducted under laboratory conditions using cassava cv M Col 111 (susceptible to both insects) and M Col 22 (susceptible to the white scale). Females of *A. albus* had a life cycle between 21-31 days (av 23.5); the males, 19.5-26 days (av 22). For *P. gossypii*, the life cycle of females was 32-41 days (av 37.8) and males, 18-24 days (av 20.7). Natural enemies (predators and parasites) and hyperparasites found in material collected in the field were sent for identification to the USDA. The following predators and parasites were identified: Coleoptera:Coccinellidae - *Celothera onerata, Cleothera* sp., *Scymnus* spp and *Coccidophilus* sp. Diptera:Syrphidae - *Ocyptamus stenogaster* complex. Lepidoptera:Cosmopterigidae - *Pyroderces* sp. Neuroptera:Chrysopidae - *Chrysopa* near *arioles* Bks. Neuroptera:Hemerobiidae - *Sympherobius* sp. Hymenoptera:Eulophidae - *Prospaltella* sp. Hymenoptera:Encyrtidae - *Anagyrus* sp. and *Acerophagus* sp. (*Author's summary*) F01

0179-9832 GIRLING, D.J., BENNETT, F.D. and YASEEN, M. **Biological control of the green cassava mite** *Mononychellus tanajoa* **(Bondar) (Acarina: Tetranychidae) in Africa.** *In*

Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.165-170. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. *Mononychellus tanajoa.* **Biological control. Mite control. Maps. Africa.**

The green mite *Mononychellus tanajoa* was first detected in 1973 on cassava cultivars in East Africa, where it causes damage of economic importance. The International Development Research Centre (IDRC) financed a biological control project for East Africa. Based on studies of predators carried out in Trinidad, as well as on surveys of naturally occurring predators in Africa (*Oligota* sp., *Typhlodromus* sp., *Stethorus* sp. and *Orius* sp.), *O. minuta* was considered the most adequate. *O. minuta* was mass released in Kenya during the dry season from Jan.-Mar. 1977. A recovery survey in western Kenya is planned for early 1978 to assess establishment and spread of *O. minuta*. Future plans include the establishment of nurseries for *O. minuta, Typhlodromalus* and other predators in West Africa; breeding rooms are being built at the Agriculture and Forestry Research Station at Muguga, Kenya. (*Summary by A.J. Trans. by I.B.Z.*) F01

0180-1165 LAL, S.S. and PILLAI, K.S. **Occurrence of new tetranychid spider mites,** *Eutetranychus orientalis* **(Klein) and** *Oligonychus biharensis* **(Hirst) on cassava.** Journal of Root Crops 2(2):59-60. 1976. Engl., 12 Refs., Illus.

Cassava. Injurious mites. *Eutetranychus orientalis. Oligonychus biharensis.* **Pest damage. Mite control. India.**

A report is made of 2 new tetranychid mites causing severe damage on cassava in India: *Oligonychus biharensis* and *Eutetranychus orientalis.* Data are given on alternate hosts, nature of damage, incidence and chemical control. (*Summary by T.B.*) F01

0181-9828 LEUSCHNER, K. and NWANZE, K. **Preliminary observations of the mealybug (Hemiptera: Pseudococcidae) in Zaire.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.195-198. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. *Phenacoccus manihoti.* **Pest damage. Insect control. Entomology. Zaire.**

Whiteflies and mites were the only important pests of cassava in Zaire until 1970 when the mealybug *Phenacoccus manihoti* was observed. The type of damage caused, economic importance and possible alternate hosts are discussed briefly. The life history of the mealybug and the influence of climatic conditions on insect development are described. The 2 principal means of dissemination are the use of infested propagating material and wind. Only a few parasites and predators that control it have been found; the most effective predator is *Spalgis limolea*. Four different approaches for handling this pest are recommended: breeding for resistance, biological control, cultural practices and chemical control. (*Summary by S.S. de S. Trans by T.M.*) F01

0182-9846 LEUSCHNER, K. **Whiteflies: biology and transmission of African mosaic disease.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.51-58. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Cassava African mosaic virus. Vectors. *Bemisia.* **Insect control. Resistance. Entomology.**

0186-8446 PASCHOAL, A.D. **Nova relação de acaros de plantas do Brasil.** (*New mite/host plant relationships in Brazil*). Revista Peruana de Entomología 14(1):174-176. 1971. Port., Sum. Engl., 27 Refs., Illus.

Cassava. *Manihot esculenta.* **Injurious mites. Brazil.**

Sixteen species of mites belonging to the families Tetranychidae, Tenuipalpidae, Tydeidae, Tarsonenidae and Eriophyidae are listed. Distribution and new hosts are given for each. *Manihot esculenta* is given as a new host of *Brevipalpus phoenicis* (Tenuipalpidae). (*Summary by T.M.*) F01

0187-1392 PEÑA, J.E and SCHOONHOVEN, A. VAN **Fluctuación de poblaciones de insectos y acarinos en yuca en la zona de Palmira, Valle del Cauca.** (*Fluctuations in insect and mite populations on cassava grown in Palmira, Colombia*). Revista Colombiana de Entomología 2(4):115-132. 1976. Span , Sum Span., Engl., 4 Refs., Illus.

Cassava. Injurious mites. Injurious insects. *Erinnyis ello. Silba pendula. Vatiga manihotae.* **Entomology. Insect agents. Colombia.**

A study was made of the fluctuation in populations of the main insect and mite pests found on cassava grown in Palmira, Valle del Cauca (Colombia), alt 1000 m. Type of damage caused is described for the mites *Mononychellus mcgregori, Tetranychus urticae* and *Oligonychus peruvianus,* the thrips *Frankliniella williamsi, Corynothrips stenopterus* and *Caliothrips masculinus;* the hornworm *Erinnyis ello;* the shoot fly *Silba pendula;* and the lace bug *Vatiga manihotae.* Five quarterly plantings were made with 90 (3 trials) or 50 (2 trials) cassava var., using 3 plants of each var. and 2 replications/planting. Monthly evaluations were made on the basis of different damage scales, described for each group of pests. It was found that the crop was attacked most during the 1st 3 mo, with the exception of mites whose populations increased with plant age. The dry season was especially favorable for buildup of populations. Planting dates for this region are recommended on the basis of these findings. Among the var. used, it was found that those with high pubescence showed a marked resistance to thrips. Fluctuation in the hornworm population was related to egg parasitism by *Trichogramma fasciatum* and larval predation by *Polistes* sp. (*Summary by T.B.*) F01

0188-1481 RAI, B.K. **Cassava: pests in Guyana, insecticidal treatment of planting material and control of pests.** Journal of Economic Entomology 71(1):152-154. 1978. Engl., Sum. Engl., 2 Refs.

Cassava. Cuttings. Germination. Insecticides. Insect control. *Erinnyis ello. Vatiga. Corynothrips.* **Field experiments. Guyana.**

Cassava cuttings were soaked in 9 different insecticides to make sprouts toxic to insects. Soaking for 12 h in 0.3% monocrotophos was best; up to 107 days after planting, plants from treated cuttings were less infested with *Vatiga illudens* and *Corynothrips stenopterus* than those from untreated material. Studies on the comparative persistence of residual toxicity of 34 insecticides against *V. illudens* showed that monocrotophos was the best. Drift spraying of 250 or 375 g a.i. monocrotophos in 20, 40 or 65 liters spray/ha resulted in max residual toxicity at 375 g a.i. in 65 liters spray. Trichlorfon at 675 g or carbaryl at 950 g a.i. in 22 liters of spray/ha as drift spray gave complete control of *Erinnyis ello* larvae. (*Author's summary*) F01

0189-9831 RODRIGUEZ, J.G. **The biology and ecology of the tetranychid mite complex in cassava in perspective.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava

The biological aspects of *Bemisia* sp. and its relationship to the transmission of African cassava mosaic virus (AMV) are reviewed. Whitefly activity depends on temperature, light and rainfall. Whiteflies feed on succulent young leaves; and since they are strongly attracted to the color yellow, cassava varieties with yellowish petioles attract more whiteflies than those with darker petioles. They fly only short distances, but wind contributes to their dissemination. *Bemisia* populations vary during the year depending on climatic conditions, predators and the condition of the host (adequate no. of succulent young leaves). Results are given of transmission experiments which show the close relationship between the population density of *Bemisia* sp. and the development of AMD. Control methods discussed include control of the vector (*Bemisia* sp.), sanitation measures and the use of AMD-resistant varieties. (*Summary by A.J. Trans. by T.M.*) F01 E04

0183-9328 MATILE-FERRERO, D. **Une cochenille nouvelle nuisible au manioc en Afrique équatoriale, *Phenacoccus manihoti* n. sp. [Homoptera, Coccoidea, Pseudococcidae].** (*Phenacoccus manihoti n. sp., a new mealybug pest of cassava in equatorial Africa*). Annales de la Société Entomologique de France 13(1):145-152 1977. Fr., Sum Engl., 3 Refs, Illus

Cassava. *Manihot esculenta.* **Injurious insects.** *Phenacoccus manihoti.* **Insect agents. Entomology. Africa.**

A new pest of cassava has appeared in western Africa in recent years; it belongs to a yet unknown species of coccids, here described and identified as *Phenacoccus manihoti* n. sp. The morphological characters of the adult female and the three female larval instars are given in detail. Parasites and predators are mentioned (*Author's summary*) F01

0184-1187 MONTE, O. **Combatendo o "mandoravá" da mandioca por meio de urubús?.** (*Controlling the cassava hornworm with vultures?*). Chácaras e Quintaes 64.69-70. 1941. Port.

Cassava. *Erinnyis ello.* **Insect control. Brazil.**

In answer to a Brazilian cassava grower who had read about the use of vultures to control the hornworm *Erinnyis ello* (dead animal bait is left in the infested fields to attract the vultures who then proceed to devour the larvae), chemical control is recommended using lead and calcium arsenate sprays for the leaves. (*Summary by T.B.*) F01

0185-9834 NYIIRA, Z.M. ***Mononychellus tanajoa* (Bondar): biology, ecology and economic importance.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.155-159. Engl, Sum. Engl., 13 Refs.

Cassava. *Mononychellus tanajoa.* **Entomology. Ecology. Mite control. Uganda.**

Results are given of studies on the biology and ecology of the green cassava mite *Mononychellus tanajoa*, carried out under laboratory conditions in Trinidad and Uganda. Population studies in Uganda showed that mite densities are mainly related to the pattern of rainfall, abundance of natural enemies (*Oligota* sp. and *Stethorus* sp.) and the availability of nutrients in the leaves Although it is apparent that the population of *M. tanajoa* is self-limiting, little is known about the mechanism involved. (*Summary by T.M.*) F01

Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.171-175. Engl., Sum. Engl, 28 Refs.

Cassava. Injurious mites. Entomology. Ecology. Resistance.

A brief review is presented on the nomenclature of the cassava mite complex. The biology and ecology of the most important ones are discussed: *Tetranychus urticae, T. cinnabarinus, T. tumidus, Oligonychus peruvianus, O. gossypii, Mononychellus tanajoa* and *M. mcgregori*. Aspects of biological and behavioral differences, type of injury caused and host plant resistance are also dealt with. (*Summary by I.B.Z.*) F01

0190-3668 SANTOS, J.H.R. DOS *et al.* **Resposta de cultivares de mandioca** *Manihot esculenta* **Crantz ao ataque do ácaro** *Mononychellus tanajoa* **(Bondar), no estado do Ceará-Brasil.** (*Response of cassava cultivars to mite attack in the state of Ceará, Brazil*). Fitosanidade 2(2):34-37. 1977. Port., Sum. Engl., 6 Refs.

Cassava. Cultivars. Resistance. *Mononychellus tanajoa.* **Field experiments. Brazil.**

Of 44 cassava cv. evaluated for resistance to attack by the mite *Mononychellus tanajoa* in a field trial at Pentecoste, Ceará in 1976, 5 were found to be fairly resistant, 15 tolerant and the rest rather susceptible. Poré, Manivainha, Aciolina and Macaxeira Tres Meses should not be planted in mite problem areas since they were highly susceptible. (*Author's summary*) F01

0191-9824 SAUNDERS, J.L. **Cassava production and vegetative growth related to control duration of shoot flies and fruit flies.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.215-219. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. *Silba. Anastrepha manihotis.* **Insect control. Timing. Plant development. Field experiments. Insecticides. Costa Rica.**

Silba sp. and *Anastrepha manihotis* were controlled on cassava for differing time periods up to 24 wk, beginning one mo after planting. Control increased branching height but did not significantly affect total height. Production was inversely correlated to control. Spraying the entire plant or the apical bud and upper stem provided equally effective control. Moderate *Silba* sp. attack stimulated branching and apparently increased total leaf area for photosynthesis and consequently increased production. (*Author's summary*) F01

0192-9823 SCHAEFERS, G.A. Grasshoppers (*Zonocerus* spp.) on **cassava in Africa.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.221-226. Engl., Sum. Engl., 26 Refs.

Cassava. Injurious insects. *Zonocerus.* **Insect control. Entomology. Insect agents. HCN. Resistance. Africa.**

A general review is presented on the life cycle, host range, economic losses on cassava, and control of *Zonocerus variegatus* and *Z. elegans*, as well as factors affecting their incidence in Africa The insects cause defoliation and feed on young shoots It seems that HCN content of leaves may be related to grasshopper incidence, but further research is required. No information is available

concerning yield losses when the attack occurs at the later stages of plant growth Apparently there are no biological control agents for *Zonocerus* spp., except some rodents and birds; studies on pathogens are recommended. Chemical control is recommended for the early nymphal stages. Further investigation on varietal resistance is advised. (*Summary by A.J. Trans. by I.B.Z.*) F01

0193-9830 SCHOONHOVEN, A. VAN **Thrips on cassava: economic importance, mechanisms and sources of resistance.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.177-180. Engl., Sum. Engl., 7 Refs.

Cassava. Injurious insects. Cultivars. Productivity. Resistance. Colombia.

A report is given of experiments conducted at CIAT (Colombia) to evaluate the economic importance of thrips, a dry-season pest of cassava in tropical America. It was found that yield losses due to thrips attack in this area ranged from 8-15% in susceptible varieties, depending on environmental conditions; and 11% in varieties with intermediate resistance. Calculated production losses for Colombia amount to 58,150 t/yr (7.67% of the total yearly production). Of 1254 clones in CIAT's cassava germplasm collection screened for resistance to *Frankliniella williamsi* and *Corynothrips stenopterus*, 20% showed no damage and 28%, slight damage. As regards the possible nature of resistance, a strong relationship between no. of hairs on the leaf lobe and degree of resistance was found; there was no correlation with leaf HCN content. Although it is more economical to breed for increased yield potential, breeders should reject all cultivars showing susceptibility (grades 4-5) to thrips during dry seasons. (*Summary by T.M.*) F01

0194-9843 TORO, J.C. and GARCIA P., S. **Caicedonia: an improved cassava-growing area with integrated control.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.71-73. Engl., Sum. Engl., 3 Refs.

Cassava. Cassava programs. Insect control. Colombia.

The results are given of 6 yr of technical assistance from CIAT, integrated with a program of the National Coffee Growers Federation, designed to diversify crops being grown in the region of Caicedonia (Colombia). From an initial 60 ha and 8 farmers in 1971, the program has developed more than 1300 ha and 90 farmers. This has been achieved through a combination of factors including favorable environmental conditions, high net profits, a high-yielding local variety (Chiroza Gallinaza), market proximity, farmer receptivity to technical assistance, and availability and timeliness of credit. Special problems dealt with successfully include biological control of *Erinnyis ello* and CBB eradication. Optimal plant density recommended for this region is 7000 plants/ha. The region has benefited both socially and economically. (*Summary by I.B.Z.*) F01

0195-9827 VARGAS H., O. **The white scale (*Aonidomytilus albus* Ckll.) on cassava.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.199-202. Engl., Sum. Engl., 13 Refs.

Cassava. *Aonidomytilus albus*. Pest damage. Entomology. Insect control. Colombia.

Scale insects have appeared as pests of cassava in South America, Asia and Africa as a result of the increase in area planted to cassava and because of the use of insecticides on other crops. The

most important species are *Aonidomytilus albus* and *Saissetia* sp., which are generally found on the stems and occasionally on the petioles. Damage is greatest when the plant is attacked during the early stages of growth before it is well established. The habits and instars of the insect are described, and the means of dissemination are given. Infestation of propagating material by scale insects can reduce the % of germination significantly, as well as delay initial growth. The most serious damage (death of lateral buds) results in the loss of planting material Control measures are discussed. (*Summary by S.S. de S. Trans. by T.M.*) F01

0196-9825 WADDILL, V.H. **Biology and economic importance of a cassava shoot fly, *Neosilba perezi* Romero and Ruppel.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.209-214. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. *Neosilba perezi.* **Entomology. Productivity. Plant height. Laboratory experiments. Field experiments. USA.**

The biological cycle of the shoot fly *Neosilba perezi,* a pest of cassava in Florida, was studied under laboratory conditions. The length of time in each immature stadium increased with decreasing temp. At 25.6°C total development time from egg to adult was 41 days; at 15.6° eggs took twice as long to hatch (6 days) and larvae failed to pupate. Seasonal population studies revealed a substantial rise in percentage of larval infestation from mid-July to early Aug., followed by a decrease. The % of larva-infested terminals peaked from late Oct. to early Nov. Simulated shoot fly damage had significant effects on plant height and no. of terminals/plant, but not on no. of leaves, roots, marketable yield or total yield. Insecticides should, therefore, be applied only when all the terminals on a plant are damaged more than once a month. (*Summary by A.J. Trans. by I.B.Z.*) F01

0197-8777 WINDER, J.A. and ABREU, J M. DE **Preliminary observations on the flight behaviour of the sphingid moth *Erinnyis ello* L. and *E alope* Drury (Lepidoptera), based on light-trapping.** Ciência e Cultura 28(4) 444-448 1976. Engl., Sum. Engl , 18 Refs , Illus

Cassava. *Erinnyis alope Erinnyis ello* **Entomology. Field experiments. Brazil.**

Preliminary experiments with omnidirectional light traps sited in a mature rubber plantation at Ituberá, Bahia (Brazil) showed that black- and blacklight blue sources collected 10 times as many adults of the sphingid moth *Erinnyis ello* as a daylight type light source In traps situated at 1, 5, 9 and 12 m above the ground, most moths were collected at 9 and 12 m For *E ello* the male/female ratio was 1.06:1 and for *Erinnyis alope* 1.1.78. Three times as many *E ello* as *E alope* were collected. Hourly trap catches of *E. ello* at 12 m showed 2 peaks, the 1st between 23.00h and 24.00h for females and 24.00h and 01.00h for males, and the 2nd between 02 00h and 03.00h for both sexes. *E. alope* showed a unimodal flight curve for females with the peak between 24 00h and 01.00h, but was very variable for males. Trap catches were drastically diminished during the period of full moon. (*Author's summary*) F01

0198-8747 YEPEZ, F.F. and TERAN B., J.B **Presencia de *Chilomina clarkei* (Amsel) y *Chilozela bifilalis* (Hampson) (Lepidoptera, Pyralidae) en yuca (*Manihot esculenta* Crantz) en Venezuela.** (*Chilomina clarkei and Chilozela bifilalis on cassava in Venezuela*). Agronomia Tropical (Venezuela) 23(4):407-411. 1973. Span , Sum. Span , Engl., 7 Refs , Illus.

Cassava. *Manihot esculenta.* **Injurious insects. Entomology.** *Chilomina clarkei. Chilozela bifilalis.* **Venezuela.**

A stemborer *Chilomina clarkei* and a bud leaf roller *Chilozela bifilalis* are reported on cassava in Venezuela. Erroneous reports of *Asciodes gordialis* and *Asciodes* spp for cassava in Venezuela are corrected, both corresponding to *C. clarkei*. Records of distribution in the country are given for both species. (*Author's summary*) F01

See also *0087* *0110* *0149* *0391*

G00 GENETICS AND PLANT BREEDING

0199-1602 DEMPSEY, A.H. **Genetics and cultivars of cassava.** *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.15-36. Engl., 847 Refs.

Cassava. *Manihot*. Plant breeding. Cytogenetics. Backcrossing. Cultivars. Tuber productivity. Nutritive value. Resistance. Genetics. Cassava programs. Developmental research. Plant fertility.

A comprehensive bibliographic revision was made of some genetic aspects of cassava including origin, cytogenetics of the species, sterility and reproduction behavior, cultivars and variability associated with genetic differences. A universal classification of cultivars based on natural relationships should be established in order to evaluate and utilize the genetic variability of *Manihot esculenta* more efficiently Because of this variability and the possibility of backcrossing between species, it is possible to conduct a breeding program to develop new and more productive material for commercial production and to increase the level of resistance to diseases and the nutritive value of cassava Some short- and long-term recommendations and objectives for the establishment of a cassava breeding program are presented as well (*Summary by A.J. Trans. by S.S. de S.*) G00

0200-9266 MAGOON, M.L. **Some immediate problems, possibilities and experimental approaches in relation to genetic improvement of cassava.** Indian Journal of Genetics and Plant Breeding 28A·109-125. 1968. Engl., Sum. Engl, 34·Refs

Cassava. *Manihot esculenta*. *Manihot*. Genetics. Cassava programs. Plant breeding. Hybridizing. Selection. Resistance. Cassava mosaic virus. India.

The range of genetic variability in both cultivated varieties of *M. esculenta* and related *Manihot* spp is critically assessed. It is suggested that further improvement of cassava through efficient exploitation of available germplasm reserves is very great. The need for combined studies of morphological, cytogenetic and biochemical aspects to make a more natural classification based on ancestral relatioships is emphasized. Current problems and experimental approaches are discussed. It is concluded that only through the use of high-yielding varieties with several desirable characteristics, together with good cultural practices, can cassava production have a future in India. (*Author's summary*) G00

G01 Breeding, Germplasm, Varieties and Clones, Selection

0201-7416 CONCEICAO, A.J. DA., CUNHA, H.M.P. DA and SAMPAIO, C.V **Melhoramento genético.** (*Plant breeding*). *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.4-7. Port.

Cassava. Cassava programs. Plant breeding. Brazil.

Information is given on experiments conducted with 190 varieties from the germplasm bank at the Universidade Federal da Bahia. Plants were pruned and an analysis was made of their starch, protein, water, fiber, HCN and mineral residue contents. Brief information is also given on controlled crosses, seed stock, induced mutations in seed and multiplication of clones. (*Summary by I.B.Z.*) G01

0202-9559 CONCEIÇÃO, A.J. DA **Caracterização agronômica da mandioca.** (*Agronomic characterization of cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.135-143. Port., 7 Refs.

Cassava. Cultivars. Sweet cassava. Bitter cassava. Selection. Brazil.

Nomenclature, differences between sweet and bitter var., HCN values for peeled roots and different types of classification based on toxicity, color of the pulp, yield, vegetative cycle, plant type and resistance, are discussed briefly. A list is given of Brazilian var. recommended for eating, for making pellets for feedstuffs and for industrial purposes (starch, alcohol), as well as early (12 mo cycle), semi-early (14-15 mo) and late-maturing var. (18-20 mo). Formulas are also given for determining root DM and starch contents and HI. (*Summary by T.B.*) G01

0203-9557 CONCEIÇÃO, A.J. DA **Métodos de melhoramento da mandioca.** (*Methods of improving cassava*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.156-164. Port., 11 Refs., Illus.

Cassava. Plant breeding. Germplasm. Clones. Selection. Brazil.

The cassava breeding program at the Universidade Federal da Bahia maintains a collection of basic genetic material, which is being evaluated for yield and other characters of importance in

developing new var. for industry, food and forage. Desirable characteristics to be looked for in the aerial and underground parts of the plant are described. The different steps involved from the evaluation of the germplasm bank to regional trials for selecting superior clones are discussed briefly. (*Summary by T.B.*) G01

0204-1181 DUMONT, C. **Comparaison des clones de manioc en experimentation.** (*Evaluation of cassava clones*). n.p., n.e., 1955. 90p. Fr., 9 Refs., Illus.

Cassava. Field experiments. Clones. Selection. Experiment design. Productivity. Resistance. Cassava African mosaic virus. Ivory Coast.

Results are given of trials with 2 groups of cassava clones in Adiopodoumé from 1954-55. The 1st group of 24 clones from the station of Boukoko in French Equatorial Africa was evaluated in Ivory Coast and compared with the best local var. Tabouca A balanced lattice design was used and the clones were harvested at 9 and 12 mo. The results were also analyzed as if randomized complete blocks had been used. The analysis of variance of both designs showed that there were no significant differences among the clones General information is also given on lattices, related principles of statistical analysis and examples of their interpretation The 2nd group of clones came from seeds harvested in 1953; cuttings were taken from the resulting plants in 1954 and planted using a rectangular lattice design. Because of the small no. of cuttings available and damage caused by rot and predators, it was impossible to interpret results correctly. Therefore, an empirical selection was made based on characteristics such as resistance to mosaic, dieback, yield and vigor. In 1955, 426 clones were compared with each other and with Tabouca. On studying the maternal origin of the 58 clones selected, it was found that many came from the same parent plant, which seems to indicate that certain var. transmit their yield capacity to their progeny. A detailed botanical description is given of the best clones (B 8, 17, 25, 33, 39, 42, 49, 50 and 54, and Tabouca), including characteristics of yield and resistance to mosaic. (*Summary by S.S. de S Trans. by T.B.*) G01

0205-9421 EKANDEM, M J. **Cassava research in Nigeria before 1967.** Ibadan, Nigeria. Federal Department of Agricultural Research. Memorandum no. 103. 1970. 16p. Engl , 18 Refs., Illus.

Cassava. Research. Plant breeding. Selection. Productivity. Cassava African mosaic virus. Seed. Germination. Mycoses. Injurious insects. Cultivation. Nigeria.

The history of cassava improvement in Nigeria from 1932-67 is discussed in detail. Initially, 70 var. were collected locally, all of which were susceptible to African mosaic (AMD). Resistant var. were imported from Goald Coast, Sierra Leone and Trinidad. In addition to selection and breeding work, emphasis was placed on the improvement of cultural practices. Observations on planting time, distance, methods, planting material, fertilization and age of maturity are discussed. Results are also given of seed germination studies. The system used for classifying AMD symptom expression is explained. The effects of the virus of plant growth rate, yield and plant tissue are discussed. Other diseases of increasing importance are caused by the fungi *Cercospora henningsii, C. caribaea, Glomerella cingulata* and *Polyporus baudoni*. The main insect pest is *Bemisia* sp., the white fly vector of AMD. Damage by other pests depends on season and type of planting material. Grasshoppers (*Zonocerus variegatus*) and red mites are dry season pests, the stink bug (*Nezara* sp.) attacks young capsules and could affect hybridization programs. Termites attack young planting material; rodents, bush fowl and goats eat sweet var. (*Summary by T.B.*) G01 E01

0206-6956 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. Manioc; Anjouan. (*Cassava; Anjouan*). *In*___. Rapport annuel d'activité 1966. Tananarive, 1967. pp.99-100. Fr.

Cassava. Field experiments. Cultivars. Adaptation. Germination. Flowering. Timing. Malagasy Republic.

A report is given on the performance of 5 introduced and 1 local variety (control). A comparison is made of yields and period of flowering. (*Summary by I.B.Z.*) G01

0207-9847 JENNINGS, D.L. **Inheritance of linked resistances to African cassava mosaic and bacterial blight diseases.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.45-50. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Cassava African mosaic virus. *Xanthomonas manihotis*. Resistance. Inheritance. Plant breeding. Genetics. *Manihot glaziovii*. Nigeria.

The relationship between resistances to African cassava mosaic disease (AMD) and to cassava bacterial blight (CBB) was studied at IITA in 1975. Resistances to AMD and CBB, derived from *M. glaziovii*, were conferred by recessive quantitative genes with additive effects. For both diseases the degree of recessiveness was influenced by environmental factors, which also had correlated effects on the 2 resistances. *M.glaziovii* progenies segregated in a discontinuous way for joint resistance to AMD and CBB. A similar type of segregation occurred in progenies of 58308, a hybrid 7 generations removed from the interspecies cross. The following hypotheses are considered: (a) that linkage occurs between genes affecting AMD resistance and others affecting CBB resistance, (b) that genes affecting AMD resistance have pleiotropic effects on CBB resistance, or (c) that linkage occurs between AMD and CBB, but pleiotropic effects also occur, increasing the degree of correlation. (*Author's summary*) G01 E04 E02

0208-9267 JOS, J.S., NAIR, R.G. and MAINI, S.B. **Quality improvement in cassava through autotetraploidy.** Sabrao Newsletter 4(2):117-118. 1972. Engl., 9 Refs.

Cassava. Plant breeding. Polyploidy. Colchicine. Tubers. Protein content. Dry matter.

Colchicine-induced $4x = 72$ plants from the var. Malayan 4 showed gigas characteristics, but the storage roots were morphologically similar to those of the diploid and yield potential was also similar. Roots from the $4x$ plants had a significantly higher protein content (3.30-4.86% of DM) compared with 2.26-3.30% for the diploid. (*Summary by Plant Breeding Abstracts*) G01

0209-1097 JOS, J.S. and HRISHI, N. **Inheritance of leaf shape in cassava.** Journal of Root Crops 2(2):10-12. 1976. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Inheritance. Plant anatomy. Leaves. Cultivars.

In cassava there are 2 distinct leaf types; namely, broad leaves prevalent among indigenous types and narrow leaves found in a few collections from Brazil, Madagascar and Malaysia. Inheritance studies indicate that leaf shape is monogenic. The broad leaf character is homozygous recessive (*aa*) (cv. M-4), and the narrow leaf character is heterozygous (*Aa*) (cv.2380). (*Author's summary*) G01

0210-1250 KAWANO, K. *et al.* **Evaluation of cassava germplasm for productivity.** Crop Science 18(3):377-380. 1978. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Field experiments. Cultivars. Hybrids. Tuber productivity. Timing. Germplasm. Selection. Soil requirements. Climatic requirements. Colombia.

A yield evaluation in single-row plots was made in Colombia of approx 1900 accessions of *Manihot esculenta*, collected throught L.A. and 4700 hybrid lines from crosses within this germplasm. Superior genotypes were selected on the basis of harvest index (proportion of root wt to total plant wt) and root yield in single-row plots and then evaluated in replicated yield trials under diverse environments. On a fertile soil and with a well-distributed rainfall of < 800 mm/yr, root DM yields of 21 t/ha/yr (av of top 10 genotypes) were obtained without irrigation or fertilization. DM yields of 12 t/ha/yr were obtained without irrigation in a climate with a 5-mo dry season. Yields of 8 t/ha/yr DM were obtained on acid oxisols of tropical savannas, with moderate fertilizer applications. Several genotypes showed consistently superior performance over a wide range of environments, their yields exceeding those of corresponding local var. by 50-150%. These results confirm that cassava is an efficient carbohydrate producer adapted to a wide range of environments, tolerant to drought and acid soils, and with great potential for genetic improvement. Present farm yields of 3-5 t/ha/yr (DM) could be increased to 10-15 t through simple selection and improved cultural practices. Large-scale carbohydrate production on tropical savanna oxisols is possible by planting improved genotypes (*Author's summary*) G01 D03

0211-4937 KAWANO, K. *et al.* **Factors affecting efficiency of hybridization and selection in cassava.** Crop Science 18(3):373-376. 1978. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Plant breeding. Genetics. Hybridizing. Heterozygosis. Plant fertility. Inheritance. Pollination. Selection. Tuber productivity. Colombia.

An analysis of genetic variability in several populations of *Manihot esculenta* revealed that it is a highly heterozygous species. This species is monoecious, and no genetic or physiological barriers to prevent self-fertilization were found. Both self- and cross-pollination occurred naturally. To ensure genetic isolation, a distance of 30 m between populations was sufficient. Av yield of selfed lines was about 1/2 the av yield of the parental genotypes. The degree of inbreeding depression varied greatly among genotypes. Av yields of populations derived from open pollination of male-fertile genotypes were lower than av yields of those derived from controlled pollinations of the same genotypes. In male-sterile genotypes, no yield difference was observed between the open-pollinated progenies and those from the controlled pollinations. Controlled pollinations are recommended as a general method of hybridization in cassava. If the open pollination method is chosen, male sterile genotypes should be used. Correlations of root yield and harvest index (proportion of root wt to total plant wt) between the seedling plant and the same genotype were high when grown from stem cuttings. Root yield in a single-row trial was no correlated with that in a replicated population trial, but HI was significantly correlated. Intergenotypic competition caused a yield difference of > 100%, but HI difference was not significant. HI was highly heritable and is an excellent selection character. (*Author's summary*) G01

0212-8769 RODRIGUEZ N., A. **Observaciones sobre el germoplasma cubano de yuca.** (*Evaluation of cassava germplasm from Cuba*). La Habana, Cuba. Centro de Información y Documentación Agropecuaria. Información Directa Agrícola no. 8. 1976. 48p. Span., Sum. Span., 20 Refs.

Cassava. *Manihot esculenta*. Germplasm. Cultivars. Identification. Field experiments. Selection. Plant anatomy. Leaves. Tubers. Tuber productivity. Cuba.

The Cuban germplasm collection (140 clones) is being evaluated by the Centro de Mejoramiento de Semillas Agámicas in Santo Domingo, Las Villas. The outstanding characteristics of this germplasm are described. Results are given of 2 experiments conducted to select the most

promising material. The 1st was a comparative 4-yr study of 10 clones. A random block design with 4 replications was used. The most promising var. were Señorita, Pinera, Especial and Baluja no. 1, yielding an av of 35.1, 30.2, 27.5 and 25.8 t/ha, respectively. The insects and diseases that had to be controlled chemically were the shoot fly *Lonchaea chalybea*, the hornworm *Erinnyis ello*, *Cercospora* spp. and *Gloeosporium* sp. The 2nd experiment was conducted at two sites to evaluate 5 promising clones on a red Matanzas clay soil (latosol) and a Santa Clara brown clay (humified alkaline). The outstanding var. were again Señorita and Pinera. There were highly significant differences in yields at both sites, being higher on the Santa Clara brown clay. Señorita is considered a very stable clone and Pinera, stable. (*Summary by T.B.*) G01 B00 D03

0213-9558 SANTOS FILHO, J.M. DOS, VALLE, D.C. DO and SAMPAIO, H.S. DE V. **Alguns aspectos de melhoramento da mandioca.** (*Aspectos of cassava improvement*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.144-155. Port., 24 Refs.

Cassava. Plant breeding. Brazil.

A review is made of literature dealing with the genetic improvement of cassava, including morphological and physiological aspects of the flowers; flowering and factors affecting it; relationships between the aerial part and the roots. The main breeding objectives for cassava are high yield and greater starch content. Protein and HCN contents in the roots, branching habits, interspecific crosses and resistance to diseases and pests are also discussed briefly. (*Summary by J.S. Trans. by T.B.*) G01

0214-3038 STOK, J.E. VAN DER **Onderzoekingen omtrent het cassave-gewas** (*Manihot utilissima* Pohl.). (*Research on cassava*). *In* ——. Onderzoekingen omtrent rijst en tweede gewassen. Batavia, Indonesia, G. Kolff, 1910. pp.120-175. (Mededeelingen uitgaande van het Departement van Landbouw no. 12). Dutch.

Cassava. Plant breeding. Cultivars. Selection. Identification. Starch productivity. Tuber productivity. Cuttings. Propagation. Indonesia.

Research on varietal improvement by selecting plants obtained from open-pollinated seeds of var. Begog and Manis is described. High yield and starch content were the main objectives. Of the 800 seedlings obtained, 93 were selected for further testing. After a yield trial, 16 were selected, several of which yielded more then the mother plants. A description is given of 53 clones, 21 of which are native to Java. Results of a yield trial with these clones are presented. A comparison was made of cuttings derived from different parts of 8-mo-old plants; highest yields were obtained using cuttings from the basal part of the plant. (*Summary by H.J.V.*) G01 D03

0215-1480 THAMBURAJ, S. and MUTHUKRISHNAN, C.R. **Co. I. Tapioca: an improved strain.** Madras Agricultural Journal 64(5):321-324. 1977. Engl., Sum. Engl., 4 Refs.

Cassava. *Manihot esculenta.* **Cultivars. Selection. Tuber productivity. Starch productivity. India.**

Outstanding characteristics are given of Co. 1 Tapioca, a promising new cv. developed at Tamil Nadu Agricultural University (India). This early-maturing cv. (8½-9 mo) yields an av of 29.97 t/ha (35% starch content). The mean increase in yield over local var. is 16.2% and could be increased 20.1% if planted at 75 x 75 cm rather than at the normal spacing of 75 x 90 cm. Mosaic incidence was also low (av 5.4%) as compared with an av of 8.9-45.2% for other var. HCN content of roots was also low (10 µg/g in the pulp and 185 µg/g in the peel). (*Summary by T.B.*) G01 D03

See also 0036 0119 0391 0429

G02 Cytogenetics

0216-4212 LIU, M.C. and CHEN, W.H. **Genetic modification of sugarcane & cassava cells through protoplast & anther culture.** Taiwan Sugar 24(2):304-311. 1977. Engl., Sum. Engl., 81 Refs , Illus.

Cassava. Cytogenetics. Shoots. Anthers. Tissue culture. Hybridizing. Taiwan.

Two new hybridization techniques are protoplast and anther culture. Large populations of viable protoplasts can be enzymatically isolated from a wide var. of plant species. In some cases whole plants have been regenerated from the isolated protoplasts, which can be induced to fuse to form homo- or heterokaryons and in rare cases even true hybrid cells or plants. These unique properties of protoplasts make them ideal for use as a tool to overcome inter- or intraspecific, inter- or intrageneric incompatability. Anther and pollen cultures are efficient means for haploid production, facilitating the breeding of a homozygous plant. These techniques have not been developed successfully for sugar cane or cassava. Proposed collaborative research between the USA and the Republic of China is outlined. Preliminary results obtained with cassava shoot apical protoplasts and cassava anther culture are illustrated. (*Summary by T.B.*) G02

H01 Cassava Foods and Nutritive Value

0217- 9332 ASENJO, C.F. *et al.* **Niacin content of tropical foods.** Food Research 15(6).465-470. 1950. Engl , Sum. Engl., 7 Refs.

Cassava. Nicotinic acid. Vitamin content.

The niacin content of 88 tropical foods from Puerto Rico was determined using a slight modification of the Snell and Wright microbiological procedure. Fresh cassava roots contained an av of 402 µg/100 g. (*Summary by T.M.*) H01

0218- 9330 ASENJO, C.F. *et al.* **Ascorbic acid and dehydroascorbic acid in some raw and cooked Puerto Rican starchy foods.** Food Research 17(2) 132-135. 1952. Engl., Sum. Engl., 9 Refs.

Cassava. Vitamin content. Ascorbic acid. Composition.

The combined ascorbic and dehydroascorbic acid content of 18 starchy vegetables commonly used in Puerto Rican diets was determined before and after cooking. The av loss of these 2 dietary constituents during cooking was 56%, expressed as ascorbic acid Those rating highest were all the varieties of sweet potato tested, cassava, *Arracacia* and the native pumpkin When cooked they contained between 9 and 22 mg/100 g, expressed as ascorbic acid As appreciable amounts of these vegetables are consumed daily, they contribute, no doubt, a significant quantity of ascorbic and dehydroascorbic acids to the insular diets. (*Author's summary*) H01

0219- 4626 AUTRET, M. **Racines et tubercules.** (*Roots and tubers*). Nutrition et Alimentation Tropicales 1957:648-657. 1957. Fr., 8 Refs.

Cassava. Tubers. Cassava flour. Gari. Cassava leaves (vegetable). Composition. Nutritive value. Digestibility. Food energy.

A brief description is given of the following aspects of cassava growing: origin, cultural practices, productivity, cassava products, chemical composition of fresh roots, flour, gari and fresh leaves, amino acid and protein contents, compared to those of sweet potatoes, yams, taro, millet, maize and rice. (*Summary by I.B.Z.*) H01

0220- 1391 CALDWELL, M.J. **Ascorbic acid content of Malaysian leaf vegetables.** Ecology of Food and Nutrition 1(4):313-317. 1972. Engl., Sum. Engl., 14 Refs.

Cassava. Leaves. Ascorbic acid. Composition. Malaysia.

Green leaf vegetables used in Malaysia were analyzed for their ascorbic acid content. Most vegetables were purchased over a period of several mo, and wide variation was found in the ascorbic acid values Av content ranged from 29 mg/100 g (*Diplazium esculentum*) to 643 mg/100 g (*Pteroccocus corniculatus*). Light leaves of cassava var. Tiga Bulan averaged 231 ± 10 and dark leaves, 482 ± 9 mg/100 g Most of the vegetables had significant amounts of ascorbic acid, especially those with dark green leaves. (*Summary by T.B.*) H01

0221-1390 CALDWELL, M.J. and ENOCH, I.C. **Riboflavin content of Malaysian leaf vegetables.** Ecology of Food and Nutrition 1(4):309-312. 1972. Engl., Sum. Engl., 8 Refs.

Cassava. Leaves. Riboflavin. Composition. Malaysia.

Riboflavin deficiency appears to be widespread throughout Southeast Asia, where polished rice is the dietary staple. To determine the potential value of green leaves in increasing riboflavin intake, over 40 species of cultivated and wild Malaysian leaf vegetables were analyzed. Av content ranged from 0.1-0.3 mg/100 g edible portion for cultivated leaves and 0.4-1.2 mg/100 g for noncultivated ones. Light leaves of cassava var. Ubi Landang had 0.33 ± 0.01 and dark leaves, 0.51 ± 0.02 mg/100 g. (*Summary by T.B.*) H01

0222-8725 CAMPOS, F.A. DE M. **A mandioca cozida e a batata doce estudadas em relacao ao complexo vitaminico B.** (*The vitamin B complex in cooked cassava and sweet potatoes*). Folia Clinica et Biológica 9(4):108-112. 1937. Port , Sum. Engl., 6 Refs., Illus.

Cassava. Thiamin. Dietary value. Cooking. Laboratory animals.

Experiments were conducted with white rats to study the vitamin value of boiled sweet cassava roots and raw sweet potatoes. The boiled cassava did not maintain the normal growth curve of the rats; however, nervous symptoms due to B_1 avitaminosis were not observed. When the rats were fed sweet potatoes, body wt increased immediately. It is concluded that cooked cassava roots are high in vitamin B but have little or no riboflavin, whereas raw sweet potatoes are rich in the latter. (*Author's summary*) H01

0223-0058 CAMPOS, F.A. DE M. **Estudo de alguns tubérculos usados na alimentação brasileira.** (*Study of some tubers used in Brazilian nutrition*). *In* Problemas brasileiros de alimentação. São Paulo, Brasil, Serviço de Alimentação da Providencia Social, 1945. pp.77-91. Port., Illus.

Cassava. Cassava tubers (vegetable). Tubers. Cassava starch. Cassava flour. Tapiocas. Nutritive value. Vitamin content. Mineral content. Food energy. Vitamin B. Brazil.

With regard to the nutritional value of cassava, fresh and cooked roots, flour, starch and tapioca were analyzed for their contents of Ca and Fe salts, P, moisture, energetic value and vitamins B1, B2 and B6. A biological evaluation was then made using rats with vitamin deficiencies (symptoms of beribèri, pellagra and acrodynia). The fresh roots were rich in the vitamin B complex; adequate levels were also found in the cooked roots. Thiamine content in the starch was very low, and none was detected in tapioca. (*Summary by T.B.*) H01

0224-2635 CRUZ, A. **Flavina (vitamina B 12) e aipim.** (*Riboflavin content of sweet cassava*). Revista Medica do Paraná 7(4):3. 1938. Port., 4 Refs., Illus.

Cassava. **Riboflavin. Vitamin B. Sweet cassava. Nutritive value.**

In an experiment conducted with growing rats to determine whether sweet cassava contained riboflavin, a factor of the vitamin B complex essential for growth, rats were fed a Hawk-Bergein diet lacking the vitamin B complex. The group given grated sweet cassava gained wt rapidly. It is concluded that cassava contains riboflavin. (*Summary by T.M.*) H01

0225-1976 GALE, M.M and CRAWFORD, M.A. **The effect of African staple foodstuffs on guinea-pig growth curves.** Transactions of the Royal Society of Tropical Medicine and Hygiene 63(6):821-825. 1969. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. Nutritive value. Laboratory animals.

A study was made of the growth curves of young offspring of guinea pigs that had been fed at least 12 wk on diets based on African staple foodstuffs (plantain, cassava, sweet potatoes) The guinea pigs showed depression of growth rates, poor fur and skin condition. The low protein content of the experimental diets was undoubtedly the major factor in growth retardation, but the low fat content and amino acid imbalance shown in 2 of the staples may also be contributing factors. (*Author's summary*) H01

0226-1986 GALE, M.M. and CRAWFORD, M.A. **The effect of dietaty histidine and arginine on growth in the guinea-pig as a test of the amino acid imbalance in plantain and cassava.** Transactions of the Royal Society of Tropical Medicine and Hygiene 63(6).826-832. 1969. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Histidine. Arginine. Dietary value. Laboratory animals. Animal health. Diets. Protein content. Analysis. Bananas-plantain.

Guinea pigs growth curves were studied using diets with the amino acid imbalance found in staple foodstuffs in Africa. Histidine (high in plantains) added to normal guinea pig diets improved growth performance, whereas histidine or arginine (high in cassava) added to low protein diets depressed growth. (*Author's summary*) H01

0227-8406 HEGARTY, P.V.J. and WADSWORTH, G.R. **The amount of iron in processed cassava (*Manihot utilissima*).** Journal of Tropical Medicine and Hygiene 71:51-52. 1968. Engl., 6 Refs.

Cassava. Tubers. Cassava flour. Mineral content. Iron.

The Fe content of unprocessed cassava roots and flour (made in iron househould graters or motor-driven mills) from different villages in Nigeria was determined. Specimens were oven dried at 100°C to a constant wt, and duplicate analyses were made using a slight modification of Wootton's method. The Fe content of flour was 3.2 mg/100 g dry wt whereas that of the fresh roots was 1.0 mg/100 g. The high Fe content of the flour is probably due to contamination with rust from the iron graters Thus actual Fe intake is several times higher than estimated and could meet dietary requirements, depending on the extent to which Fe added by contamination can be absorbed from the intestines. (*Summary by A.J. Trans. by T.M.*) H01

0228-8771 INSTITUT DU MANIOC. **Faites - le avec du tapioca.** (*Recipes using tapioca*). Paris, 197? 15p. Fr., Illus.

Cassava. Tapiocas. Human nutrition.

Recipes using different forms of tapioca for preparing timbales, sauces, soups, croquettes and other dishes are given. A brief history of the use of tapioca, its nutritive, digestive and culinary qualities are also discussed. (*Summary by I.B.Z. Trans. by T.M.*) H01

0229-8743 JAYARAJ, A.P., TOVEY, F.I. and CLARK, C.G. **The possibility of dietary protective factors in duodenal ulcer. II. An investigation into the effect of pre-feeding with different diets and of instillation of foodstuffs into the stomach on the incidence of ulcers in pylorus-ligated rats.** Postgraduate Medical Journal 52(612):640-644. 1976. Engl., Sum. Engl., 22 Refs.

Cassava. Tapiocas. Uses. Laboratory animals. Laboratory experiments. Dietary value.

Rats prefed on a South Indian diet showed a much higher incidence of stomach ulceration after pyloric ligation than those on a North Indian diet. Removing vegetables and pulses from the North Indian diet deprives it of its protective effect. Staple foodstuffs with a high buffer content (unmilled rice, unrefined wheat and a millet) placed in the stomach after pyloric ligation are also protective, but those with a low buffer content (milled rice, tapioca, sorghum and maize) are not. The significance of these findings in relationship to the distribution of duodenal ulcers in India and Africa is discussed. (*Author's summary*) H01

0230-9329 LELONG, M. *et al.* **La floculation de la caséine du lait de vache en présence des empois d'amidon; comparaison entre le tapioca et les autres amidons.** (*Curdling of cow's milk in the presence of starch pastes; comparison of tapioca and other starches*). Archives Françaises de Pédiatrie 22:427-439. 1965. Fr., Sum. Fr., 12 Refs., Illus.

Cassava. Tapiocas. Analysis. Dietary value. Human nutrition.

By boiling flours for 15 min, 4 g made to 100 g with water, gels were prepared and viscosity was measured at 80, 40 and 15°C; pH was measured 1 or 24 h after addition of 0.5 or 1 ml N HCl to 20 ml cow's or human milk, or to 10 ml water or gel, or after adding 0.08 ml N HCl to 10 ml cow's milk with the gels. At 40°, the normal temp for infant feeds, tapioca gave the most viscous gel. At all temp rice was not sufficiently viscous to keep the milk curd suspended. With 0.08 ml, buffering capacity was related to P and ash content of the mixtures with starch; it was least for tapioca and maize, greatest for rice and intermediate for wheat Buffering made little difference to the texture of the curd. Texture of curd and the stability of its suspension were tested in mixtures of cold milk with boiling or cold starch gel. Gels of wheat or rice were heterogeneous and rice stuck to the pan; maize gel was homogeneous but its surface set at 15°. Tapioca could be mixed directly with hot water to a homogeneous gel which when added to milk gave good dispersion and a stable suspension of curd. Tapioca was thought to be best, followed by maize, wheat and rice starch in that order. Published work on digestibility and toleration of tapioca is considered; it should interfere less than the other starches with digestion of milk protein. (*Summary by Nutrition Abstracts and Reviews*) H01

0231-9708 MARTIN, F.W., TELEK, L. and RUBERTE, R. **Some tropical leaves as feasible sources of dietary protein.** Journal of Agriculture of the University of Puerto Rico 61(1):32-40. 1977. Engl., Sum. Engl., 10 Refs.

Cassava. Leaves. Protein content. Dietary value.

The possibility of using 34 tropical plant species found in Puerto Rico for high-protein green leaf vegetables and as sources of leaf protein concentrate was studied. In addition to protein and carotenoid content, they were tested for toxins including alkaloids, hydrocyanic glucosides and oxalic acid. Six species (*Manihot esculenta, Sauropus androgynus, Cnidoscolus chayamansa, Canavalia ensiformis, Lablab niger* and *Vigna unguiculata*) that combine high protein yields with suitable agronomic characteristics were selected for further trials. It is concluded that green leaves are crops of high potential for Puerto Rico and the protein-hungry tropics. (*Author's summary*) H01

0232-1485 NICOL, B.M. and PHILLIPS, P.G. **The utilization of proteins and amino acids in diets based on cassava (*Manihot utilissima*), rice or sorghum (*Sorghum sativa*) by young Nigerian men of low income.** British Journal of Nutrition 39:271-287. 1978. Engl., Sum. Engl., 27 Refs.

Cassava. Human nutrition. Proteins. Amino acids. Diets. Dietary value. Digestibility. Gari. Metbionine. Tryptophane. Human physiology. Rice. Sorghums. Nigeria.

The net protein utilization (NPU) of Nigerian diets based on rice, sorghum or cassava was compared to that of a minimal protein diet used to determine endogenous N excretion, supplemented with whole egg. The addition of DL-methionine and L-tryptophan to the rice diet produced a small but nonsignificant increase in NPU, whereas the addition of DL-methionine to the cassava diet produced a very significant increase in NPU. The NPU of home-pounded sorghum flour was higher than that of milled whole meal sorghum due to the low digestibility of the latter. Digestibility of the rice and cassava diets was the same although the total crude fiber content of the former was lower. The Nigerian men used the proteins of the egg diet and the mixed rice, sorghum and cassava diets more efficiently than predicted by applying FAO/WHO methods (1973). Recommendations of this organization to reduce the amounts of sulfur amino acids and tryptophan contained in the provisional pattern of amino acids proposed by the FAO Committee on Protein Requirements (1957) are supported, but the increases in lysine and threonine are not supported by the present results. (*Author's summary*) H01

0233-7044 SERVOT, J. **Les timbales de cassave. (*Cassava timbales*).** Paris, France, Institut du Tapioca, 1976. 18p. Fr., Illus.

Cassava. Tapiocas. Food products. Human nutrition.

Ten recipes are given for preparing timbales, which are made of a dough containing tapioca, milk, eggs, butter and spices. The timbale is filled with ham, mushrooms, candied fruits, etc. and served with rich sauces made from fruits, cream, vegetables or different liquors The Brazilian legend explaining the origin of cassava (mandioca) is also given. (*Summary by I.B Z. Trans. by T.M.*) H01

0234-0083 UMOH, I.B. and OKE, O.L. **The supplementary role of leaf protein concentrate in some tropical and sub-tropical food in rats.** Nutrition Reports International 16(1):29-35. 1977. Engl., Sum. Engl., 16 Refs.

Cassava. Cassava meal. Protein enrichment. Laboratory animals. Nutritive value. Food energy. Metabolism. Digestibility. Laboratory experiments. Supplements. Proteins.

Rat feeding trials were conducted to evaluate effects of fortification with 10% leaf protein concentrate (LPC) on the nutritional value of diets based on (i) maize starch, together with (ii) cassava powder, (iii) yam flour or (iv) rice powder. A control diet contained no LPC; a diet

fortified with 10% casein was also studied. Tables of data are given for the protein and metabolizable energy contents and the protein efficiency ratio, net protein utilization, biological value, etc. of the diets. Of the supplemented diets, that based on (i) had the highest protein nutritional value followed (in order of decreasing protein nutritional value) by those containing (ii), (iv) and (iii). All the LPC-supplemented diets were of nutritional value inferior to the casein-supplemented diet. It is concluded that LPC may be of value as a protein supplement in human diets based on (i), (ii), (iii) or (iv). (*Summary by Food Science and Technology Abstracts*) H01

0235-5356 VEGA S., G. **Determinación del contenido en clorhidrato de thiamina en algunos alimentos peruanos.** (*Determination of thiamine hydrochloride content in some Peruvian foods*). Boletín de la Sociedad Química del Perú 9(9):62-68. 1943. Span., 10 Refs.

Cassava. Thiamin. Vitamin B. Analysis.

The minimum thiamine required to protect against beriberi is 200 IU although the optimal value is > 400 IU, depending on body wt and total calorie intake. Using the Merck Laboratory method, the vitamin B_1 content of 3 raw and cooked Peruvian foods (potatoes, sweet potatoes and cassava) was determined. Uncooked cassava had 46 IU / 100 g vitamin B_1, as compared with 82 IU for uncooked potatoes. (*Summary by T.M.*) H01

0236-0086 WATLINGTON, F. **Yuca y población en Boriken.** (*Cassava and the population in Borinquen*). Revista de Ciencias Sociales de la Universidad de Puerto Rico nos. 1-2:47-55. 1974. Span., 27 Refs., Illus.

Cassava. History. Socio-economic aspects. Human nutrition. Puerto Rico.

Cassava was a basic foodstuff of the natives in precolonial Puerto Rico. Its potential in human and animal nutrition, as well as industry, in the 2nd half of the 20th century is discussed in accordance with the country's socioeconomic situation. (*Summary by J.S. Trans. by T.B.*) H01

0237-1179 WATSON, J.D. **Ascorbic acid content of plant foods in Ghana and the effects of cooking and storage on vitamin content.** Ecology of Food and Nutrition 4:207-213. 1976. Engl., Sum. Engl., 15 Refs.

Cassava. Cassava products. Ascorbic acid. Dried tubers. Tubers. Gari. Foofoo. Fresh products. Composition. Cooking. Nutrient loss. Storage. Ghana.

In the Ghanaian diet, ascorbic acid may be derived from a no. of plant sources including the starchy roots, tubers and starchy fruits, and when available, leafy and other vegetables Data are presented on the ascorbic acid content of these foods. Losses due to cooking varied considerably, depending on the class of foodstuff and method employed. The starchy roots, tubers and fruits retained some ascorbic acid after cooking whereas leafy vegetables lost the most. Uncooked cassava roots had 41.3 ± 1.35 mg/ 100 g ascorbic acid; boiled roots, 17.4 ± 1.37; foofoo, 18.0 ± 1.16, gari 9.9 ± 1.59 and kokonte, 6.3 ± 0.42. (*Summary by T.B.*) H01

See also 0032 0067 0287 0372 0378 0387 0410 0413

H02 Nutritive Disorders in Humans

0238-9799 BRUDZYNSKI, A., VAN PEE, W. and KORNAZEWSKI, W. **The occurrence of aflatoxin B_1 in peanuts, corn and dried cassava sold at the local market in Kinshasa, Zaire; its coincidence with high hepatoma morbidity among the population.** Zeszyty Problemowe Postepów Nauk Rolniczych 189:113-115. 1977. Engl., Sum.-Pol., Rus., 3 Refs.

Cassava. Toxicology. Moulds. Aflatoxins. Human health. Zaire.

Of several samples of peanuts, maize and cassava tested, some (33% of the dried cassava) were contaminated with aflatoxin B_1, with the mytoxin concentration ranging from $<$ 12 ppb to $>$ 1000 ppb. The favorable climatic conditions for mold growth and the high incidence of hepatomas in the inhabitants of Kinasha are briefly discussed in view of the aflatoxin B_1 content of foods. (*Summary by Chemical Abstracts*) H02

0239-8410 OSAMUDIAME A., J. **The tropical amblyopia syndrome (or tropical nutritional amblyopia) in the Mid-Western State of Nigeria.** African Journal of Medical Sciences 5:41-48. 1976. Engl., Sum. Engl., Fr., 37 Refs., Illus.

Cassava. Ataxic neuropathy. Clinical manifestations. Human health. Etiology. Nigeria.

A report is given of 107 patients from the Mid-Western State of Nigeria with the tropical amblyopia syndrome. Of these, 95 had the ambloypia syndrome, 12 had ambloypia and other manifestations of tropical ataxic neuropathy. This disease is attributed to diets consisting mainly of cassava and its by-products. (*Summary by T.M.*) H02

H03 Animal Feeding

0240-9025 ADEGBOLA, A.A. **Methionine as an additive to cassava-based diets.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.9-17. Engl., Sum. Engl., 44 Refs., Illus.

Cassava. Feeds and feeding. Methionine. Supplements. HCN. Toxicity. Detoxification. Cassava meal. Tubers. Leaves. Nutritive value. Swine. Poultry. Animal nutrition.

Methionine is required by animals for the synthesis of proteins, as a major source of methyl groups; and in cassava-based rations, it serves as a source of sulfate ions for the purpose of detoxication. It shares this role with other sulfur donors such as cystine, thiosulfate and elemental sulfur. The amino acid patterns of cassava leaf meal and cassava root meal show a deficiency of methionine. Added methionine may be required to improve the quality and utilization of dietary protein. In a properly balanced diet, additional methionine may be required primarily for the detoxication of HCN released in the hydrolysis of linamarin and lotaustralin. Levels of 0.2-0.3% methionine for poultry and 0.2% methionine for pigs have been used in rations for these species, and positive responses in terms of growth performance have been obtained in most cases. Attention is drawn to the need to relate responses to added methionine in rations to the levels of protein in the diet, as well as to physical nature and palatability of the feed. There is a need to relate the results of added methionine to the levels of cysteine plus methionine in order to explain better the contradictory observations on urinary thiocynanate, particularly in swine. (*Author's summary*) H03

0241-9034 ALEXANDER, J.C. **Laboratory animal nutrition with fungi grown on cassava.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.85-90. Engl., Sum. Engl., 36 Refs., Illus

Cassava. Cassava starch. Culture media. Protein enrichment. Laboratory animals. Nutritive value. Proteins. Analysis. Amino acids. Methionine. Supplements. Fermentation. Industrial microbiology. Laboratory experiments.

Various strains of fungi including *Aspergillus fumigatus* were grown on media based on cassava carbohydrate and evaluated for their nutritional quality, including safety for use as an animal feed. All samples had a low sulfur amino acid level. Biological evaluations included protein efficiency ratio (PER) and net protein ratio (NPR) methods, with male weanling rats. The protein control showed significantly better results for PER, NPR and wt gain than the fungal proteins. However, by basing the dietary protein on the α-amino acid content and supplementing it with

methionine, there was much better rat performance. The feeding of *A. fumigatus* resulted in increased relative kidney weights; and at high levels of intake (30 and 40%) more blood urea N, and a drop in blood albumin. A deficiency in methionine, due to reduced feed consumption, may have contributed to these changes. No significant differences between the control and experimental groups were found by histopathological examinations. (*Author's summary*) H03 103

0242- 9732 AÑEZ F., R. **Análisis económico de la alimentación de cerdos a base de yuca (*Manihot esculenta*).** (*Economic analysis of cassava-based rations for swine*). Tesis Zoot. Jusepín, Venezuela, Universidad de Oriente. Escuela de Zootecnia, 1973. 52p. Span., Sum. Span., Engl., 4 Refs.

Cassava. Animal nutrition. Swine. Economics. Costs. Fattening. Finishing. Income. Feeds and feeding. Feed constituents. Venezuela.

The economic advantages of using protein-supplemented fresh cassava roots in diets for growing-finishing pigs were studied in a 99-day feeding trial using 40 65-day-old crossbred Duroc x Yorkshire x Landrace. Animals were distributed at random in 5 treatment groups with 4 replications each. Four treatments consisted of fresh chopped cassava roots fed ad libitum + a protein supplement (av 53.8% protein) consisting of cottonseed, sesame, peanut, fish and meat meals and lysine. The 5th treatment was a commercially prepared diet. Capital gains and net income were calculated for the growing and finishing periods, as well as for the total feeding period. The 4 cassava-based diets showed the highest capital gains and net income for all periods whereas the commercial diet represented an actual loss in net income. During the growing period and in the overall evaluation, the commercial diet showed a very small capital gain; during the finishing period, this value was negative. Based on the analysis of results, properly supplemented fresh cassava gives higher net income, as compared to a commercial diet, which was uneconomical in this case. (*Author's summary*) H03 J00

0243- 1382 ARGAÑOSA, V.G. **Cassava as feed for swine.** Agriculture at Los Baños 14(2):13-14. 1975. Engl.

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

The costs, advantages and disadvantages of using different %s of fresh cassava, cooked roots or meal in life-cycle swine feeding are discussed on the basis of experiences of several Philippine pork producers and trials conducted at the University of the Philippines at Los Baños. (*Summary by T.B.*) H03

0244- 2989 ATHANASSOF, N. **Mandioca para as vaccas leiteiras.** (*Cassava for dairy cows*). Chácaras e Quintaes 12(6):455. 1915. Port.

Cassava. Animal nutrition. Dairy cattle. Brazil.

The use of cassava in animal nutrition is discussed briefly. Dairy cows give good milk on 10 kg of fresh cassava roots/head/day. Although inferior in quality, meal can also be used. Cassava meal + skim milk can be given to calves. The aerial part of sweet var. can also be used as green forage. (*Summary by T.M.*) H03

0245- 1487 BOON, O.C. **A comparison of sago flour versus tapioca root meal with varying proportions of fish meal and soybean meal for growing/finishing pigs.** Malaysian Agricultural Journal 50(4):427-434. 1976. Engl., Sum. Engl., 14 Refs.

Cassava. Cassava meal. Sago. Swine. Finishing. Fattening. Diets. Composition. Dietary value. Costs. Animal nutrition. Malaysia.

Six pigs (av 20 kg) in 4 groups (2 groups of Large White, 1 of Landrace and 1 of Tamworth crosses) were fed 6 different treatments ad libitum to compare the use of 2nd grade sago flour and cassava meal as energy sources for growing-finishing pigs, using different fish meal/soybean meal mixtures as main protein supplements. Sago flour gave significantly lower growth rates but was comparatively cheaper than cassava rations, in terms of kg feed as well as kg wt gain. No significant difference was found between the use of fish or soybean meals, but the combined use of both these protein sources gave better feed efficiency and also resulted in a reduction of feeding costs. (*Summary by T.B.*) H03

0246-1698 BROUWER, E. **Voederproef met tapiocameel bij melkvee.** (*Cassava meal for dairy cattle*). *In* Vereeniging tot exploitatie eener proefzuivelboerderij te Hoorn. Hoorn, Holland, A. Houdik, 1932. pp.79-111. Dutch.

Cassava. Cassava meal. Dairy cattle. Feeds and feeding. Nutritive value. Feed constituents. Supplements. Composition. Diets.

Cassava meal (CM) is a feedstuff rich in carbohydrates and poor in proteins and minerals. Av data from analyses of 41 samples of CM (in %s) were proteins 1.5, fat 0.5, carbohydrates 91.5, cellulose 4.1 and minerals 2.2. Vitamin A and B contents were low. The effect of a ration containing 2.24 kg CM and 0.39 kg peanut meal given daily to cows was compared to rations containing 2.45 kg maize meal (control). The group on CM and peanut meal produced somewhat less milk and fat-free DM than the control group, but the % of fat was 0.1% higher so total butterfat production was equal for both groups. It is concluded that CM can be used very well in rations for dairy cows when it is properly supplemented with protein-rich feedstuffs. (*Summary by H.J.V.*) H03

0247-8350 BUITRAGO A., J. **Resultados de estudios recientes en nutrición de cerdos.** (*Results of recent studies on swine nutrition*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 197? 5p. Span.

Cassava. Waste utilization. Finishing. Fattening. Swine. Feeds and feeding. Animal nutrition. Colombia.

A bried description is given of swine-feeding trials using different forms of cassava, soybean soap stock and dehydrated chicken manure as substitutes for maize. It has been found than 30 and 60% dehydrated cassava ampas (by-product of starch extraction) can be used satisfactorily to replace maize in diets for growing-finishing pigs. One of the problems of using fresh cassava roots is their conservation for long periods of time. Promising results have been obtained with growing-finishing pigs fed roots that had been stored in plastic bags for 30-40 days. (*Summary by T.M.*) H03

0248-9566 CAMPOS, O.D. DE *et al.* **Valor nutritivo da raspa de mandioca e do bagaço de cana para rumiantes.** (*Nutritive value of cassava chip meal and sugar cane bagasse for ruminants*). Revista Ceres 24(135):521-529. 1977. Port., Sum. Engl , Port., 10 Refs.

Cassava. Cassava meal. Sheep. Protein content. Dry matter. Food energy. Digestibility. Feeds and feeding. Feed constituents. Proteins. Nutritive value. Animal nutrition. Brazil.

The apparent digestibility of DM, gross energy and crude protein of cassava meal (CM) and sugar cane bagasse (SCB) was studied with sheep kept in metabolism cages. CM was fed alone or

supplemented with soybean meal (SBM), the SCB was given with CM and/or SBM. Apparent digestibility coefficients for the CM and SCB, respectively, were 81.7 and 26.6% for DM, 11.3 and 11.7% for crude protein, and 85.2 and 43.8% for gross energy. Digestible crude protein was 0.3% for CM and 0.2% for SCB; the respective digestible energy contents were 2864 and 1743 kcal/kg. The TDN calculated from the digestible energy values were 65 1% for CM and 39.6% for SCB. (*Author's summary*) H03

0249-9424 CHRISTENSEN, A.C., KNIGHT, A.D. and RAUSCHER, G.E. **An evaluation of cassava root meal as an energy source for broiler chicks.** Turrialba 27(2).147-149 1977. Engl., Sum. Engl., Span., 6 Refs.

Cassava. Cassava meal. Chicks. Feeds and feeding. Food energy. Dietary value. Cooking. Animal nutrition.

A study was undertaken to evaluate cassava meal made from peeled, cooked roots as an energy source replacement for maize. Rations providing 2 levels of fish meal (10 and 20%) and 4 levels of cassava meal (0, 21, 43 and 60%) were fed to broilers for 7 wk. Each of the rations was supplemented with 0.20% d-l methionine. Growth was not adversely affected when maize was replaced by cassava meal. It is concluded that cassava meal supplemented with methionine and protein can satisfactorily replace all or part of the maize in a ration for growing broilers, provided mineral and vitamin levels are adequate. (*Author's summary*) H03

0250-9728 CONTRERAS D., R.E. **Yuca fresca suplementada en la alimentación de cerdos en crecimiento.** (*Fresh cassava in diets for growing pigs*). Tesis Zoot. Jusepín, Venezuela, Universidad de Oriente. Escuela de Zootecnia, 1973. 35p. Span., Sum. Span., Engl., 31 Refs., Illus.

Cassava. Tubers. Swine. Fattening. Supplements. Feed constituents. Fresh products. Proteins. Dietary value. Sweet cassava. Venezuela.

The nutritional value of fresh cassava in diets for growing pigs was studied in a 60-day feeding experiment using 8-wk-old crossbred Duroc x Yorkshire x Landrace. Forty animals were allotted at random to 5 treatments with 4 replications each. Four groups were given chopped fresh sweet cassava roots + protein supplement (cottonseed, sesame, peanut, fish and meat meals and lysine); the 5th group was given a commercial feed. Daily av feed intake (kg), wt gain (kg) and feed conversion (feed/gain) were (I) 1.58, 0.594, 2.66; (II) 1.52, 0.568, 2.63; (III) 1.56, 0.642, 2.44; (IV) 1.49, 0.535, 2.79; and (V) 1.38, 0.619, 2.24. Treatment V showed the best feed conversion ($P < 0.01$). Of the cassava-based diets, treatment III was the best ($P < 0.01$). There were no significant differences in intake or in gain. Results indicate than when chopped fresh sweet cassava is properly supplemented, it can be utilized as the only energy source for feeding growing pigs. (*Author's summary*) H03

0251-1472 CRESWELL, D.C. **Cassava (*Manihot esculenta* Crantz) as a feed for pigs and poultry - A review.** Tropical Agriculture 55(3):273-282. 1978. Engl., 45 Refs.

Cassava. Cassava meal. Leaves. Swine. Poultry. Dietary value. Animal nutrition.

A bibliographic review was made of the use of cassava roots and leaves for feeding swine and poultry. It was concluded that cassava can contribute substantially to the energy requirements but not as the sole energy source. Differences in findings related to total balance of dietary nutrients and levels of potential toxicity are discussed. Methionine supplementation is important, especially for its role in detoxification and metabolic removal of cyanogenic glucosides. Reasons for low palatability (fine powdery nature of dried cassava) and possible solutions (adding molasses and fat) are mentioned. More data are needed on the economic advantages of using

cassava at high dietary levels, taking into account animal performance as well as the relative costs of cassava and other energy and protein sources. Limited data are available on cassava leaf meal, but it seems to be a valuable protein source; limiting factors are methionine and energy. (*Summary by T.B.*) H03

0252-1162 DEVENDRA, C. and LEE KOK CHOO, T. **Studies on Kedah-Kelantan cattle. II. The effect of feeding increasing levels of tapioca (*Manihot esculenta* Pohl) on growth.** MARDI Research Bulletin 4(1):80-89. 1976. Engl., Sum. Engl., Mal , 14 Refs , Illus.

Cassava. Animal nutrition. Calves. Cassava chips. Feed constituents. Dietary value. Concentrates. Animal physiology. Forage. Malaysia.

The inherent growth potential of Kedah-Kelantan cattle was further evaluated when given an increased energy supply in the form of cassava chips. For 490 days, 3 groups of 12 calves were fed 40, 60 and 80% cassava chips in the concentrate, which made up 25% of the total DM intake, *Pennisetum purpureum* provided the remaining 75%. The main ingredients of the isonitrogenous diets were copra cake, molasses and urea (the sole source of dietary N in treatment 3). Changes in body measurements, liveweight gain and efficiency of feed conversion were measured There were no statistically significant differences in the parameters measured. However, the best daily liveweight gain of 312.9 g confirmed the previously obtained value of 318.7 g and a higher growth capacity for this cattle than was believed. The data (in comparison to an earlier study) also suggested that up to 60% cassava chips in the concentrate diet was optimal. There were statistically significant ($P < 0.01$) correlations between heart girth, height at withers, body length, hip width with liveweight. (*Author's summary*) H03

0253-8724 DEVENDRA, C. **Studies on the utilisation of rice straw by sheep. IV. Effect of carbohydrate source on the utilisation of dietary urea and nitrogen retention.** Malaysian Agricultural Journal 50(3):358-370. 1976. Engl., Sum. Engl., 43 Refs., Illus.

Cassava. Sheep. Cassava chips. Dietary value. Feeds and feeding. Feed constituents. Digestibility. Diets. Composition. Animal physiology. Animal nutrition. Supplements. Malaysia.

The effect of the carbohydrate sources molasses, maize and cassava on the utilization of dietary urea and N retention in sheep was studied in 2 trials: Trial 1 with 9 isonitrogenous treatments (3 each) on 20, 40 and 60% rice straw + molasses, maize, copra cake and urea; and Trial 2 with 10 treatments with a 30% rice straw level, 5 of which were also given cassava chips. In each case the crude protein requirements supplied entirely by urea ranged from 6.3-14.2% in the dry matter. In both trials statistically significant differences were noted on daily DM and N intake. Highest DM intake with cassava supplementation was probably stimulated by a change in the pattern of rumen fermentation, with the production of more propionate. When cassava was added, N retention was further increased significantly ($P < 0.05$). (*Summary by Abstracts on Tropical Agriculture*) H03

0254-1488 DEVENDRA, C. **The utilisation of poultry excreta by sheep.** Malaysian Agricultural Journal 50(4).513-522. 1976. Engl., Sum. Engl., 39 Refs.

Cassava. Cassava chips. Sheep. Animal nutrition. Feed constituents. Supplements. Malaysia.

The digestibility of increasing levels of poultry manure (0, 10, 20, 30 and 40%) in molasses-based isonitrogenous diets (40% molasses, 15% cassava chips, copra cake, urea and mineral supplements) was evaluated using 20 native Malaysian sheep 4-5 yr old (20-24 kg) in two 21-day trials (14 days adaptation, 7 days collection period). For all components measured, apparent

digestibility decreased with increasing levels of manure. Except for crude fiber digestibility in trial I and P digestibility in both trials, there were statistically significant treatment differences ($P < 0.05$) in apparent digestibility. High crude protein digestibility was consistent with the fact that up to 65% total crude protein requirements were supplied by the poultry manure. It was concluded that 20-30% poultry manure was optimal in terms of DM and crude protein digestibility. (*Summary by T.B.*) H03

0255-9037 DEVENDRA, C. Cassava as a feed source for ruminants. *In* Nestel, B. and Graham, M , eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.107-119. Engl., Sum. Engl., 120 Refs

Cassava. Animal nutrition. Cattle. Feeds and feeding. Leaves. Tubers. Stems. Composition. Goats. Sheep. Beef cattle. Dairy cattle. Feed constituents. Digestibility. HCN. Toxicity.

A review of literature revealed that present knowledge concerning cassava as a feed source for ruminants with respect to type of feeds from the cassava plant, nutritive value, utilization of leaves, stems and roots, pattern of starch digestion, utilization of nitrogen, and HCN toxicity is limited. The approx. proportions of principal products and by-products of the cassava plant at maturity are 6% leaves, 44% stems and 50% roots. The roots are made up of 8% peel, 11% water, 31% starch; and pomace, a by-product of starch manufacture, contributes 17% (chemical compositon is reported). The crude protein content of the leaves is relatively high, but they have been inadequately used as a protein source. A 25% level of cassava forage (leaves + stems) with 75% grass appears to be promising Roots can be substituted for cereals or other carbohydrate energy sources without any loss in performance, especially of dairy and beef cattle, with attendant feed cost reductions. The potential to increase the use of roots and leaves to supply energy and protein requirements and possibly use leaves and stems as forage is quite enormous. (*Author's summary*) H03

0256-1469 ENRIQUEZ V., F., ARTEAGA F., C. and AVILA G., E. Harina de yuca (*Manihot esculenta*) en dietas para pollos de engorde y gallinas en postura. (*Cassava meal for broiler chicks and layers*). Técnica Pecuaria en México 32:53-57. 1977. Span., Sum. Span., Engl., 11 Refs

Cassava. Cassava meal. Chicks. Poultry. Feeds and feeding. Feed constituents. Diets. Dietary value. Animal nutrition. Eggs. Mexico.

The use of 15, 30 and 45% cassava meal (CM) as a substitute for maize was evaluated in diets for broiler chicks (0-8 wk old). At 45% CM, wt gains of the chicks decreased significantly, but at 15 and 30% there were no detrimental effects. In a 2nd experiment with layers, the use of 29.5 and 59% CM (replacing 50 and 100% maize) was evaluated. At the 59% level (100% substitution), there was no effect on egg production, egg wt and feed conversion of White Leghorn hens over an 84-day period. (*Author's summary*) H03

0257-1395 FURNEMONT, A. Alimentation artificielle des veaux (type economiseur de lait). (*Cassava flour in diets for calves*). Bulletin Agricole du Rwanda 9(3):163-170. 1976. Fr.

Cassava. Cassava flour. Calves. Animal nutrition. Economics. Feeds and feeding. Africa.

An experiment was conducted at the station of Songa to find a diet low in whole milk for raising calves until they reach 8 mo, with a daily wt gain of 600 g and to overcome the crisis of weaning without problems. Crossbred Jersey x Sahiwal, Jersey x Ankole and a few pure Ankole were

given cassava flour.(120-300 g/day) as a part of their concentrated diet from the 4th-13th wk, when they received no more milk. The animals should be allowed to graze from the 3rd wk on. Based on 1974 prices, this type of artificial feeding for calves is profitable as long as the mothers produce a min of 1200 liters of milk during these 8 mo. Moreover, this diet has the advantage that the calves are accustomed to grazing and can overcome the crisis of weaning more easily. (*Summary by S.S. de S. Trans. by T.B.*) H03

0258-4125 GAVIDIA S., C. **Uso de la yuca para engorde de cerdos en Tarapoto.** (*Cassava for fattening swine in Tarapoto*). Tarapoto, Perú. Centro Regional de Investigación Agropecuaria del Oriente. Avances en Investigación 1(1):37-47. 1977. Span., Sum. Span., 5 Refs.

Cassava. Swine. Fattening. Tubers. Feeds and feeding. Supplements. Costs. Dietary value. Peru.

A comparison was made of 100% cassava rations (fresh roots) supplemented with 15 or 27% vegetable protein and 100% maize (unsupplemented), the feed normally used by farmers in Tarapoto, Peru for fattening pigs (treatments B, C and A, respectively). Av initial wt of the animals was 30 kg; the experiment was terminated when the 1st lot of pigs reached market wt (90 kg liveweight) at 93 days. Av wt gains were 26.2, 62.4 and 57.1 kg for treatments A, B and C, respectively; respective feed conversion rates were 5.8, 3.8 and 3.3. Differences between treatments B and C were not significant; C is preferred, however, because less concentrate (and more cassava) is used. An economic analysis showed that cassava treatments (B and C) were much more profitable than the maize control (A), which actually gave a small loss. (*Summary by T.B.*) H03

0259-9031 GOMEZ, G. **Life-cycle swine feeding systems with cassava.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.65-71. Engl., Sum. Engl., 23 Refs.

Cassava. Cassava meal. Swine. Fattening. Finishing. HCN. Toxicity. Cassava tubers (vegetable) Proteins. Supplements. Feeds and feeding. Dietary value. Feeds and feeding. Animal nutrition. Colombia.

Sweet cassava roots are an excellent source of energy for swine feeding if properly supplemented with protein, vitamins and minerals. Fresh bitter cassava roots are not readily consumed by pigs because of their high linamarin content. Chopped fresh cassava can be fed to pigs throughout their life cycle, separately or mixed with a protein supplement. A tendency to overconsume the protein supplement and therefore to waste the excess protein was observed in all experiments where fresh cassava and supplement were fed ad libitum and separately. A life-cycle swine feeding program based on the use of high levels of cassava meal (60-70%) was tested at CIAT and compared with a conventional common maize feeding program. Soybean meal was the protein source used for all diets. Gilts in the cassava meal feeding program grew more slowly during pregestation and gestation, as compared with the gilts in the control program. However, gilts fed the cassava diets gained weight during lactation, whereas the gilts from the maize feeding program lost weight during the same period. Litter performance at weaning was significantly inferior for the gilts fed the cassava meal diets; and since feed consumption was similar for both experimental groups, the amount of diet required to produce a weaned pig in the cassava feeding program was significantly higher than in the common maize feeding program. Recent experimental information suggests that methionine suplementation is not the factor responsible for the lower reproductive performance obtained in the cassava meal feeding program. (*Author's summary*) H03

0260-1376 GOMEZ, G.G. and BUITRAGO A., J. **Effect of processing on nutrient content of feeds: root crops.** Cleveland, Ohio, Handbook of Nutrition and Food, 1977. 47p. Engl., Sum. Engl., 64 Refs.

Cassava. Cassava flour. Cassava meal. Cassava starch. Cassava chips. Pellets. Processing. Storage. Animal nutrition. Nutritive value. Silage. Composition. Bitter cassava. Sweet cassava.

Roots and tubers are important staples for people in the tropics and are basically grown for food. Recent developments in crops such as cassava, potatoes and sweet potatoes may lead to an increased production, which would make alternative uses (e.g., animal feedstuffs) for roots and tubers feasible. This chapter reviews the root and tuber crops of major importance in human and animal nutrition: cassava, potatoes, sweet potatoes, yams and taro. Fresh roots and tubers have a high moisture content and are therefore highly perishable when harvested; postharvest losses have been estimated at 25% of production. The main causes of postharvest losses, as well as methods for storing fresh roots and tubers, are reviewed. These methods consist mainly in preserving the nutritive quality of roots and tubers for human consumption and minimizing postharvest losses. Conservation of the product for long periods requires different processing methods. The production of starch, chips, pellets, meal and flour, as well as dehydration, canning and fermentation processes, are reviewed with special reference to cassava and potato products. In addition to obtaining stable storable products, processing methods usually change the physical properties of roots and tubers, resulting in improved feeding value. In the case of bitter cassava roots and potatoes, toxic factors are reduced through processing. Because of their high-quality starch, roots and tubers are valuable potential products for animal feedstuffs. Extensive experimental evidence on the use of cassava, potatoes and sweet potatoes suggests the possibility of partially or totally substituting them for conventional energy-supplying feeds. The use of root crops in animal feeding is reviewed. (*Author's summary*) H03 I02

0261-3070 GROSSMAN, J. and OLIVEIRA, W.M. DE **A mandioca em comparação com o milho na alimentação do gado leiteiro.** (*Cassava as compared with maize in dairy cattle feeding*). Boletim da Diretoria da Produção Animal 5(10).3-15. 1950. Port., Sum. Port., Illus.

Cassava. Maize. Dairy cattle. Feeds and feeding. Feed constituents. Animal nutrition. Costs. Economics. Brazil.

Results are given of a 3-mo experiment conducted in Montenegro, territory of Amapá (Brazil), comparing the use of chopped cassava and groung maize in dairy cattle feeding Five groups of 3 cows each were given one of the following diets: (I) 100% cassava (13.7 kg/head/day), (II) 100% maize (4.4 kg/head/day), (III) 50% cassava + 50% maize, (IV) 75% cassava + 25% maize and (V) the inverse of (IV). Different quantities of alfalfa, linseed cake and rice bran were also given in accordance with the production rates of each cow. The most profitable treatments were III and II; the least profitable, I; there were, however, no significant differences in the cost of feed/kg milk produced. The use of cassava depends on its cost in comparison to other forages since it must be balanced for protein. (*Summary by T.B.*) H03

0262-8734 GUEGUEN, L., FOREST, R. and DURAN, M. **Utilisation du phosphate monoammonique chez le mouton. I. Utilisation comparée du phosphore des phosphates monoammonique et monosodique et influence sur le métabolisme du calcium et du magnésium.** [*Utilization of monoammonium phosphate by sheep. I. Comparative utilization of phosphones (from monoammonium and monosodium phosphates) and effect on calcium and magnesium metabolism*]. Annales de Zootechnie 25(1):111-118. 1976. Fr., Sum. Fr., Engl., 11 Refs.

Cassava. Cassava meal. Sheep. Nutritive value. Animal physiology. Minerals. Metabolism.

Two consecutive mineral balance experiments were carried out with 5 male lambs weighing about 30 kg and fed a diet containing beet pulps and cassava with a low P content (1.3 g/kg DM) and a high Ca content (10 g/kg). The basal diet was enriched with P either derived from monosodium phosphate (diet 1) or from monoammonium phosphate (diet 2) in order to triple the P level. A parallel trial with isotopic dilution (after injection of ^{32}P) was realized on 4 animals in order to determine the endogenous fecal losses of P, which increased with P intake. Urinary losses of P and Ca were always negligible; those of Mg were relatively large. On account of the amount of endogenous fecal P (55-60 mg of P/kg liveweight/day), the true availability of P was 62% on an average for the 2 diets. This indicates an intestinal availability of phosphate P exceeding 65% in spite of the presence of an excess of dietary Ca. The true availability of Ca was low, but noticeably higher for diet 2 (21%) than for diet 1 (14%). Acidification due to monoammonium phosphate did not have any unfavorable action on mineral metabolism since Ca and Mg balances were improved. The biological efficiency of monoammonium phosphate was at least equal or superior to that of monosodium phosphate. (*Summary by Biological Abstracts*) H03

0263-4767 HANSSON, N. **Maniokakli, ett nytt inom Sverige tillverkadt fodermedel.** (*A new fodder for domestic animals*). Kungliga Landtbruks Akademiens Handlingar och Tidskrift 52:370-376. 1913. Swed., Sum. Swed., 3 Refs

Cassava. Feeds and feeding. Domestic animals. Nutritive value. Animal nutrition.

Maniokakli is a trade name given to a cassava bran product, whose chemical composition is as follows: H_2O, 16; N, 6.25-2.81; ether extract, 0.79; fiber, 6.57; starch, 59.93; other carbohydrates, 12.01; ash, 1.89%. It gives favorable results when fed, but other substances should also be given to raise the % of protein in the ration. (*Summary by Chemical Abstracts*) H03

0264-9026 HUTAGALUNG, R I. **Additives other than methionine in cassava diets.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.18-32. Engl., Sum. Engl., 245 Refs.

Cassava. Feeds and feeding. Feed constituents. Supplements. Minerals. Amino acids. Proteins. Chicks. Swine. Nutritive value. Animal nutrition.

The problems of nutritional insufficiencies and metabolic diseases associated with feeding cassava-based diets and the roles of feed additives intended to alleviate these are discussed. Improvements in the nutritive value of cassava-based diet with feed additives can be made through (1) adjustments in the energy (nutrient) density by adding fats or oils, sugar or molasses and balancing the source and level of protein, amino acids, minerals, vitamins and pigments, or (2) enrichment by microbial fermentation. The primary consideration in the improvement of cassava products through either feed additive fortification or microbial enrichment should be the economic feasibility of substitution with conventional feedstuffs and their safety for animal feeds, as well as the suitability of the subsequent animal products for human consumption (*Author's summary*) H03

0265-0195 HUTANUWATR, N. *et al.* **Pelleted cassava root meals as an energy source for finishing steers.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978. pp.131-135. Engl., Illus.

Cassava. Animal nutrition. Pellets. Food energy. Beef cattle. Diets. Composition. Feed constituents. Dietary value. Cassava programs. Thailand.

Nine groups of 3 yearling steers (Brahman x native) were fed (1) 60.6% pelleted cassava meal + 15.9% soybean meal, (2) 73.8% ground maize + 2.7% SBM, or (3) 30.3% cassava meal, 36.9% ground maize + 9.3% SBM. Differences in av daily gain, daily feed intake, feed/gain ratio and dressing % were not significant. Nevertheless, performance in terms of av daily gain and daily feed intake of steers receiving treatment 2 tended to be superior. Overall performance was relatively low, which might be due to the limited genetic potential of the experimental animals and/or feed intake. Av intake as % of av body wt was 2.216, 2.041 and 2.314, respectively, for the 3 treatments (*Summary by T.M.*) H03

0266-1164 IRIKI, T., SHIBUI, H. and ABE, M. **Effects of supplemental fish meal and corn gluten meal in a diet containing urea and cassava on the growth and the nitrogen retention of steers.** Japanese Journal of Zootechnical Science 48(12):748-756. 1977. Engl., Sum. Engl, Jap., 22 Refs.

Cassava. Cattle. Animal nutrition. Cassava meal. Supplements. Feed constituents. Fish meal. Maize meal. Digestibility. Animal physiology. Diets.

The effect of 2 protein sources with different amino acid composition in cassava meal- and urea-based diets on growth and N retention of 9 Holstein steers (av 130 kg) was studied in a 12-wk trial. Concentrations of plasma free amino acids were also determined. Treatment 1 (control) consisted of 73.2% cassava meal (CM) + 6% urea; 82.4% of total N was derived from the urea and the rest from CM. Treatments 2 and 3 used 70% CM and 4% urea; 55.1 or 54.0% total N were derived from urea and 25.9% from fish meal or 26.3% from maize gluten meal, respectively. All groups were fed chopped rice straw and water ad libitum. Groups 2 and 3 tended to grow more rapidly than the control, but differences were not significant. Plasma levels of leucine and aspartic acid were significantly higher ($P < 0.05$) in groups 2 and 3; levels of lysine and isoleucine were significantly higher (P 0.05) in group 2. In an N-balance trial, 3 Holstein steers (ca. 200 kg) were assigned to each of the concentrate diets used in the growth trial and fed daily 4.5 kg concentrate, 600 g rice straw and allowed free access to water. N retention of group 3 was significantly higher (P 0.05) than the other 2 groups. Plasma levels of leucine and proline were also significantly higher (P 0.05). No remarkable changes were observed in plasma amino acid patterns between group 2 and the control (*Author's summary*) H03

0267-4433 JENTSCH, W. *et al.* **Die energetische Verwertung der Futterstoffe. VII. Die energetische Verwertung der Knollen und Wurzeln durch Ratten.** (*Utilization of the energy of feeds. VII. Utilization of the energy of tubers and roots by rats*). Archiv für Tierernahrung 16:11-31. 1966. Germ., Sum. Germ., Rus., Engl., 12 Refs.

Cassava. Cassava meal. Cassava chips. Food energy. Nutrient loss. Digestibility. Metabolism. Composition. Laboratory animals. Dietary value. Tubers.

Groups of 5 male white Wistar rats (210-310 g wt) were used in experiments calculating the net energy value of roots and tubers. There were 3 basal diets with a cereal and cerealy by-product, meat or fish meal and legume oil meal, dried skimmed milk, minerals and vitamins. Feeds tested were potatoes, Jerusalem artichoke tubers, sugar beets, fodder beets, carrots, cassava meal and chips. Of 156 metabolism experiments with the basal diets, 140 were used; and of the 130 with the test feeds, 117. Special trials were made to ensure that there was no loss of volatile substances during storage and drying of the roots and tubers. Results of those thests are reported. Tables show gross energy value and chemical composition in terms of organic matter, ash, crude protein, true protein, crude fat, crude fiber, N-free extract, cellulose, pentosans, lignin, undetermined carbohydrate and sugar; digestibility of organic matter, crude protein, crude fat, crude fiber, N-free extract and energy; digestible crude protein, crude fat, crude fiber and N-free extract in g/kg DM; metabolizable energy; net energy as kcal/kg DM and per kg digestible organic matter and as a % of metabolizable and of digestible energy; and finally measured and calculated net energy

values are compared. Two equations for calculating net energy are presented, one for roots and tubers rich in polysaccharides and one for those rich in sugar. (*Summary by Nutrition Abstracts and Reviews*) H03

0268-0149 KHAJARERN, J. **The maximum economic replacement of maize by cassava root meal in broiler diets.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.71-85. Engl., Sum. Engl., 11 Refs.

Cassava. Animal nutrition. Chicks. Cassava meal. Pellets. Maize. Diets. Composition. Feed constituents. Dietary value. Costs. Cassava programs. Economics. Thailand.

An experiment was conducted to determine the substitutional value of cassava pellets for maize in broiler rations, using a randomized complete block design with 6 dietary treatments and 4 replications. A diet consisting of a blended mixture of the 6 diets was fed to 1200 1-day-old Arbor Acres chicks during the 1st wk of age. Then each group of 50 chicks was fed a diet with 0, 20, 30, 40, 50 or 57.5% cassava pellets; the maize-based diet was not pelleted. Cassava pellets fully replaced maize in the broiler rations when diets were carefully balanced in all nutrients, especially protein and methionine. Rations containing high levels of cassava must be given in pelleted form for maximum performance. Cassava-based diets must be fortified by natural or synthetic pigmentations (carophyll or xanthophyll) to maintain the quality of carcass appearance. (*Author's summary*) H03

0269-0145 KHAJARERN, J. **The maximum economic replacement of maize by cassava root chips in broiler diets.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.86-104. Engl., Sum. Engl., 15 Refs.

Cassava. Animal nutrition. Chicks. Cassava chips. Proteins. Methionine. Supplements. Diets. Composition. Feed constituents. Food energy. Pellets. Cassava programs. Thailand.

Six groups of 1200 Arbor Acres broiler chicks were fed 0, 20, 30, 40, 50 and 57.5% pelleted cassava chips from 1-9 wk of age. Each group of 200 birds was divided into 4 replications. Cassava chips fully replaced maize when diets were carefully balanced for all nutrients, especially methionine, protein and energy. Although there was a tendency towards poorer growth and feed conversion with increasing cassava, the chicks fed 57.5% cassava gained wt as rapidly as and had even better feed efficiency than those on the maize-based diet. Incorporation of chips up to 57% had no adverse effect on carcass grade, dressing % and carcass composition. Thus the replacement of maize by cassava will depend not only on the adjustment of protein, amino acids and energy content but also on the development of mechanical methods of processing to eliminate the bulkiness of the diet and undigestible factors, especially crude fiber, ash and other growth-depressing factors. For maximum performance, broiler chicks must be given high levels of cassava chips in pelleted form. (*Author's summary*) H03

0270-0153 KHAJARERN, J. **A preliminary study on the utilization of cassava products as energy source for broilers.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp 54-70. Engl., Sum. Engl., 10 Refs.

Cassava. Animal nutrition. Chicks. Cassava meal. Pellets. Diets. Composition. Feed constituents. Supplements. Dietary value. Cassava programs. Thailand.

A preliminary experiment was conducted to determine the substitutional value of cassava meal for maize in broiler rations, using a randomized complete block design with 6 dietary treatments and 4 replications. A diet mixture containing about 25% cassava was fed to 600 one-day-old Arbor Acres broiler chicks for a 1-wk preparation period. Then each group of 25 chicks was fed a mash diet containing 0, 10, 20, 30, 40 or 50% cassava pellets until they were 9 wk of age. Poorer wt gain and feed conversion during wk 1-5 were observed with increasing levels of pellets. At a level of 30%, cassava satisfactorily replaced maize from wk 1-5; 50% from wk 5-9; and 40% from wk 1-9 when rations were balanced with protein and methionine. Carcass quality of cassava-fed chicks was similar to that of the maize-fed control group. It was also observed that as the chicks grew older, their ability to utilize cassava pellets increased. (*Author's summary*) H03

0271-0180 KHAJARERN, J.M. *et al.* **Biological titration of Thai cassava root products of various quality grades with broiler chicks.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978. pp.34-62. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Animal nutrition. Chicks. Cassava chips. Pellets. Nutritive value. HCN. Composition. Supplements. Minerals. Feed constituents. Animal physiology. Cassava programs. Thailand.

Four experiments with 4132 broiler chicks were conducted to determine the nutritive value of several cassava products as compared to maize-based diets and a local commercial product. It was found that cassava chips were a poorer energy source for young chicks than pellets. Previously washed and rapidly dried chips were not a consistently superior energy source for broilers when compared to other conventionally prepared products; they also had a higher HCN content, which might be the major cause of the decreased performance of the chicks. Further studies should be made of the relationship of drying period to HCN content. Maize diets gave performance comparable to the cassava diets but inferior to the commercial ones, which had a higher protein concentration. It is concluded that up to 57.5% cassava pellets can be used to replace maize in diets for broiler chicks, provided the diet is duly balanced for all essential microingredients. Chip quality can be improved by washing and partial peeling of the roots. If chips are dried to an acceptable moisture content, they would be a more suitable energy source than the pellets, which are more adulterated. (*Summary by T.M.*) H03

0272-0186 KHAJARERN, S. *et al.* **Biological tritation of Thai cassava root products of** various quality grades. *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978. pp.121-131. Engl , Sum. Engl., 1 Ref., Illus.

Cassava. Cassava products. Cassava chips. Swine. Fattening. Finishing. Cassava meal. Diets. Composition. Feed constituents. Animal nutrition. Cassava programs. Thailand.

In an experiment using units of 3 pigs (total 36) assigned to 1 of 4 dietary treatments, an evaluation was made of graded levels (40-50-60 and 50-60-70%) of the best quality cassava products as compared to maize and commercial diets. Results are given up to the finishing period (pigs weigh approx 90 kg). Available data suggest that cassava meal can be totally substituted for maize in all diets for market pigs. Performance of pigs on the higher cassava diets was comparable to that of the pigs given commercial rations. Another experiment has been initiated to evaluate 3 grades of cassava root products against the commercial diets to substantiate the findings of this experiment. (*Author's summary*) H03

0273-9030 KHAJARERN, S. *et al.* **Cassava in the nutrition of swine.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977.

Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.56-64. Engl., Sum. Engl., 103 Refs.

Cassava. Tubers. Leaves. Cassava meal. Protein enrichment. Feeds and feeding. Nutritive value. Diets. Composition. Swine. Animal nutrition.

A review of the nutritive value of cassava products and the utilization of these products in swine rations is presented. It is generally agreed that cassava root products can be used successfully as an energy source for swine. The products, once properly prepared and carefully balanced for all nutrients, can be used at levels of 40-75% in diets for growing-finishing swine without adversely affecting performance or carcass characteristics. Both the technical and economic aspects of the limitations and the fortifications required for the utilization of the products are discussed. Experimental results at Khon Kaen University have demonstrated that cassava root products at levels as high as 50 and 68-70% can be incorporated successfully in starting and growing-finishing diets, respectively. The possibility of lowering the protein level in swine rations containing high levels of cassava root meal is suggested because the protein quality, once fortified with methionine, is higher in cassava-based than in cereal-based diets. (*Author's summary*) H03

0274-0102 KHAJARERN, S. **The economic replacement of maize by cassava root meal in swine rations.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.140-159. Engl., Sum. Engl., 43 Refs.

Cassava. Animal nutrition. Economics. Swine. Cassava meal. Fattening. Maize. Diets. Composition. Finishing. Cassava programs. Thailand.

Thai cassava root products of moderate quality (3.5% crude fiber and 4.0% ash) replaced maize at levels of 30-60, 40-70 and 60-70% of diets for pigs from 17-35, 35-60 and 60-100 kg body wt, respectively. Cassava-fed pigs performed as well, consumed as much pelletized feed and had as good-quality carcass as the control group fed a maize-based diet. In addition, it was 2-5% cheaper to raise pigs on cassava under the conditions of this experiment. The margin of profit could be increased if cassava-based diets were introduced to the pigs at the proper growth period; this requires further study. (*Author's summary*) H03

0275-0126 KHAJARERN, S. **A preliminary study of the substituting cassava root meal for cereals and their by-products in swine ration.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.122-139. Engl., Sum. Engl., 10 Refs.

Cassava. Animal nutrition. Swine. Cassava meal. Cereals. Diets. Composition. Feed constituents. Fattening. Finishing. Supplements. Cassava programs. Thailand.

An experiment was conducted to study performance of pigs in terms of av daily gain, feed/gain and production costs when rations were based on graded levels of cassava meal instead of the conventional cereals. It was observed that pigs grew at a slower rate and required more feed/kg gain as cassava levels increased from 0 to 65% in each growth period. Production costs followed the same pattern as the amount of feed required per kg gain. Pigs fed diets containing more than 33% cassava had lower feed intake, which was probably due to bulkiness, dusty texture and low palatability. Another highly probable limiting factor in high cassava diets is the deficiency of sulfur-containing amino acids, particularly methionine. This is due to the use of soybean meal as the protein balancer. Supplementing methionine at the level of 0.1% may not be sufficient for optimum performance. (*Author's summary*) H03

0276-0184 KHAJARERN, S. *et al.* **An evaluation of the comparative feeding value of cassava root meal, sorghum, maize and rice by-products as energy sources for pigs.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand. 1978. pp.109-120. Engl., Sum. Engl., 4 Refs

Cassava. Cassava meal. Swine. Fattening. Finishing. Palatability. Dietary value. Feed constituents. Diets. Composition. Animal nutrition. Sorghums. Rice. Maize. Cassava programs. Thailand.

In a randomized complete block experiment, units of 3 pigs (total 36) were assigned to 1 of 4 dietary treatments based on sorghum, maize, rice by-products and cassava meal, respectively, as the main energy source. The cassava product was used at 50, 60 and 70%, respectively, in the starting, growing and finishing diets. There were 3 replications. Based on available data from this ongoing experiment, cassava at 50% of the diet was not fully utilized by starting pigs. Once body wt was >35 kg, the pigs were able to use 60% cassava as well as the sorghum, maize or rice by-products. Palatability seemed to be one of the major drawbacks of the cassava-based diets. (*Author's summary*) H03

0277-9336 KHOR, G.L. *et al.* **Safety evaluation of *Aspergillus fumigatus* grown on cassava for use as an animal feed.** Canadian Journal of Comparative Medicine 41(4) 428-434. 1977. Engl., Sum. Engl., Fr., 13 Refs.

Cassava. Industrial microbiology. Laboratory animals. Feeds and feeding. Diets. Composition. Biochemistry. Animal physiology. Animal nutrition.

A safety evaluation was made of *Aspergillus fumigatus* 121, grown in a cassava carbohydrate and salts medium. Male weanling rats were fed the fungus at 20, 30 and 40% of the diet for 90 days. A control group was given soybean oil meal as the sole protein source. Weekly determinations of body wt and feed intake were made. A few days prior to termination of the feeding study, a kidney function test was carried out. At the end of the feeding period hematology, blood biochemistry, urine analyses and histopathology studies of various tissues were carried out, and organs were weighed. Rats fed *A. fumigatus* 121 gained less wt than the controls, but kidney wt increased. Increases in serum alkaline phosphatase and glutamic-oxaloacetic transaminase were not related to dosis level. Blood urea N was increased for rats fed 40% of the fungus. Rats fed 30 and 40% of the fungus showed a significant drop in albumin. Deficiency in methionine or other essential amino acids due to limited feed intake may have caused a decrease in albumin synthesis Rats fed the highest level of the fungus showed increases in neutrophils and monocytes concomitant with decreases in lymphocytes and eosinophils, which may be a response to stress. Urine analyses did not reveal any significant differences. The test rats were capable of concentrating urine adequately when deprived of water for 24 h. No significant differences between the control and experimental groups were found by histopathological examinations. (*Author's summary*) H03 I03

0278-0091 KITPANIT, N. **The economic substitution of cassava root meal for the conventional energy feedstuffs in swine rations.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.160-172. Engl., Sum. Engl., 19 Refs.

Cassava. Animal nutrition. Economics. Swine. Cassava meal. Fattening. Finishing. Supplements. Feed constituents. Diets. Composition. Cassava programs. Thailand.

An experiment was conducted to evaluate the use of Thai cassava pellet products to replace conventional energy feedstuffs (maize, rice and rice polishings) at levels of 30 or 50% in starting diets, 38 or 68% in growing diets and 60 or 70% in finishing diets for pigs. Growth performance

consistently showed that cassava meal of moderate quality could be successfully incorporated into pelletized diets for pigs up to 50% for starting rations and 68-70% for the growing-finishing period. There were no statistical differences in carcass characteristicis of these pigs at market wt, except lower dressing % and thinner back fat. (*Summary by T.M.*) H03

0279-0189 KITPANIT, N., VIBULCHAI, A. and INTAWONG, B. **The substitution of maize by cassava root meal in swine ration.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978 pp.97-108. Engl., Sum. Engl., 15 Refs.

Cassava. Animal nutrition. Swine. Cassava meal. Maize. Fattening. Finishing. Diets. Composition. Feed constituents. Cassava programs. Thailand.

Three groups of 9 pigs each were fed a maize mash diet or 30-40-50 and 50-60-70% Grade A cassava chips containing 21.5, 16.0 and 14.0% crude protein during the starting, growing and finishing periods, respectively. Av daily gain, feed/gain, feed intake and feed cost/kg gain were not significantly different among treatments during any growth period except daily feed intake, feed/gain, feed cost/kg gain in the finishing period and overall feed cost/kg gain. Overall feed/gain of cassava-fed pigs was superior to the control group. There were no differences in carcass characteristics except carcass length; pigs receiving 30% cassava had significantly shorter carcasses than the other 2 groups. These pigs also had lowest wt when slaughtered for carcass evaluation. It is concluded that levels of Grade A cassava as high as 50, 60 and 70% can be substituted for maize in starting, growing and finishing diets without any adverse effects on growth performance or carcass characteristics of pigs. (*Summary by T.M.*) H03

0280-9268 KUMAR, M.N.A. and MATHUR, M.L. **Effect of feeding urea along with tapioca in the ration on the growth of calves.** Indian Journal of Dairy Science 23.198-200. 1970. Engl., 7 Refs., Illus.

Cassava. Calves. Feeds and feeding. Urea. Digestibility. Dietary value. Feed constituents. Animal nutrition. India.

Nine male Red Sindhi calves 26 wk old and of similar body weight were given 4.5 kg freshly chopped Para grass and hay to appetite and the rest of the required digestible crude protein and total digestible nutrients were provided by mixtures with cassava and 0.1 or 2% urea. Av gains were 62.5, 58 and 65 kg, respectively, up to 52 wk of age. Av intake of concentrate mixture during the experiment was 187, 176 and 181 kg, intake of Para grass was 874, 779 and 792 kg; and that of hay was 169, 139 and 176 kg. The av intake of urea was 0, 1.6 and 2.4 kg. Cost of feeding was less with cassava and urea. Av daily intake of DM was 2.79, 2.41 and 2.55 kg. (*Summary by Nutrition Abstracts and Reviews*) H03

0281-9709 LANGUIDEY, P.H. *et al.* **Melaço de cana e/ou mandioca desecada em rações contendo uréia para novilhos de corte.** (*Molasses and/or dried cassava in beef steer rations containing urea*). Arquivos da Escola de Veterinaria da Universidade Federal de Minas Gerais 28(3):307-315. 1976. Port., Sum. Engl., Port., 25 Refs.; Illus.

Cassava. Dried tubers. Beef cattle. Molasses. Feed constituents. Dietary value. Forage. Animal nutrition. Brazil.

The efficiency of sugar cane molasses and dried cassava roots on the utilization of urea was evaluated in a random complete block design using 40 Holstein x zebu steers. The 5 treatments were A - molasses + urea; B - dried cassava + urea; C - molasses + dried cassava + urea; D - dried cassava + urea (high energy); and E - molasses + dried cassava + urea (high energy). The 140-day

feeding trial was divided into a 28-day adaptation period and a 112-day experimental period. Av daily gains for the experimental period were 427, 667, 602, 791 and 763 g, respectively, for the 5 treatments There were significant differences ($P < 0.05$) among treatments All were superior to treatment A, and high-energy treatments D and E were superior to the low-energy B and C. It is concluded that molasses is not an adequate energy source as compared to dried cassava for fattening steers fed *Pennisetum purpureum* ad libitum with 7.5% urea added to the energy source. (*Author's summary*) H03

0282-1934 A **MANDIOCA** na alimentação das vaccas letteiras. (*Cassava for dairy cows*). Agricultura e Pecuaria 2:688. 1930. Port.

Cassava. Dairy cattle. Animal nutrition. Feeds and feeding. Brazil.

The use of cassava roots and branches for dairy cattle in Bahia and Paraná (Brazil) is described. From 5-10 kg of roots are given in the form of dry chips, which store longer. The branches can be fed fresh or in the form of meal (preferred), to which is added a little salt or maize meal. The meal cannot be stored more than 48 h because it ferments and turns liquid. The use of bitter var. is recommended because they are more productive; because of their toxicity, however, they should not be given to the cattle until 3 days after harvest. Cassava-based rations should be supplemented with feedstuffs rich in N (wheat or alfalfa meals, cotton or linseed cakes). (*Summary by I.B.Z. Trans. by T.B.*) H03

0283-9710 MANICKAM, R., GOPALKRISHNAN, C.A. and SADASIVAN, PILLAI, K.G. **Studies on feeding of tapioca in pigs.** Indian Journal of Animal Research 10(1):11-16. 1976 Engl., Sum. Engl., 9 Refs.

Cassava. Cassava chips. Swine. Feed constituents. Feeds and feeding. Costs. Fattening. Animal nutrition. India.

The use of 100% cassava chips to replace maize in rations for Large White Yorkshire pigs was studied at Tamil Nadu Agricultural University. Av total and daily wt gain did not differ significantly. Better feed efficiency was observed in the cassava diet. Carcass length, back fat thickness, loin eye area and dressing % were almost the same. Production costs are given; the use of cassava chips is economical. (*Author's summary*) H03

0284-8740 MELLO, R.P. DE *et al.* **Milho desintegrado com palha e sabugo e raspa de mandioca, combinados com diferentes fontes protéicas no arraçoamento de novilhos em confinamento.** (*Ground ears of maize and cassava meal, combined with different protein sources, in feedlot feeding of steers and heifers*). Revista da Sociedade Brasileira de Zootecnia 5(1).70-82. 1976. Port., Sum. Port., Engl., 21 Refs.

Cassava. Cassava meal. Maize. Beef cattle. Diets. Dry matter. Protein content. Mineral content. Dietary value. Animal nutrition. Animal physiology. Brazil.

The partial replacement of ground soybeans by urea (10%) and/or fish meal (20%) in the presence of 2 energy sources (ground ears of maize and cassava meal) was studied in a 98-day feeding trial with 40 heifers and 40 steers (Swiss x zebu), 14 mo old, using a randomized complete block design The soybeans and urea were not mixed together. Sorghum silage, minerals and water were given ad libitum Animals receiving cassava meal gained significantly more wt ($P < 0.05$) than those receiving ground ears of maize. Although wt gains did not reach expected levels, it is interesting to note that crude protein intake was similar to NAS (1970) requirements; however, DM and TDN intake was slightly lower than the required. (*Author's summary*) H03

0285-3034 MEYRELES, L., MACLEOD, N.A. and PRESTON, T.R. **Forraje de yuca como fuente proteica en dietas de caña de azúcar para el ganado: efecto de diferentes niveles de yuca y urea sobre parámetros de fermentación ruminal.** (*Cassava forage as a source of protein in diets for cattle based on sugar cane: effect of different levels of cassava and urea on parameters of ruminal fermentation*). Producción Animal Tropical 2:309-314. 1978. Span., Sum. Span., 12 Refs., Illus.

Cassava. Forage. Cattle. Feeds and feeding. Dietary value. Animal physiology. Animal nutrition. Dominical Republic.

The use of cassava forage (0, 20, 40, 60%) as a source of protein in sugar cane/urea based diets for 18-mo-old zebu steers confined in cages was assessed in a Latin square design for 14 days at the Centro Dominicano de Investigación Pecuaria con Caña de Azúcar (Sto. Domingo). The diets were balanced for N, using a urea and ammonium sulfate solution. The sugar cane had 27.5% DM and 14.2°Brix; the cassava forage had 20% DM (2.4% N). There were no significant differences in the principal parameters of ruminal fermentation or in the level of blood urea; parameters did vary, however, according to time of sampling, following patterns established by other authors. It appears that the protein in cassava forage is easily soluble. Voluntary intake of DM was significantly greater for the 3 cassava forage diets. (*Summary by T.B.*) H03

0286-3035 MEYRELES, L. and PRESTON, T.R. **Forrage de yuca como fuente proteica en dietas de caña para ganado: efecto de la adición de azufre y harina de raíz de yuca.** (*Cassava forage as a source of protein in diets for cattle based on sugar cane: effect of adding sulfur and cassava meal*). Producción Animal Tropical 2.289-292 1978. Span., Sum. Span., 8 Refs.

Cassava. Forage. Cassava meal. Cattle. Feeds and feeding. S. Animal nutrition. Dietary value. Dominican Republic.

A 2 x 2 factorial design with 2 replications was used at the Centro Dominicano de Investigación Pecuaria con Caña de Azúcar (Sto Domingo) to evaluate the effect of supplementing a basal diet of fresh chopped sugar cane (80%) and cassava forage (20%) with supplemental sulfur (57 g ammonium sulfate/day) and cassava meal (500 g/day) on 24 zebu steers (12-18 mo old, av wt 165 kg), confined in cages for 84 days. The cassava forage, cut 3-5 mo after regrowth, had a DM content of 25.2%; the sugar cane had 23.6% DM and 10.7°Brix. Daily wt gain decreased with the addition of ammonium sulfate (290 vs 257 g) but increased with cassava meal (240 vs. 307 g). Although wt gains were better than in a previous trial, they were considerably lower than the potential (800 g/day); the possible reasons for these results are discussed. (*Summary by T.B.*) H03

0287-1478 MICHAELIS, O.E., NACE, C.S. and SZEPESI, B. **Effect of refeeding raw and cooked starches on hepatic enzyme activities of rats.** British Journal of Nutrition 39(1).85-89 1978. Engl., Sum. Engl., 21 Refs., Illus.

Cassava. Cassava starch. Laboratory animals. Animal physiology. Enzymes. Feeds and feedings. Cooked starches. Animal nutrition.

Responses of hepatic glucose-6-phosphate dehydrogenase (EC 1.1.1.49; G6PD), malic enzyme (EC 1.1.1.40; ME), acetyl-CoA carboxylase (EC 6.4.1.2; ACAC) and fatty acid synthetase (FAS) were studied in male Wistar rats after a period of starvation and refeeding of diets containing 400 g glucose or raw or cooked starches (maize, potato, wheat, rice, cassava) as the source of carbohydrate. When compared to rats on the glucose diet, those on raw maize or rice starch diets had a significantly lower ME response; and rats on raw potato starch had significantly lower G6PD, ME, ACAC and FAS responses. Enzyme responses of rats given cooked starches were similar to those of glucose-fed rats, except for those on cooked wheat starch, which had

significantly lower G6PD and ME responses. When the enzyme responses to refeeding of the same starch source in either raw or cooked form were compared, it was found that (1) the FAS response was significantly higher to cooked than to raw maize starch, (2) the G6PD and ACAC responses were significantly higher to cooked than to raw potato starch. These results suggest that reported differences in the lipogenic enzyme responses between simple sugars and starch may in some instances be magnified because of the use of uncooked starches in experimental diets. (*Author's summary*) H03 H01

0288-9036 MONTALDO, A. **Whole plant utilization of cassav for animal feed.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.95-106. Engl., Sum. Engl., 62 Refs., Illus.

Cassava. Tubers. Leaves. Cassava meal. Cassava chips. Wastes. Foliage. Nutritive value. Composition. Animal nutrition.

Cassava is an important food crop in the tropics. Both fresh and dry roots and foliage (leaves and stems) are used in animal nutrition. The root is a good carbohydrate source (80-90%). The aerial part of the plant (stems, branches and leaves) has a protein content as high as 17%. Foliage can be cut from the plant at 4 mo and then every 60-75 days to give 4 t of crude protein/ha/yr. In Venezuela, cassava meal can be produced for about 1/5 the cost of imported alfalfa meal. By using cassava products for 70% of the rations, it is estimated that 6 kg of poultry meat, 5 kg of pork and 200 eggs/person could be supplied to the 2 3 billion people in the tropics, using only a fraction of the area that would be required for an equivalent production of animal products based on cereals and oil seed crops. (*Author's summary*) H03

0289-9028 MONTILLA, J.J. **Cassava in the nutrition of broilers.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.43-50. Engl., Sum. Engl., 40 Refs.

Cassava. Chicks. Feeds and feeding. Cassava meal. Leaves. Stalks. Feed constituents. Nutritive value. Animal nutrition. Pellets.

One of the main obstacles to efficient animal production in the tropics is the lack of excess agricultural products that can be used as raw materials for animal rations. Cassava products (roots and foliage) appear to be one of the best possibilities for overcoming the chronic deficit in tropical agricultural production. The majority of the research carried out during the last 10 yr shows that cassava root flour can be substituted for cereals in broiler rations at levels of up to 30%. When the diets are prepared in the form of pellets, it appears possible to use cassava root meal and cassava foliage meal at levels up to 50 and 20%, respectively. The author strongly believes that even if a deterioration of 10% occurs in body wt increase and feed efficiency, cassava-based diets can be an economically feasible proposition within the framework of the developing countries It is proposed that broiler feeding experiments utilizing cassava products not only evaluate body wt increase and feed efficiency but also state the product yield in terms of production/ha as this is a more logical approach to an agricultural activity. In addition, several areas of research requiring emphasis are suggested. (*Author's summary*)H03

0290-1926 OLSON, D.W., SUNDE, M.L. and BIRD, H.R. **The metabolizable energy content and feeding value of mandioca meals in diets for chicks.** Poultry Science 48(4):1445-1452. 1969. Engl., Sum Engl., 13 Refs.

Cassava. Cassava meal. Chicks. Feeds and feeding. Food energy. Dietary value. Animal physiology. Metabolism. Feed constituents. Animal nutrition. Diets. Composition. Supplements.

Metabolizable energy determinations were conducted on samples of cassava meal. In 5 trials with 2 replications each, cassava meal contained 3.44 kcal/g on a DM basis. Two 4-wk experiments evaluated 0–45% (increases of 7.5%) cassava meal as a replacement for maize in diets for chicks. Corresponding increases were made in animal fat and soybean meal supplementation to maintain energy and protein. Although growth was slightly depressed as levels of cassava increased, reductions were significant only at 37.5 and 45%. It is concluded that cassava meal can be incorporated up to 30% in chick rations without sacrificing gain if the ration is balanced with respect to protein and energy. (*Author's summary*) H03

0291-9029 OMOLE, T.A. **Cassava in the nutrition of layers.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.51-55. Engl., Sum. Engl., 56 Refs.

Cassava. Animal nutrition. Poultry. Cassava meal. Leaves. Composition. HCN. Toxicity. Detoxification. Nutritive value. Dietary value. Methionine. Supplements. Feeds and feeding.

The high price of cereal grains and their low production level in the tropics have led to an increase in the price of eggs There is an urgent need for an alternate source of dietary energy for egg production. Cassava yields several times more energy per hectare than maize or guinea corn and poses fewer storage problems. As a result of the release of HCN from cassava, this paper studies its effect on nutrient availability, nutrient utilization, efficiency of production and egg quality of layers fed cassava diets The irreversible reaction of hydroxycobalamin with cyanide to form cyanocobalamin is beneficial in promoting the release of the available form of vitamin B_{12} in the process of cyanide detoxication by the layers. The activity of the shell gland of the layer may be depressed by the action of HCN, which combines with hemoglobin to form a nonoxygen-carrying compound cyanohemoglobin. Also, cytochrome oxidase activity may be reduced as HCN forms a reversible complex with the copper of the oxidase system. Iodine availability is similarly hampered in layers fed cassava diets. The result of these reactions may be low hatchability, prolonged hatching time and depressed production rate. However, up to 60% cassava root meal may be fed to layers if the diets is well balanced in other nutrients The use of 0 5% cassava leaf meal may remove the yolk color problem; whereas egg wt may be increased by the use of added fat and synthetic methionine Since cassava is high in ascorbic acid, egg shell thickness may not be a problem at high temp. More extensive studies are recommended (*Author's summary*) H03

0292-8739 PEIXOTO, R.R. and MAIER, J.C. **Influência da presagem (pellets) de ração inicial para aves com elevado teor de farinha de mandioca.** (*Value of initial ration pellets with a high cassava meal content for poultry*). Revista da Sociedade Brasileira de Zootecnia 4(2):115-121. 1975. Port., Sum. Port., Engl., 6 Refs.

Cassava. Pellets. Cassava meal. Chicks. Feed constituents. Dietary value. Animal nutrition. Brazil.

An experiment was conducted at the Universidade Federal de Pelotas (Brazil) to evaluate the effect of pelleting rations with a high cassava meal or maize content on the performance of 4-wk-old chicks. Results showed that pelleting increased ($P<0.05$) wt gain and feed intake significantly for both diets. It is believed that increased consumption was the main reason for improved performance. (*Author's summary*) H03

0293-8741 PEIXOTO, R.R. and FARIAS, J.V. DA S. **Estudo da influência da prensagem (pellets) de ração com elevado teor de farinha de mandioca no desempenho de porcos em crescimento e terminação, e nas características da carcaça.** (*Value of ration pellets with a high cassava meal content for growing-finishing swine*). Revista da Sociedade Brasileira de Zootecnia 5(1):1-8. 1976. Port., Sum. Port., Engl., 11 Refs.

Cassava. Pellets. Swine. Fattening. Finishing. Feed constituents. Cassava meal. Dietary value. Animal nutrition. Brazil.

A feeding trial with 32 growing-finishing pigs was conducted at the Universidade Federal de Pelotas (Brazil) to compare the use of meal and pelleted rations containing a high percentage of cassava meal. A raondomized block design was used. Analysis of variance did not show any difference between treatments. It was concluded that pelleting did not improve pig performance or carcass characteristics; however, pellets were very hard and results might be improved by breaking them up and feeding them free choice in automatic feeders. (*Author's summary*) H03

0294-0212 PHALARAKSH, K. *et al.* **The economic replacement of maize by cassava root meal in starter, grower, developer and layer diets.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978. pp.63-80. Engl., 6 Refs.

Cassava. Poultry. Cassava meal. Feeds and feeding. Diets. Feed constituents. Dietary value. Eggs. Cassava programs. Animal nutrition. Composition. Thailand.

In previous reports, results are given of 800 pullets given 40, 60 and 60% cassava meal (CM) in starter, grower and developer diets, respectively. In this experiment all pullets fed 0% CM from the developmental period were pooled and randomly distributed into 8 groups of individual laying cages and assigned to 0 and 50% CM for ten 28-day periods. In addition all pullets on 60% CM from the developmental period were handled similarly, making this a completely randomized block with 4 blocks and 4 treatments. Layer performance is summarized in 10 tables Based on these data the following conclusions were reached: With the exception of egg production, previous findings were confirmed that there was no adverse effect on subsequent egg wt, albumen height, shell thickness or mortality when pullets were fed up to 60% CM during the growing period and up to 50% during the laying period. Contrarily, the layer diet containing 50% CM caused lower egg production on the hen-day basis than those fed maize. Further studies are needed to elucidate the real inhibiting factors in the cassava root that lower egg production, especially for the tropical heavy layers. Guidelines are given for future research work along these lines. (*Summary by T.B.*) H03 J00

0295-0132 PHALARAKSH, K. **The economic replacement of maize by cassava root meal in starter, grower, developer and layer diets.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.105-121. Engl., Sum. Engl., 22 Refs.

Cassava. Animal nutrition. Poultry. Cassava meal. Chicks. Maize. Dietary value. Feed constituents. Diets. Composition. Cassava programs. Thailand.

A total of 800 female chicks were assessed for body wt, feed/gain and mortality as influenced by 40, 50 and 60% cassava meal in starter, grower and developer diets, respectively. Feed cost and cost of ready-to-lay pullet production were also determined. Out of the 800 pullets 384 birds were alloted to test the effect of 50% cassava meal in the layer diet on performance for ten 28-day laying periods. Dietary treatments were a 2 x 2 factorial combination of maize- or cassava-based prelaying diets, each of which was subdivided into maize- and 50% cassava-based laying diets. The ability of chicks to utilize cassava meal increased with age. With the balanced pelleted diets,

there is the possibility and advantages of using cassava meal in the ready-to-lay pullet production. Data from the 1st 28-day laying period indicated statistically similar results between the maize and 50% cassava meal diet for performance, except for the Haugh units which were higher in the cassava treatment. Conclusions cannot be drawn since the experiment is still under way. (*Author's summary*) H03

0296-0213 PHALARKSH, K. *et al.* **An evaluation of the replacing value of cassava root meal for maize, broken rice or sorghum in starter, grower, developer and layer diets.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand. 1978. pp.81-95. Engl., 3 Refs., Illus.

Cassava. Poultry. Cassava meal. Feeds and feeding. Diets. Supplements. Composition. Animal physiology. Animal nutrition. Cassava programs. Feed constituents. Costs. Thailand.

Earlier findings showed that it was possible to replace maize with 40, 60 and 60% cassava meal (CM) in diets for starter, grower and developer birds but that layer performance on 50% CM was inferior to the maize control. The present experiment was conducted to confirm previous findings and to determine the factor(s) responsible for poor performance, and to compare the feeding value of CM with other conventional cereals (maize, broken rice and sorghum). The composition and analyses of the different starter, grower, developer and layer diets are given in tables. Based on the results, it is concluded that Thai CM can be used without adverse effects at levels as high as 40, 60 and 60% of starter, grower and developer diets, respectively. In terms of body wt, feed/gain and mortality, CM gave results similar to those for maize, broken rice and sorghum. From an economic standpoint, the sorghum diets had the lowest feed cost/bird of the diets, the rest of which were similar to each other. Between maize and cassava, however, the birds on CM tended to have a slightly lower production cost. Data on the laying period could not be obtained because of the lack of uniformity of supplied feedstuffs and the breakdown of the pellet mill. This experiment is being repeated. (*Summary by T.B.*) H03 J00

0297-3506 SILVA, J.F.C. DA *et al.* **Raspa de mandioca e melaço como veículos da uréia para bovinos em confinamento.** (*The utilization of urea in cassava meal and molasses mixtures for steers in dry-lot feeding stems*). Revista Ceres 24(132): 134-140. 1977. Port., Sum Port., Engl., 16 Refs.

Cassava. Cassava meal. Beef cattle. Feeds and feeding. Feed constituents. Supplements. Animal nutrition. Brazil.

An evaluation was made of the utilization of urea in 3 feed mixtures used as protein-energy supplements to napier grass (*Pennisetum purpureum*) in a dry-lot feeding system for beef cattle at the U. Federal de Viçosa (Minas Gerais, Brazil). In a randomized block design with 21 Holstein x Zebu crossbred steers (42 mo old, av 379 kg), animals were given chopped grass and mineral mixtures ad libitum. The 3 treatments, all containing 1.0 kg cottonseed meal, were as follows: (A) 3.6 kg cassava meal (0,2 kg urea), (B) 4.0 kg molasses (5% urea), and (C) the same as (B) but using a commercial molasses preparation containing Ca and phosphoric acid. Av daily wt gains were 0.544, 0.292 and 0.482 kg for A, B and C, repectively; but differences were not statistically significant. Animals in (A) consumed significantly more mineralized salt than those fed molasses ($P < 0.05$). There were no significant differences in DM intake. (*Author's summary Trans. by T.B.*) H03

0298-0070 UMOH. I.B. and OKE. O.L. **Cassava-leaf mixture as animal feed II.** Nutrition Reports International 16(6):821-824. 1977. Engl., Sum. Engl., 4 Refs.

Cassava. Cassava starch. Leaves. Proteins. Feed constituents. Dietary value. Animal nutrition.

Cassava was substituted for maize starch at levels of 0-40% in rat diets, using leaf protein concentrate (LPC) as the only source of protein. With maize starch only, LPC proved to be a suitable source with high digestibility, 89; biological value (BV), 74; net protein utilization, 66; and protein efficienty ratio (PER), 1.8. At 20% replacement there was no significant change in parameters (PER 1.7); but at 40%, PER decreased considerably (0.4), as did the other parameters. Supplementation with methionine at levels of 0-0.3% showed that 0.15% gave max effect, with a better PER (2.3) than the control. The other parameters followed the same trend. (*Author's summary*) H03

0299-4219 UMOH, I.B. **Effect of levels of cassava on the utilization of leaf protein in the rat.** Nutrition Reports International 16(4):397-402. 1977. Engl., Sum. Engl., 11 Refs.

Cassava. Concentrates. Proteins. Dietary value. Laboratory animals. Animal physiology. Feed constituents. Animal nutrition. Nigeria.

The nutritive value of 15% leaf protein concentrate (LPC) in 6 cassava-based diets (20-70% pulverized chips) was compared to a casein reference diet and a non-protein control (maize starch) in a 14-day bioassay with rats. All rations were highly digestible (86-94%). The PER of the control was 1.90% at 20% cassava, it dropped to 1.60, after which it fell rapidly until the 60% level when the PER became negative (-0.48). NPU and BV followed the same tendencies. In all cases the values for all parameters were significantly lower than the casein diet. There was a noticeable decrease in liver wt, kidney wt increased, and there were no particular changes in thyroid gland wt. In general LPC was better utilized at levels of up to 40% cassava. At 60% cassava, wt losses, growth retardation, loss of fur and signs of malnutrition occurred. (*Summary by T.B.*) H03

0300-1079 VOON FONG, H. and HUTAGALUNG, R.I. **Aflatoxicosis in swine feeding.** MARDI Research Bulletin 5(2):122-128. 1977. Engl., Sum. Engl., Mal., 16 Refs.

Cassava. Cassava meal. Maize. Swine. Fattening. Finishing. Feed constituents. Feeds and feeding. Toxicology. Animal nutrition. Malaysia.

An experiment was conducted to study the effects of 0, 15, 30, 45 and 60% cassava meal on the performance and carcass characteristics of growing-finishing pigs in comparison to maize. Thirty Landrace pigs (av 15 kg) were assigned at random to the 5 treatments. Pigs fed the basal diet performed abnormally poorly with av daily gains of 0.28 kg, whereas those on 60% cassava meal gained twice as fast. As more maize was substituted by cassava, pigs performed better in terms of av daily gain, feed intake and feed efficiency. The depressed growth of the maize-fed pigs was accompanied by inappetance and depression. Icterus of the pigs on the maize and 15% cassava diets was apparent. Carcass analysis, which revealed petechial and ecchymotic hemorrhages on the surfaces of the liver and spleen, led to suspicion of aflatoxicosis in the maize. This was confirmed when cultures made from the maize showed a predominance of *Aspergillus flavus;* TLC revealed the presence of aflatoxins. (*Author's summary*) H03 H04

0301-1160 WANDERLEY, R. DE C. *et al.* **Engorda confinada de bovinos na Zona da Mata Úmida de Pernambuco (Pontas de cana, melaço, mandioca, farelo de algodão, farelo de mamona desintoxicado, tórula o sais minerais).** (*Fattening of cattle in confined feedlot systems in Pernambuco using sugar cane tops, molasses, cassava, cottonseed meal, detoxified castor oil meal, Torula yeast or mineral salts*). Recife, Brasil, Instituto de Pesquisas e Experimentação Agropecuárias do Nordeste, 1966. 10p. Port., 5 Refs.

Cassava. Cattle. Fattening. Feeds and feeding. Feed constituents. Animal nutrition. Brazil.

Results are given ot the 1st 2 in a series of experiments being conducted in the Zona da Mata Úmida, state of Pernambuco (Brazil), to develop adequate supplements for a confined feedlot system using sugar cane tops for fattening cattle. Sugar cane was fed ad libitum to 70 zebu steers (av 365 kg) divided into 7 treatments evaluating molasses (control), cottonseed meal and/or castor oil meal, Torula yeast and chopped cassava roots. Animal performance, feed intake, feed conversion efficiency and efficiency of the protein and energy sources were analyzed at 30 and 60 days. A detailed cost analysis was also made. There were significant differences between the control and the other treatments, the former being insufficient to maintain animal wt. There was no significant difference between the cassava and noncassava treatments as regards wt gain; thus the economics of using cassava was inferior to the noncassava treatment. Further studies should be made of the utilization of cassava roots by the animals. There were significant differences between protein sources, Torula yeast being greatly inferior to the others. In the 2nd experiment (90 days), best wt gains were obtained with cottonseed + castor oil meal and cassava treatments (449 and 401 kg, respectively). (*Summary by T.B.*) H03

0302-1163 YEONG, S.W. and SYED ALI, A.B. **The use of tapioca in layer diets.** MARDI Research Bulletin 4(2).91-96. 1976. Engl., Sum. Engl., Mal., 10 Refs.

Cassava. Animal nutrition. Poultry. Dietary value. Feed constituents. Eggs. Methionine. Supplements. Animal health. Malaysia.

The use of cassava chip meal as a partial substitute for maize was evaluated in a randomized block experiment where 180 31-wk-old Commercial White Leghorn crossed pullets were fed 5 isonitrogenous diets (0, 15, 30, 45 and 60% cassava) during the 1st stage (wk 31-42). During the 2nd stage (wk 43-74) the cassava diets were supplemented with 0.2% methionine for a total level of 0.5%. Results from the 1st stage showed that egg production decreased significantly ($P < 0.01$) with increasing levels of cassava in spite of equal crude protein content. Egg wt, feed conversion efficiency and total egg mass produced were lower in the cassava groups. These factors were corrected by the methionine supplementation in the 2nd stage. There were no significant differences in these parameters in any of the treatments. The better results obtained in the 2nd stage may be due to a detoxifying effect of the sulfur amino acid on the HCN content in the meal. No difference in mortality was observed Paleness of the egg yolk caused by substituting cassava for maize can be corrected by supplementing cassava diets with commercial carotenoid pigments. (*Author's summary*) H03

See also *0309* *0332* *0334* *0350* *0375* *0381* *0391* *0412* *0433*

H04 HCN Toxicity and Detoxification

0303-1385 COOKE, R.D. and MADUAGWU, E N. **The effects of simple processing on the cyanide content of cassava chips.** Journal of Food Technology 13·229-306. 1978. Engl, Sum. Engl, 20 Refs., Illus

Cassava. Cassava chips. Drying. Boiling. Cyanides. Composition. Analysis. Detoxification processes.

Changes in concentration of free cyanide (nonglycosidic) and bound cyanide (cyanogenic glucosides) in fresh cassava chips were studied during dehydration, boiling or soaking in water. All these processes removed free cyanide from the chips rapidly, but only 8-12% of the total cyanide was present as free cyanide. Air drying at 4 temp showed that 29% of the bound cyanide was removed at 46.5°C; smaller losses were recorded at the higher temp. Boiling chips for 25 min removed 55% of the bound cyanide, all of which could be accounted for in the boiling water. Stirring in cold water was ineffective for short periods (< 5% loss after 4 h), but cyanide losses increased after longer periods (50% loss after 18 h), probably because of the onset of fermentation. These decreases in total cyanide content are smaller than indicated by earlier workers. (*Author's summary*) H04 C03

0304-7473 HILL, D.C., ALEXANDER, J.C. and LOSOS, G J. **Dietary significance and metabolism of linamarin.** Guelph, Canada, University of Guelph, Department of Nutrition, 1974. 20p. (Cassava Research Project Progress Report no. 4, December 1974) Engl, Illus.

Cassava. *Manihot esculenta* **Linamarin. Metabolism. Laboratory animals. Animal physiology. Toxicity. Detoxification. Methionine. Vitamin B12. Iodine. Supplements. Cassava programs. Developmental research.**

The objective of this research is to study the effects of ingestion of pure cyanide and linamarin on wt gain of rats, feed efficiency, thiocyanate excretion and histology of various tissues. Findings to date are as follows (1) Young rats reacted to sub-lethal intake of cyanide by reduction in wt gain, depressed food consumption and efficiency, and a high level of thiocyanate excretion in the urine (active detoxification mechanism for cyanide in the rat). (2) Even with low dietary levels of methionine, vitamin B_{12} and iodine, 1500 ppm KCN was not lethal to rats receiving the diets for 12 wk. (3) Interrelationships among the effects of KCN and methionine and wt gains and thiocyanate excretion support an important role for methionine in the detoxification of cyanide in rats. (4) Histological examination of tissues showed no changes that could be attributed to ingestion of cyanide. Only rats on a diet deficient in methionine, vitamin B and iodine, together with added KCN, showed markedly enlarged thyroids with histological abnormalities (5) Examination of 3 brain regions of cyanide-fed rats (1500 ppm) for glutamic acid decarboxylase

activity, an enzyme sensitive to some cyano compounds and to thyroxine deficiency has not shown an effect on this enzyme. Nevertheless, preliminary finds are that cyanide ingestion together with a dietary methionine deficiency may give significant alterations in free amino acids in the brain regions, which may reflect changes in activity of other enzymes. Longer periods of cyanide feeding (1 yr) are being investigated (*Summary by T.M.*) H04

0305-9027 HILL, D.C. **Physiological and biochemical responses of rats given potassium cyanide or linamarin.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp. 33-42. Engl., Sum. Engl., 20 Refs., Illus.

Cassava. Cyanides. Linamarin. Detoxification. Metabolism. Thiocyanates. Diets. Vitamin deficiencies. Tracers. Animal physiology. Laboratory animals. Methionine. Deficiencies. Toxicology. Biochemistry.

Young rats fed, ad libitum, a diet containing 2400 ppm KCN showed no obvious signs of distress other than a decrease in wt gain. Similarly, rats fed for 12 wk a diet deficient in vitamin B_{12} and methionine and containing 1500 ppm KCN, appeared healthy although wt gains were reduced by the deficienceis of B_{12} and methionine and by the addition of KCN. No evidence was found that the feeding of the KCN resulted in lesions in the central nervous system, spinal cord, or other tissues. Linamarin administered by stomach tube in the absence of linamarase was partially metabolized to yield thiocyanate and a portion was absorbed intact from the gastrointestinal tract and excreted as such in the urine. Doses of 50 mg linamarin/100 g body wt were invariably fatal, and some mortality resulted from doses of 25 mg, particularly if inadequeate levels of methionine were provided. Rats receiving fatal doses of linamarin showed characteristic alterations in electrocardiograms similar to those resulting from fatal doses of KCN. Alterations in several biochemical parameters measured in the blood and in heart tissue were observed in these rats and also in rats receiving lesser but nonlethal doses. The toxicity of linamarin is mainly, if not entirely, due to cyanide released by the glucoside, and methionine contributes sulfur to aid in detoxification leading to thiocyanate formation. The severity of the reaction to KCN and linamarin was strongly influenced by the manner in which they were administered Mixed with the diet and fed over a period of hours they were tolerated in large amounts; whereas death resulted from single large doses. (*Author's summary*) H04

0306-4221 NAVARRO, M.D., GUEVARA, B.Q. and SANTOS, A.C. **Nitriloside-containing foods and their possible effects on health and nutrition.** Journal of the Philippine Medical Association 52(11/12(;357-372. 1976. Engl., Sum. Engl., 31 Refs., Illus.

Cassava. Laboratory experiments. Laboratory animals. Therapeutants. Uses. Linamarin. Philippines.

A literature survey showed that a diet rich in nitrilosides may be useful in preventive medicine. Nitrilosides are utilized by the body for nitrilization of hydrocobalamin to convert it to the active form of vitamin B12. A survey was made of Philippine plant and other plant products for nitriloside content, using qualitative and quantitative tests. Cassava was particularly rich in nitrilosides (linamarin). Rabbits fed raw cassava bark and leaves gained wt and increased their red blood cell count as compared with the control animals. Preliminary studies on culture of cancer cells showed inhibition by nitriloside on the dehydrogenase using methylene blue as the indicator. The extraction of nitrilosides (linamarin) from cassava is being studied. (*Summary by T.B.*) H04

0307-9802 PHILBRICK, D.J., HILL, D.C. and ALEXANDER, J.C. **Physiological and biochemical changes associated with linamarin administration to rats.** Toxicology and Applied Pharmacology 42:539-551. 1977. Engl., Sum. Engl., 32 Refs., Illus.

Cassava. Linamarin. Laboratory animals. Animal physiology. Toxicity. Cyanides. Laboratory experiments. Biochemistry. Clinical manifestations. Toxicology.

All cassava var. contain linamarin; hydrolysis by the cassava plant enzyme linamarase yields D-glucose, acetone and KCN. Two experiments on the effects of linamarin dosing were conducted. A single oral dose of pure synthetic linamarin (500 mg/kg) administered to rats caused clinical signs including cardiac arrhythmias and respiratory changes. Similar signs were observed in rats given a single oral dose of cyanide (6 mg/kg). All animals given either linamarin or cyanide died; however, appearance of toxic signs and death occurred later in the linamarin-dosed group than in those given cyanide. Compared to untreated rats, those dosed with linamarin or cyanide showed an increased whole blood lactate/pyruvate ratio and serum K^+ concentration and decreased cardiac K^+ concentration and cardiac cytochrome oxidase activity. Rats given sublethal doses of linamarin (94 mg/kg) daily for 5 wk showed no obvious signs of toxicity. Reductions in systolic blood pressure and cardiac cytochrome oxidase activity and an increased whole blood lactate/pyruvate ratio were observed in these rats. The results show that an oral dose of pure linamarin can produce physiological and biochemical changes in rats. The production of these changes does not require hydrolysis of linamarin before ingestion or the simultaneous presence in food of the active linamarase enzyme. (*Author's summary*) H04

0308-8332 SPATH, C.D. **The toxicity of manioc as a determinant of settlement patterns.** Chicago, University of Illinois, 1971. 15p. Engl., Sum. Engl, 38 Refs.

Paper presented at Annual Meeting of the American Anthropological Association, 70th., New York, 1971.

Cassava. HCN. Toxicity. Detoxification. Human nutrition.

Although the presence of cyanogenic toxins in cassava is often noted in literature, this factor is rarely dealt with in a systematic way. It is assumed that these toxins are disposed of in the processing of the pulp of the bitter cassava roots. These toxins are only partially and secondarily removed by the processing, and the cyanogens in the diet have a very real effect on other dietary needs and ultimately on settlement or economic patterns. The free HCN radicals react with sulfhydryl groups in dietary proteins, placing an additional demand on the human body for consumption of sulfur-bearing proteins. This is of particular significance in a cassava diet that provides virtually none of its own protein (*Author's summary*) H04

0309-8941 TEWE, O.O., MANER, J.H. and GOMEZ, G. **Influence of cassava diets on placental thiocyanate transfer, tissue rhodanese activity and performance of rats during gestation.** Journal of the Science of Food and Agriculture 28.750-756 1977. Engl, Sum. Engl., 17 Refs., Illus

Cassava. Diets. HCN content. Cassava meal. Fresh tubers. Laboratory animals. Thiocyanates. Metabolism. Rhodanese. Animal physiology. HCN.

Two 19-day gestation/metabolic studies were carried out with 30 female rats to investigate the influence of fresh and dried cassava containing 173 parts/10^6 and 92 parts/10^6 HCN, respectively, on placental thiocyanate transfer, metabolic changes in maternal and fetal tissues and their gestational performance. The cassava diets caused marked changes in the wt gain and thiocyanate concentration of the urine and serum of the gestating rats. Amniotic fluid thiocyanate was significantly increased by the fresh cassava diets ($P < 0.01$), but fetal thiocyanate was not significantly different between treatments ($P > 0.05$). Rhodanase activity and fresh weights of maternal and fetal tissues were not significantly affected by the cassava diets ($P > 0.05$) either. (*Author's summary*) H04 H03

0310-4218 UGOCHUKWU, E.N. and OSISIOGU, I.U.W. **Hydrogen sulphide from leaves of** *Manihot utilissima* **cassava.** Planta Medica 32:105-109. 1977. Engl., Sum. Engl., 15 Refs.

Cassava. Leaves. Toxicity. Analysis. Biochemistry. Hydrogen sulfide. Laboratory experiments.

Cassava leaves, known to be deficient in sulfur-containing amino acids, were shown to contain labile sulfur released as hydrogen sulfide at high temp and on treatment with ethanol (80%), aniline or water. Dry heat released much more H_2S than the other treatments. It is suggested that these labile precursors of H_2S may be intermediates in the funneling off of S from protein synthesis. The levels of H_2S found in this study may make the uncontrolled consumption of cassava leaves potentially dangerous. (*Author's summary*) H04 C03

See also *0029* *0030* *0031* *0300*

0311-8752 ALLEN, J.E., HOOD, L.F. and CHABOT, J.F. **Effect of heating on the freeze-etch ultrastructure of hydroxypropyl distarch phosphate and unmodified tapioca starches.** Cereal Chemistry 54(4):783-793. 1977. Engl., Sum. Engl., 25 Refs.

Cassava. Cassava starch. Modified starches. Analysis. Temperature. Gelatinization. Laboratory experiments.

The freeze-etching technique was used to study ultrastructural changes that occur during heating of hydroxypropyl distarch phosphate (modified) and unmodified cassava starch granules in a Brabender Viscoamylograph. Prior to heating, the fracture faces of both the unmodified and modified granules had similar particulate appearances. As heating progressed, water infiltrated into the granules from the truncated end, and a starch-water reticulum formed in the central regions and subsequently enlarged throughout the granules. Swelling took place after reticulate bands were formed in the peripheral regions of the granules. These outer bands remained until the integrity of the granules was lost near peak viscosity and the gel matrix was formed. Chemical modification of the granules stabilized the outer reticulate bands and reduced the size of the interstices within the matrix. (*Author's summary*) I01

0312-8742 CIACCO, C.F. and D'APPOLONIA, B.L. **Characterization of starches from various tubers and their use in bread-baking.** Cereal Chemistry 54(5):1096-1108. 1977. Engl., Sum. Engl., 29 Refs., Illus.

Cassava. Cassava starch. Geletinization. Viscosity. Analysis. Composite flours. Breads. Cassava bread. Yams. Laboratory experiments.

Physicochemical properties of starches isolated from yams (*Dioscorea alata*), cassava (*Manihot esculenta*) and arrowroot (*Maranta arundinacea*) were studied in an attempt to relate these parameters to the performance of these starches in breadmaking. The mol wt of the amylose triacetate isolated from the different starches ranged from 195,000 to 260,000 whereas intrinsic viscosity of amylose and amylopectin ranged from 1.87 to 3.13 and 1.55 to 2.35, respectively. Differences in pasting properties were noted, with the cassava starch having the lowest initial pasting temp (49.0°C) and yam starch the highest (73.5°). There were also differences in water-binding capacity, intrinsic viscosity, absolute density and amylose content. Farinograms of starch-gluten-water-soluble blends indicated shorter dough development time and stability with cassava and arrowroot than with yam starch. Bread baked from the cassava and arrowroot blends had a yellow, very gummy crumb. Amylograms of the freeze-dried bread crumb indicated that cassava and arrowroot are gelatinized to a much greater extent during baking than wheat or yam starches. Results suggest the importance of the pasting properties of the tuber starches when used in composite flours for breadmaking. (*Author's summary*) I01 I02

0313-1479 CONWAY, R.L. and HOOD, L.F. **Comparison of spectrodensitometric and colorimetric methods for quantifying starch hydrolysis products separated by thin-layer chromatography.** Journal of Chromatography 129:415-419. 1976. Engl., 18 Refs.

Cassava. Cassava starch. Analysis. Hydrolysis. Laboratory experiments.

A comparison of a colorimetric method with a densitometric method for quantifying starch hydrolysis products separated on thin-layer chromatograms is reported. Cassava starch was used. (*Summary by Biological Abstracts*) I01 C03

0314-8765 FUJIMOTO, S. **[Studies on the fat produced by hydrolysis of sweet potato starch. Changes in the bound fatty acids during development of the granules].** Bulletin of the Faculty of Agriculture, Kagoshima University 26:197-229. 1976. Jap., Sum. Engl., 81 Refs., Illus.

Cassava. Cassava starch. Analysis. Potatoes.

Comparison of potato, cassava, sweet potato, wheat, maize and rice starches showed that starches with a high fatty acid content tended to contain a high proportion of linoleic acid while other starches contained a high proportion of palmitic acid. Uptake of fatty acids did not vary greatly with species. Decomposition of sweet potato and maize starches showed that fatty acids were tightly bound in amylose. Starch grains from sweet potato tubers of various sizes were examined to trace the development of starch grains. The amylose content was higher and its chain length greater at the early stages of development and at this stage fatty acid content was also high. The results indicated that the fatty acid with amylose may act as a nucleus for starch grain formation. (*Summary by Field Crop Abstracts*) I01

0315-9419 HOOD, L.F. and O'SHEA, G.K. **Calcium binding by hydroxypropyl distarch phosphate and unmodified starches.** Cereal Chemistry 54(2).266-271. 1977. Engl., Sum. Engl., 11 Refs.

Cassava. Cassava starch. Modified starches. Analysis. Gelatinization. Laboratory experiments.

Hydroxypropyl distarch phosphate (HDP) and unmodified starch were held in Ca solutions The starch was separated centrifugally and the amount of Ca remaining in the supernatant determined by atomic absorption spectrophotometry. Bound Ca was calculated by subtracting the Ca in the supernatant from that in the original solution. The effects of starch gelatinization, pH, temp, time and Ca:starch ration on binding were studied. Ungelatinized, unmodified starch and HDP bound up to 86 µg Ca/g starch. Binding was influenced markedly by the Ca concentration in the reaction mixture. The pH influenced the degree of binding by HDP but had no effect on unmodified starch. As temp increased from 5 to 45° C, the extent of binding decreased. The amount of Ca bound was constant after a 20-min reaction time. Unmodified cassava bound more Ca than unmodified maize or waxy maize starch. Gelatinization of both HDP and unmodified cassava starch nearly eliminated binding. These results suggest that binding of Ca by starch is related to granule structure and that it is principally nonionic in unmodified starch and both nonionic and ionic in HDP. (*Author's summary*) I01

0316-9806 NAKAMURA, I.M., MORAES, I.O. and MARTUCCI, I.O. **Considerações sôbre a tecnologia da fécula de mandioca fermentada produção, propriedades físico-químicas e aplicações.** (*The technology of fermented cassava starch production, physicochemical properties and applications*). Científica 4(2):196-202. 1976. Port., Sum. Port., Engl., 8 Refs., Illus.

Cassava. Cassava starch. Analysis. Fermentation. Viscosity. Gelatinization. Temperature. Laboratory experiments.

Polvilho azedo is obtained by fermenting cassava starch. This product has many applications in Brazilian cookery. An explanation is given of the practices used in industry. Fermentation is a very rudimentary, empirical process. In addition to giving the characteristic flavor to the cassava starch, fermentation changes its physicochemical properties: the fermented starch becomes more soluble and swells easily in water; and when the aqueous suspension is heated, the paste formed is less viscous than that of the nonfermented starch. (*Author's summary*) 101

0317-8766 PALMER, K.N. and TONKIN, P.S. **The explosibility of dusts in small-scale tests and large-scale industrial plant.** *In* Symposium on Chemical Process Hazards with Special Reference to Plant Design, 3rd., London, 1967. Proceedings London. Institution of Chemical Engineers. Symposium Series no 25. 1968. pp.66-75. Engl., Sum. Engl , 11 Refs , Illus.

Cassava. Cassava starch. Analysis.

A brief description is given of established small-scale tests for determining the explosibility of combustible dust clouds in air. The extent to which dusts that are marginally explosible in the tests are able to propagate explosion in large-scale equipment was investigated with dust mixtures of graded explosibility and with individual industrial dusts. Based on the behavior of the dusts in large-scale equipment, a reappraisal was made of the existing classification of dusts for explosibility. The dust mixtures used were composed of a readily explosible and an inert material. Calculation of the minimum % of inert dust required to prevent propagation of flame in the explosible dust was in good agreement with the experimental findings. Cassava dust was classified in Class 1, "dusts that ignite and propagate flame readily, the source of heat required for ignition being small". (*Author's summary*) 101

0318-9331 RODRIGUEZ P., C. and AQUINO P., R. **Almidón de yuca (*Manihot esculenta* Crantz) como reactivo indicador por coloración en las titulaciones yodométricas). (*Cassava starch as a reagent for staining in iodometric titrations*).** Boletín de la Sociedad Química del Perú 42(1):24-30. 1976. Span., Sum. Span., 8 Refs., Illus.

Cassava. Cassava starch. Analysis. Uses.

The possibility of using cassava starch as a reagent in iodometric titrations to replace soluble potato starch, imported for this purpose, was studied. Results obtained in titrations, pH of the solutions, reversibility and sensitivity, and absorption spectra of 3 starches (soluble potato, total and soluble cassava starches) showed that cassava starch can be used in either form (*Author's summary. Trans. by T.M.*) 101

See also 0370

I02 Uses, Industrialization, Processing and Storage

0319-9043 AGRICULTURAL ENGINEERS LTD. **Gari making plant.** Accra, Ghana, Wisdom Press, 19?? 2p. Engl., Illus.

Cassava. Gari. Industrial machinery. Ghana.

The following simple machinery (made by a firm in Ghana) used in the making of gari is described and illustrated: a cassava root grater, a hydraulic press, a sieving and sifting machine, frying pan, gari grading machine and a gari grinder. (*Summary by T.M.*) I02

0320-1169 BALAGOPAL, C. and NAIR, P.G. **Studies on the microflora of market cassava chips of Kerala.** Journal of Root Crops 2(2):57-58. 1976. Engl.

Cassava. Cassava chips. Bacterioses. Mycoses. Storage. India.

A study was made of microbial populations on cassava chip samples from 9 different markets in the state of Kerala. No actinomycetes were found. Max bacterial populations were 55.55 x 10^4; min, 1.13 x 10^4. Max fungal populations were 1.57 x 10^3; min, 0.17 x 10^3. The genera most frequently encountered were *Rhizopus, Penicillium, Aspergillus, Fusarium* and yeasts. (*Summary by T.B.*) I02

0321-4930 BECK, H. **Arroz, milho e mandioca. II.** (*Rice, maize and cassava. II.*). Revista Brasileira de Química 41(246):357-358, 360, 362, 364. 1956. Port., 22 Refs.

Cassava. Cassava chips. Cassava flour. Cassava starch. Legal aspects. Processing. Brazil.

The minimum quality requirements for cassava starch, flour and chips to be exported from Brazil have been regulated by law. Specifications are given for the following factors: granule color, size and uniformity; % of moisture, impurities and ash content; acidity; viscosity; and traces of SO_2. In laboratory trials with cassava starch, it was found that it contained vitamins of the B complex, D and E. Most of the 1600 processors have small, outdated and uneconomical operations. The manufacture of flour and starch needs to be modernized in order to obtain better yields and quality. The making of alcohol from cassava has good perspectives. (*Summary by T.B.*) I02 J00

0322-4921 BIEHL, E.G. **Exposição comparativa de um novo sistema de fabricação de farinha de mandioca especial granulada, denominada "sistema Biehl" com as atafonas ainda**

atualmente en uso. (*The Biehl system, a new process for manufacturing special granulated cassava flour, as compared to mills presently in use*). Lavoura 1942:47-48. Maio-Julho 1948. Port.

Cassava. Cassava flour. Processing. Labour. Industrial machinery. Costs. Factories. Brazil.

The special Biehl system mill is composed of 6 machines required to process fresh cassava roots into granulated flour: cleaning and rasping of the roots, grinding into a liquid mass, mechanical dehydration, watery suspension of the cake, granulation and roasting of the wet mass, and cooling and classification of the finished product. On a small scale, 15 50-kg sacks can be produced; on a large scale, 30 sacks. Four operators are needed for the former and 6 for the latter operation. The new system required less fuel (4 vs. 12 m³ firewood) and yields 50% more (300 vs. 200 kg flour/1000 kg roots). (*Summary by T.M.*) 102 J00

0323-1798 CASIER, J.P.J. Invloed van de wateronoplosbare endosperm-pentosanen van tarwe en rogge, op de bak- en deegeigenschappen van zachte tarwe en endere zetmeelrijke grondstoffen als maniok, rijst, sorghum, millet, enz. (*Effect of water-insoluble endosperm pentosans of wheat and rye on the dough and baking properties of soft wheat and other starch-rich raw materials, such as cassava, rice, sorghum and millet*). Fermentatio 71(3):117-134. 1975. Dutch , 22 Refs., Illus.

Cassava. Cassava bread. Breads. Bread improvers. Analysis. Flours.

The results are given of a literature review on the effect of pentosans from wheat and rye on the dough and baking properties of flours derived from soft wheat, cassava, rice, sorghum and millet. Pentosans consist of 20-30% protein and 70% sugar. When added to the dough, they improve baking quality and give better bread structure. Flour from soft wheat, for example, consists mainly of gluten and starch, which gives a weak dough surface, resulting in poor-quality bread. By adding 1-4% pentosans, dough quality and elasticity are improved. Kneading time is shorter; the bread has better volume, a lighter, more even texture and crumb elasticity. These favorable characteristics of pentosan broaden the possibilities of making bread from starch-rich materials such as cassava, maize, soft wheat, potatoes, rice, sorghum and millet. (*Summary by M.T.*) 102

0324-9803 CIACCO, C.F. Tubers: composition and use in bread baking. Ph.D. Thesis. Fargo, North Dakota State University of Agriculture and Applied Science, 1977. 104p. Engl., Sum. Engl., 98 Refs., Illus.

Cassava. Cassava flour. Biochemistry. Analysis. Breads. Bread improvers. Cassava starch. Composite flours. Composition. Proteins. Laboratory experiments. Yams.

The biochemical constitutents of cassava and yam flours were investigated in view of their possible influence in breadmaking. Definite differences were observed with regard to their basic biochemical composition, starch physicochemical properties, water-soluble nonstarchy polysaccharides, lipid composition and protein quality. The 2 flours had a similar free-sugar pattern although the amounts of this sugar differed. To study the influence of these starches in breadmaking, a model system containing cassava, yam or arrowroot (*Maranta arundinacea*) starch + gluten and water solubles from wheat flour was used. Farinography and baking studies with starch reconstituted flours revealed that starches with similar physicochemical properties also showed similar farinograph and baking properties. Among the physicochemical properties examined, water-binding capacity and pasting characteristics were related to baking absorption and bread crumb characteristics. Physical dough properties and baking behavior were investigated by using blends of cassava flour or starch or yam flour as the tuber source, with wheat flour, with and without incorporation of a dough strengthener (sodium stearoyl-2-lactylate). Results showed that in addition to the effect on physical dough properties, tuber-wheat flour

blends have a particular breadbaking response dependent on the type of bread produced and the breadbaking system used. Blends containing cassava starch, regardless of the bread type or baking procedure, produced better bread than when using cassava flour. Blends containing cassava starch or yam flour produced similar conventional-type bread; however, with the continuous breadbaking procedure, cassava starch blends produced the best bread and yam flour the poorest. (*Author's summary*) I02

0325-1483 CIACCO, C.F. and D'APPOLONIA, B.L. **Baking studies with cassava and yam flour. I. Biochemical composition of cassava and yam flour.** Cereal Chemistry 55(3):402-411 1978 Engl., Sum. Engl., 41 Refs.

Cassava. Cassava flour. Yams. Protein content. Ash content. Fat content. Starch content. Fibre content. Sugar content. Analysis. Wheat flour. Bakery products.

The biochemical composition of cassava and yam flour was determined. Definite differences were observed with regard to their basic chemical composition. Yam flour had higher protein, ash and fat content than cassava flour, while the latter had higher starch and fiber content. The level of damaged starch in cassava flour was high, which may be an important consideration in breadmaking Yam flour had a higher total sugar content; and the individual free sugar pattern for these flours, although similar, differed in amounts for each sugar. The water-soluble nonstarchy polysaccharides (WSNP) differed in amount, protein content and sugar composition. Diethyl-aminoethyl-cellulose chromatography of yam WSNP suggested the presence of acidic polysaccharides in the extract. The lipids present in the flours were markedly different in nature and extractability. The majority of the yam-extractable lipid was polar in nature whereas that of cassava was primarily nonpolar. Yam protein was found to be of better quality. The sulfur-containing amino acids were the 1st limiting amino acids for both flours. (*Author's summary*) I02 H01

0326-8762 FONTEIN, F J. and DIJKSMAN, C. **Process of manufacturing starch and by-products from tubers by counter-current hydrocyclone separation.** United States Patent 2,798,011. 1957. 5p. Engl., 5 Refs., Illus.

Cassava. Cassava starch. Processing. Patents.

A starch paste obtained by triturating natural products such as potatoes and cassava roots with a restricted amount of water, containing particles no larger than 0.17 mm, is treated in a countercurrent system of 11 hydrocyclones whose diameters do not exceed 15 mm. The purified starch is obtained in one fraction and the concentrated waste water containing protein and cell walls is obtained in another. (*Summary by Chemical Abstracts*) I02

0327-1375 GRACE, M.R. **Elaboración de la yuca.** (*Cassava processing*). Roma, Italia, Organización de las Naciones Unidas para la Agricultura y la Alimentación. Colección FAO: Producción y Protección Vegetal no. 3. 1977. 162p. Span., 159 Refs., Illus.

Cassava. Cassava meal. Cassava flour. Cassava starch. Cassava chips. Pellets. Tapioca. Peeling. Washing. Rasping. Screening. Silting. Drying. Packaging. Factories. Industrial machinery. Industrialization. Uses. Human nutrition. Animal nutrition. Legal aspects. Production. Costs.

This book is an updated version of *Elaboración de la yuca y sus productos en las industrias rurales*. **The following aspects are dealt with: (1) Cultivation. The plant, cultural practices, mechanization; (2) Flour and starch. Root supply, processing, starch extraction from dry cassava chips; (3) Tapioca products. Preparation of the moist flour, gelatinization, drying; (4) Products**

for feedstuffs. Chips, coarsely chopped roots, pellets, meal and wastes; (5) Starch factories. Types and economic feasibility study for a factory with a capacity for 24 t of dry starch/day, (6) Uses. Cassava in human nutrition, cassava starch, composite flours, feedstuffs, industrial uses, fermented products; (7) Quality control. Analysis of the raw materials, determination of the quality of flour and starch, analysis of tapioca products, specifications for different uses, (8) World production and trade. Exports, imports, distribution and transportation, recommendations; (9) Development of the cassava industry and its future. Appendices give data on specifications for cassava flour, dextrin, starch, and chips and flour in Thailand, equipment for a starch factory, as well as FAO studies in Colombia, Ghana, Malaysia, Nigeria, Dominican Republic, Senegal, Sri Lanka, Tanzania. (*Summary by T.B.*) 102

0328-9260 INDIAN STANDARDS INSTITUTION. **Specification for tapioca starch for use in the cotton textile industry.** New Delhi, India. IS.1605-1960. 1960. 18p Engl.

Cassava. Cassava starch. Industrial starches. Legal aspects. Textiles. Processing. Analysis. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for the manufacture of cassava starch to be used as a sizing and finishing material in the cotton textile industry The cassava starch granules are described and illustrated and their chemical composition given in table form. Packing and marking instructions are given. Methods are given for testing for quality of reagents, identification and particle size; determining moisture, ash, crude fiber and protein content; estimation of petroleum ether extract, free acidity, pH of aqueous extract, viscosity and cold-water solubles. (*Summary by T.M.*) 102

0329-9263 INDIAN STANDARDS INSTITUTION· **Specification for edible tapioca chips.** New Delhi, India. IS:1317-1969 1969. 10p. Engl

Cassava. Cassava chips. Legal aspects. Processing. HCN. Analysis. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for white and parboiled chips, made from raw and boiled, peeled cassava roots, respectively. The chips should not exceed 20 mm thickness; outher residual peel should not exceed 2% by wt and % of moisture by wt, 13. The chips should be free from all extraneous material and HCN. Data for packing and marking are also given. The procedures for determining outer residual peel, testing for HCN, determining cold-water solubles and preparing material for tests are explained. (*Summary by T.M.*) 102

0330-9711 INDIAN STANDARDS INSTITUTION. **Specification for edible tapioca flour.** Indian Standard IS:1318. 1969. 8p. Engl.

Cassava. Cassava flour. Legal aspects. Analysis. Food products. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for the manufacture of edible cassava flour. Aspects dealt with include granule and particle size; max % of moisture by wt (13.0), total ash (1.80), min starch on a dry wt basis (82.0), max crude fiber (2.10), cold-water solubles (11.0) and pH of aqueous extract (4.5-7); packaging and marking. The procedures for testing for HCN and determining cold-water solubles are given. (*Summary by T.M.*) 102

0331- 9259 INDIAN STANDARDS INSTITUTION. **Specification for edible tapioca starch.** New Delhi, India. IS:1319-1969. 1969. 8p. Engl., Illus.

Cassava. Cassava starch. Legal aspects. Analysis. Food products. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for the manufacture of edible cassava starch. Aspects dealt with include granule and particle size; % of moisture by wt (12 5), total ash (0.50), starch on a dry wt basis (98.0), crude fiber (0.20), cold-water solubles (0 70) and pH of aqueous extract (4.5-7); packaging and marking. The procedure for determining cold-water solubles in also given. (*Summary by T.M.*) 102

0332-9262 INDIAN STANDARDS INSTITUTION. **Specification for tapioca spent pulp as livestock feed.** New Delhi, India. IS-5064-1969. 1969. 6p. Engl.

Cassava. Wastes. Waste utilization. Legal aspects. Animal nutrition. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for the use of cassava spent pulp (ampas) in livestock feeding. The spent pulp is a by-product of starch extraction and should be in the form of a coarse powder, creamy white to light brown in color Maximum % of moisture by wt should be 10; crude protein (N x 6 25), minimum 2.0; crude fiber, maximum 15; total ash, maximum 3; acid-insoluble ash, maximum 1.5. Instructions for packing and marking are also given. Criteria are given for determining the conformity of material as regards crude protein and acid-insoluble ash. (*Summary by T.M.*) 102 H03

0333-9264 INDIAN STANDARDS INSTITUTION. **Specification for tapioca sago (Saboodana).** New Delhi, India. IS:899-1971. 1971. 8p. Engl.

Cassava. Tapiocas. Tapioca seeds. Legal aspects. Processing. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for the manufacture of tapioca. Aspects dealt with include description of the tapioca pearls, chemical composition, gelatinization properties, packing and marking Procedures are given for testing for gelatinization and determining the starch in gruel after cooking, as well as for determining the color of gelatinized alkaline paste. (*Summary by T.M.*) 102

0334-9261 INDIAN STANDARDS INSTITUTION. **Specification for tapioca as livestock feed.** New Delhi, India. IS:1509-1972. 1972. 14p. Engl.

Cassava. Cassava chips. Cassava meal. Legal aspects. Animal nutrition. Analysis. Composition. India.

Detailed specifications, as well as methods of sampling and testing, are given for cassava chips and meal to be used in livestock feeding. Dry chips should be no thicker than 15 mm; as for meal, no more than 5% of the material should be retained on a 1.70 mm IS sieve and not more than 10% should pass through a 1.00 mm sieve. Chemical composition of the 2 products is given in table form. Packing and marking instructions are given. Procedures are given for determining particle size of cassava meal, moisture content, total ash, acid-insoluble ash, crude fiber, HCN content, alcoholic acidity. (*Summary by T.M.*) 102 H03

0335-5206 **INTERMEDIATE TECHNOLOGY what is it?** Second Development Decade Topics no. 4. 1972. 4p. Engl., Illus.

Cassava. Processing. Gari. Mechanization. Small-scale equipment. Nigeria.

A definition is given of intermediate technology and the role of the Intermediate Technology Development Group, a charitable organization in London. Intermediate technology is relatively low cost, easy to handle and maintain because it utilizes local materials and labor. An example is given in Nigeria, where gari (ground cassava) is a basic food. There are 2 ways to grind cassava: with a motorized machine (costly, advanced technology) and by hand. An easily constructed, intermediate method was designed, made from bicycle parts, plywood, iron water pipe and old hacksaw blades. (*Summary by A.J. Trans. by T.M.*) I02

0336-9572 JAMES, A.W. **Breadmaking with cassava starch and coconut protein isolate.** *In* Dendy, D.A.V. and Timmins, W.H. Development of a wet-coconut process designed to extract protein and oil from fresh coconut. London. Tropical Products Institute G78. 1973. pp.29-61. Engl., 102 Refs , Illus.

Cassava. Cassava starch. Breads. Wheat flour. Protein enrichment. Processing. Analysis.

Using the Chorleywood process, bread was made of 50% Canadian wheat flour (14.5% protein), 43.8% cassava starch and 6.2% coconut protein concentrate (80% protein). Loaf vol and net protein utilization compared very favorably with standard wheat loaves. Appendix tables give data on coconut production and composition, composition of kernels, copra and press cake, coconut oil specifications and amino acid analysis of coconut protein. Flow charts of different processes for coconut oil and protein concentrate are also included. (*Summary by T.M.*) I02

0337-9412 JESUITAS, E P. **An investigation of tapioca wastes.** Mag. Sc. Thesis. Bangkok, Thailand, SEATO Graduate School of Engineering. Asian Institute of Technology Thesis no 136. 1966. 109p. Engl., Sum. Engl , 30 Refs., Illus.

Cassava. Cassava starch. Factories. Wastes. Analysis. Biochemistry. Thailand.

The cassava starch production process is reviewed, and the sources of major wastewaters were located and sampled. Two main process wastes were identified as separator waste and wash water, these were analyzed at different times for physical, chemical and biochemical characteristics. Effects of primary treatments such as plain sedimentation, submerged filtration and chemical coagulation were evaluated for separator waste. The feasibility of biological degradation of settled separator waste was studied; biochemical conditions and parameters such as oxygen uptake, nutrient deficiency and reaction rate constants were determined Investigations on wash water covered coagulation and sedimentation. Results indicated that plain sedimentation was most applicable as a primary treatment. A sedimentation tank was designed to accomodate the range of waste characteristics encountered Chemical coagulation was uneconomical and unnecessary if secondary treatment was considered. Subsequent biological treatment for stabilization of the residual organic constituents of the waste was feasible. Nitrogen and phosphorus supplementation, as well as pH adjustment of the settled waste, was beneficial prior to biological treatment. Kinetic studies of biological treatment gave rate-constant values comparable with those observed by other workers on different wastes Chemical coagulation was satisfactory for the wash water, and the effluent obtained could be reused in the basic process (*Author's summary*) I02

0338-0168 KHAJARERN, J. *et al.* **Determination of basic chemical parameters of cassava root products of different origin, processing technology and quality.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76. Khon Kaen, Thailand, 1977. pp.37-53. Engl., Sum. Engl., 11 Refs , Illus.

Cassava. Cassava chips. Pellets. Water content. Protein content. Fibre content. Ash content. Mineral content. Prices. Cassava programs. Thailand.

A total of 595 samples of cassava root products from the Khon Kaen region were analyzed for basic chemical components over a 16-mo period. It was found that Thai cassava products had higher moisture, crude fiber and ash content than those from other countries. Moisture content varied greatly with drying temp and slightly with selling price. Crude fiber and ash content varied with selling price as well as with monthly rainfall. The quality of the Thai product could be improved partially by improving the processing. (*Author's summary*) I02

0339-0178 KHAJARERN, J.M. *et al.* **Determination of basic chemical parameters of cassava root products of different origin, processing technology and quality.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1977. Khon Kaen, Thailand, 1978. pp.15-33. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Pellets. Cassava chips. Fibre content. Ash content. Protein content. Carbohydrate content. Mineral content. Water content. Drying. Processing. Cassava programs. Thailand.

A total of 692 samples of cassava roots and products were analyzed for proximate analytical composition in 1977. In addition, structural carbohydrate concentration, insoluble ash and amylose content were also determined. It was found that products were still adulterated in 1977, although to a lesser extent than in 1976. There was a tendency toward further improvement in product quality. The extent and type of adulteration were clearly indicated by the product's acid detergent fiber and ash content. The relationship between product quality and climatic conditions and market situation is discussed. A general pattern for improving the Thai cassava product quality and price recommendations are given. (*Author's summary*) I02

0340-9415 KIM, J.C. and RUITER, D. DE **Baking products from non-wheat flours; a survey of a study made in the Netherlands.** Wageningen, Netherlands, Institute for Cereals, Flour and Bread TNO, 1969. 13p. Engl , 2 Refs.

Paper presented at Reunião Latino-Americana de Especialistas em Elaboração de Farinhas e Panificação, Rio de Janeiro, 1969.

Cassava. Cassava bread. Cassava flour. Analysis. Composite flours. Biscuits.

The results are given of a series of studies conducted by the Institute for Cereals, Flour and Bread TNO in Wageningen (Netherlands) on the possibility of making bread and other products from nonwheat flours. Initial materials tested were cassava, yams, sago and maranta in combination with protein concentrates such as soya, peanut and cottonseed flours and fish meal. Successful recipes and procedures are given for cassava/soya bread, wheat/maize/soya bread, wheat/maize or cassava/soya bread and cassava/soya biscuits. The cassava/soya batter is semiliquid and requires cake-making equipment. Acceptable bread with wheat flour/30% nonwheat flour was obtained when using bread improvers such as calcium stearoyl lactylate or di-acetyl succinic acid esters, or a relatively high % of fat and sugar. (*Summary by T.B*) I02

0341-1197 KUIZON, P.G. **The manufacture of cassava starch as a home industry.** Agricultural and Industrial Life 18:13, 34. 1956. Engl.

Cassava. Cassava starch. Small-scale processing.

From 14-20% starch is extracted on a small scale from cassava roots in the Philippines. Rudimentary equipment for this process is described, including a motor-driven peeler, a tin root pulverizer (grater), a copper screen, wood or concrete settling tanks and aluminum sheet driers. A flash drier is preferable since the starch is pulverized at the same time. (*Summary by T.B.*) I02

0342-1468 LAGES, A.C.A. and TANNENBAUM, S.R. **Production of glucose from tapioca (cassava starch) and farinha de mandioca (cassava meal).** Journal of Food Science 43(3):1012-1014, 1018. 1978. Engl., Sum. Engl., 31 Refs., Illus.

Cassava. Cassava meal. Cassava starch. Glucose. Enzymes. Hydrolysis. Temperature. Laboratory experiments.

Starches from fresh cassava and cassava meal were converted to glucose in a batch laboratory-scale process, using a jacketed, stirred-tank reactor. Liquefaction or thinning of the starch slurries was carried out with a thermostable, bacterial α-amylase that is active and stable in starch solutions at temp >100°C. The resulting 2-3% dextrose solutions were cooled to 60°C; the pH was adjusted to 4.8-5.0 and saccharified with low concentrations of a fungal amyloglucosidase. Yields of approx 100 g glucose/100 g starting material were obtained after 12-24 h saccharification for cassava starch and after 24-36 h for cassava meal starch. Rheological problems and potential industrial applications of the processes are discussed. (*Author's summary*) I02

0343-9148 LEE, J. **The cassava grinder: a design from the Zaria workshop.** Appropriate Technology 1(2):10-11. 1974. Engl., Illus.

Cassava. Grinding. Small-scale equipment.

Instructions are given on how to build a simple man-powered cassava root grinder from iron tubing, bicycle parts, plywood, hacksaw blades and sheet metal. (*Summary by T.M.*) I02

0344-9836 LOZANO, J.C., COCK, J.H. and CASTAÑO, J. **New developments in cassava storage.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp 135-141. Engl., Sum. Engl, 8 Refs, Illus.

Cassava. Tubers. Deterioration. Storage. Timing. Temperature. Colombia.

Cassava roots deteriorate rapidly after harvest. Deterioration is either physiological or microbial, but the former generally occurs within 48 h of harvesting. Experimental results show that physiological deterioration can be prevented either by pruning the plants 2-3 wk before harvest or by packing the roots in polyethylene-lined paper bags after harvest. Microbial deterioration can be prevented by dip-treating the roots with broad-spectrum fungicides such as Manzate. (*Author's summary*) I02

0345-1398 MAHMUD, Z. and CONG THANH, N. **Tapioca chips and pellets; an improved technology.** Agricultural Mechanization in Asia 8(2):25-30. 1977. Engl., Illus.

Cassava. Cassava chips. Pellets. Drying. Timing. Solar drying. Small-scale equipment. Small-scale processing. Thailand.

A study was made of the parameters affecting the drying and pelletizing of cassava chips in order to obtain a product with constant, optimal quality under conditions typical of rural areas in Thailand and similar agroeconomic regions of Southeast Asia. Various shapes and sizes of roots were cut manually and dried on different media. It was found that chip drying time could be greatly shortened by using a black drying floor or a perforated shelf-drier. Drying time is greatly influenced by chip shape and size; slices and strips produced by the Malaysian cutting machine were optimum for drying efficiency. No noticeable differences were found in drying efficiency due

to season. In the pelleting process study, it was found that good pellets were produced by steam heating chips to ca. 70°C before pressing. Small chips in the form of slices and strips, with a moisture content of 12-14%, were best. The quantity of steam/unit wt of input ingredient affects pellet quality; 0.152 kg steam/kg input material gave dense, glossy and hard pellets. (*Summary by T.B.*) 102

0346-9002 MALAYSIA. DEPARTMENT OF AGRICULTURE. FARM MECHANIZATION BRANCH. **Construction and operation of a simple tapioca chipper.** Malaysia, 1974. 25p. Engl., Illus.

Cassava. Cassava chips. Small-scale equipment. Costs. Malaysia.

Detailed, illustrated instructions are given on how to construct and operate a mechanical cassava chipper with a 4.5-hp gasoline-driven motor that will process 2 t chips/h. Costs for building and operating the chipper are also included. (*Summary by T.M*) 102

0347-1210 MENEZES, T.J.B. and LAMO, P.R. DE. **Produção do álcool de mandioca.** (*Alcohol from cassava*). Boletim do Instituto de Tecnologia de Alimentos no. 46.37-54. 1976. Port., Sum. Port., Engl., 14 Refs., Illus.

Cassava. Ethanol. Processing. Brazil.

The following aspects of producing ethyl alcohol from cassava are discussed: the different steps of the process, preparation of the raw material, saccharification, fermentation and distillation. (*Summary by T.B.*) 102

0348-1205 MENEZES, T.J.B. DE *et al.* **Sistemas de hidrólise na produção do álcool etílico da mandioca.** (*Hydrolytic systems in the production of ethyl alcohol from cassava*). Coletânea do Instituto de Tecnologia de Alimentos 7(1):209-215. 1976. Port., Sum. Port., Engl., 10 Refs.

Cassava. Ethanol. Hydrolysis. Processing. Laboratory experiments. Brazil.

The effect of several saccharifying agents on cassava starch hydrolysis for alcohol production was studied to compare alcohol yields from the traditional hydrolytic systems of submerged fungal cultures and acid hydrolysis. It was found that a combination of commercial preparations of a heat-stable bacterial α-amylase and fungal amyloglucosidase yielded an alcohol content 95% of the theoretical, whereas a yield of only ca. 70% was obtained with the traditional systems. (*Author's summary*) 102

0349-9740 MEUSER, F. *et al.* **Extraction of tapioca starch from roots, chips, and pellets on laboratory scale.** Berlin, Germany, Institut für Lebensmittel Technologie, 1978. 30p. Engl., Sum. Engl., 33 Refs., Illus.

Cassava. Cassava starch. Cassava chips. Pellets. Tubers. Analysis. Composition. Processing. Laboratory experiments. Productivity. Particle size. Viscosity.

Cassava is not used as a raw material for starch processing in Europe since the importation of roots is uneconomical; their high moisture content makes them highly perishable after harvesting. The feasibility of extracting starch from pellets and chips was studied on a laboratory scale. Impurities present in chips and pellets must be removed before grinding. Chips can be cleaned by dry or wet processes; pellets, however, must be cleaned in a dry process since wet cleaning causes

problems in starch recovery. The cell structure can be broken down in a pin mill. It was not possible to obtain good starch yields from chips and pellets as compared to the fresh roots; purity and degree of whiteness were also lower. Yield was not increased by pretreating (steeping in SO_2 or fermentation), but purity and color were improved. Scanning electronmicrographs of the different starches are included. Because of the lower quality, starch from chips and pellets would probably be limited to industrial uses. It is recommended that the large amounts of solids in the process water should be recovered for use in animal feedstuffs. (*Summary by T.B.*) I02

0350-9038 MULLER, Z. **Improving the quality of cassava root and leaf product technology.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp.120-126. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Developmental research. Cassava chips. Cassava meal. Leaves. Pellets. Processing. Industrialization. Composition. Legal aspects.

The importance of cassava in tropical nutrition is reviewed; lower amylose content of cassava starch makes this feed a suitable source of energy for ruminants. Aspects of quality are discussed, with special emphasis on the content of critical nutrients in cassava root products. Cassava chips are generally of higher quality than pellets, and both the shape and size of the chips are very practical with regard to the time required for sun drying. Thin slices (2mm) spread over black painted floors can be dried on sunny days within 8 h or less; whereas roughly chipped cassava takes several days to dry with detrimental results on quality and economic considerations. Pelleting reduces the volume of cassava root products by 25-40%, which is an important freight cost consideration. Aspects of both good and bad practices of pelleting cassava-based diets are discussed. One of the great advantages of cassava in ruminant nutrition is the slow release of N from the cassava-NPN complex. The aerial part of the cassava plant can also be processed into leaf meal or pellets and is a good source of protein. Industrial production of leaf protein concentrate from cassava leaves by the PRO-XAN process offers new investment opportunities, despite its high capital intensive characteristics. (*Author's summary*) I02 H03

0351-1466 NOON, R.A. and BOOTH, R.H. **Nature of post-harvest deterioration of cassava roots.** Transactions of the British Mycological Society 69(2):287-290. 1977. Engl., Sum. Engl , 6 Refs., Illus.

Cassava. Tubers. Deterioration. Timing. Storage. Post-harvest losses.

Vascular discoloration of cassava roots occurred within a few days after harvest. Microorganisms could not be isolated from freshly discolored areas of roots but were isolated from decaying tissue. These isolates were not associated with the development of similar symptoms of discoloration when healthy roots were inoculated. Results suggest that microorganisms do not cause this primary deterioration of cassava; observations on the effects of several chemicals on root slices suggest that the reaction may be an endogenous physiological process. (*Author's summary*) I02

0352-1470 OLATUNJI, O. and AKINRELE, I.A. **Comparative rheological properties and bread qualities of wheat flour diluted with tropical tuber and breadfruit flours.** Cereal Chemistry 55(1):1-6. 1978. Engl., Sum. Engl., 9 Refs.

Cassava. Cassava flour. Wheat flour. Composite flours. Analysis. Yams. Cocoyams. Breadfruit. Breads. Laboratory experiments.

The effect of adding, 10, 20 and 30% tropical tuber flour (yam, cocoyam and cassava) and breadfruit flour to wheat flour was studied using the falling no. apparatus, farinograph, extensograph, amylograph and baking tests. Addition of the different %s of these flours to wheat altered its rheological properties. Diastatic activity in terms of falling no., the water absorption and tolerance index of the farinogram increased with increasing amounts of nonwheat flours while dough development time and stability decreased. Dough area, extensibility and the peak of the curve in the amylogram decreased significantly while resistance and proportional no. increased with increases in the nonwheat flours However, the area under the curve of the 10% yam flour blend and the extensibility of the 10% yam and cocoyam blends were higher than the corresponding values for 100% wheat flour at 45- and 90-min intervals. The 10% blends in all cases gave results comparable to tne control and produced better quality bread than the 20 and 30% blends. Sources of the nonwheat flours and increased additions significantly affected the proportional no. ($P < 0.05$). Specific volume of the bread and the total acceptability score were also significantly different. Breads from 100% wheat flour and the 10% blends were very similar, whereas bread from the 20% blend (excluding yam flour) was definitely poorer than that of the 100% wheat flour. The 30% blends were unsatisfactory. Generally, cocoyam flour blends gave bread that scored the closest to 100% wheat flour bread. (*Author's summary*) I02

0353-9224 PFEIFER & LANGEN **A method for degreasing crushed, starchy, fatty vegetable material. British Patent 1,398,459. 1975.** 7p. Engl., Illus.

Cassava. Processing. Patents.

It is claimed that this method for degreasing crushed starchy fatty vegetable material such as grains and tubers (potatoes and cassava) yields fats, free fatty acids and other valuable components by means of an inert gas in a supercritical condition or a fixed inert gas at a pressure higher than critical. The extracted substances are separated by temp increase and/or pressure release under supercritical conditions of the gas. Extraction is conducted preferably at temp from 20-100°C at a pressure of 40-150 atm. Inert gases with a critical temp below 200° (alkanes, alkenes, butylene, dimethyl ether, etc.) are preferred. Separation of fats may also be accomplished by temp increase at constant pressure while maintaining the range of supercritical conditions Extracting with gas in the liquid phase at a pressure ca. 30 atm above critical pressure and at a subcritical temp of the gas is advantageous since working pressure is lower and time is economized because more oil and vegetable components (e.g., lecithin and carotene) are removed by the liquid solvent at each stage of the extraction Several examples with maize are given. (*Summary by T B.*) I02

0354-3067 PIZZINATTO, A. and VITTI, P. **Pães mistos de trigo, soja e mandioca.** (*Breadmaking with a mixture of wheat, soybean and cassava flours*). Coletânea do Instituto de Tecnologia de Alimentos 6:189-202. 1975. Port., Sum. Port., Engl., 16 Refs.

Cassava. Cassava bread. Composite flours. Soybean flour. Wheat flour. Breads. Bread improvers. Nutritive value. Analysis. Brazil.

A study was made of the behavior of untreated and pregelatinized cassava flour (13%) in a mixture of wheat (80%) and soybean (7%) flours for breadmaking. The additives potassium bromate, ascorbic acid and calcium stearyl lactylate were also tested. The best mixtures was with pregelatinized cassava flour and the additives, ascorbic acid and calcium stearyl lactylate. (*Author's summary*) I02

0355-1135 RADLEY, J.A. **Tapioca, cassava or Brazilian arrowroot starch.** *In* ——. Starch Production Technology. London, Applied Science Publishers, 1976. pp.189-212. Engl., 68 Refs.

Cassava. Cassava. starch. Washing. Peeling. Rasping. Silting. Centrifuging. Drying. Legal aspects. Uses.

A brief description is given of the cassava plant, its cultivation and industrial uses. Details of the steps in the starch extraction process are explained: washing, peeling, rasping, straining; sedimentation, washing, silting; draining, centrifuging, drying. Specifications of the Imperial Institute in London and the Tapioca Institute of America, as well as methods for testing, are discussed at length. (*Summary by T.B.*) 102

0356-3125 ROA, G. Natural drying of cassava. Ph.D. Thesis. East Lansing, Michigan State University. Department of Agricultural Engineering, 1974. 234p. Engl., Sum. Engl., 77 Refs., Illus.

Cassava. Cassava chips. Solar drying. Timing. Experiment design. Costs. Statistical analysis. Small-scale equipment. Field experiments. Laboratory experiments. Water content. Colombia.

Annual worldwide transactions of dried cassava to the EEC from developing countries are estimated at US$100 million. Cassava production is presently dried by slow and risky operational systems. Experimental and analytical studies were conducted with several cassava var. of different ages to evaluate conventional and newly designed drying systems under variable weather conditions. Differences in systems were attributed to the relative positions of the layers of the product (in mesh trays and on the floor) or to different geometrical forms of the cassava chips. The influence of var. and age were not significant in drying. A mathematical model predicted ca. 1700 hourly experimental moisture content values on a fresh wt basis (av error of 2%). Final moisture content value at the end of a drying day could also be predicted within 3% by using av atm conditions A sensitivity analysis based on the model indicated that the max wt of a layer that could be dried without deterioration depended mainly on chip size, the saturation water vapor pressure deficit and wind velocity. A vertical-type drier consisting of 2 parallel wire panels was the most efficient. The cassava layer takes nearly all the required energy for evaporation from the air enthalpy. The vertical position of the layer and adequate product geometry permits the air to move through the product, creating turbulence. The air gives off part of its sensible heat and removes the evaporated moisture. When covered by a roof, drying rates are not reduced; thus drying can continue overnight or during rain. Horizontal, elevated mesh trays are less efficient that the vertical drier but more so than the conventional system of drying cassava on concrete floors. Two low-cost cutting mechanism (a manual press and a disc cutter) were designed to produce rectangular cassava bars, the optimum geometric figure found. The disc cutter produces the bars at a rate of 240 kg/h when operated by a bicycle pedal mechanism or 500 kg/h when motor driven A deterioration criterion was established to recommend max densities allowed to dry safely as a function of av environmental conditions and type of drying system. A cost analysis of a commercial operation was made based on the experimental work and the simulated results. Limitations of natural drying are summarized and suggestions for future work are made. The computer programs of analysis are included in the appendices. (*Author's summary*) 102 J00

0357-3105 ROJAS V., M. **Algunos cambios químicos en raíces de yuca (*Manihot esculenta* Crantz) durante el almacenamiento en silos de paja y tierra. (*Chemical changes in cassava roots during storage in field clamps*).** Tesis Ing. Agr. Palmira, Universidad Nacional de Colombia. Facultad de Ciencias Agropecuarias, 1977. 46p. Span., Sum. Span., Engl., 28 Refs., Illus.

Cassava. Field experiments. Tubers. Storage. Starch content. Water content. Dry matter. Sugar content. Nutrient loss. Timing. Colombia.

An experiment was conducted at CIAT (Palmira, Colombia) to determine the quality of cassava roots stored in field clamps for 8 wk. The content of starch, sugar, water, DM and extractable

starch was analyzed weekly. Results showed a decrease in starch content and an increase in sugar content, possibly due to the conversion of starches to sugars. Statistical analysis of the sum of starches and sugars (total carbohydrates) showed a nonsignificant decrease, probably due to metabolic changes in the roots during storage. It is therefore concluded that the quality of stored roots in relation to the control is preserved in acceptable form. (*Author's summary*) 102 C03

0358-8750 SEFA-DEDEH, S. and RASPER, V.F. **Water-soluble nonstarchy polysaccharides of composite flours. I. Chemical nature of polysaccharides from yam (*Dioscorea*) and cassava flours.** Cereal Chemistry 54(4):746-759. 1977. Engl., Sum. Engl., 59 Refs., Illus.

Cassava. Cassava flour. Composite flours. Water content. Fibre content. Protein content. Analysis. Viscosity. Laboratory experiments. Yams.

GLC analysis of derived hydrolysates of water-soluble nonstarchy polysaccharides (WSNP) extracted from flours milled from dried tubers of 3 species of yams(*Dioscorea rotundata, D. alata* and *D. cayenensis*) and roots of cassava (*Manihot utilissima* var. Ankra) revealed marked differences in their composition. While D-glucose was the major component of material extracted from cassava flour, WSNP of *D. alata* and *D. cayenensis* origin were characterized by a high concentrations of D-mannose, which accounted for almost 50% of their total carbohydrate content. Though pentoses were present in all tested samples, *D. rotundata* WSNP were the only ones in which 5-carbon ring sugars formed the major fraction; they represented 57% of the total carbohydrate content, with arabinose being the major component. The uronic acid content in all extracted materials was relatively high, reaching over 24% in WSNP of *D. rotundata* flour. Viscometric measurements on unoxidized and oxidized solutions and UV absorption analysis indicated behavior similar to that characteristic of water-soluble wheat flour "pentosans." Data obtained by UV absorption analysis and TLC provided evidence for the involvement of a phenolic compound in the oxidative gelation of these solutions. The presence of ferulic acid and other phenolic acids in the tested materials was confirmed by TLC. (*Author's summary*) 102

0359-8751 SEFA-DEDEH, S., MacDONALD, B. and RASPER, V.F. **Water-soluble nonstarchy polysaccharides of composite flours. II. The effect of polysaccharides from yam (*Dioscorea*) and cassava flours on the rheological behavior of wheat dough.** Cereal Chemistry 54(4):813-819. 1977. Engl., Sum. Engl , 7 Refs., Illus.

Cassava. Cassava flour. Analysis. Breads. Composition. Laboratory experiments. Yams. Wheat flour. Composite flours.

Water-soluble nonstarchy polysaccharides (WSNP) extracted from flours milled from dried tubers of the 2 most common West African species of yam (*Dioscorea rotundata* and *D. alata*) and roots of cassava (*Manihot utilissima* var. Ankra) were tested for their effect on the rheological behavior of wheat dough during mixing and in simple tension. WSNP were prepared in the same way as water-soluble wheat "pentosans" of a typical bread flour which were used as a standard for comparison. While 1% replacement of wheat flour with an equal amount of cassava WSNP resulted in a reduced farinograph absorption of the mixture, yam WSNP as well as wheat pentosans exhibited an opposite effect. The highest increase in farinograph absorption (4.7%) followed the substitution of wheat flour with WSNP of *D. rotundata* origin. Analysis of data obtained in simple tension revealed that the tested materials (with the exception of *D. rotundata* WSNP) behaved as a rheologically inert material showing no significant effect on parameters other than those influenced by the changes in the water absorption characteristics. A distinct "strengthening" effect was noticed with doughs containing *D. rotundata* WSNP, which was unrelated to the high water-binding capacity of this material. In rheological tests on bromated doughs, all WSNP appeared as an inert material with respect to the bromate reaction. (*Author's summary*) 102

0360-8523 SINGHALACHATI, C. **Design and development of a cassava root crop shredder.** Mag. Sc. Thesis. Rizal, Philippines, Araneta University Foundation. Institute of Graduate Studies and Applied Research, 1974. 77p. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Small-scale equipment. Rasping. Costs. Cassava starch. Processing. Philippines.

An inexpensive portable cassava root rasper, driven by a 1/3 hp electric motor, was designed to handle 100-110 kg roots/h and is recommended for small-scale industry. Construction and operating costs are given. Background data are included on cassava starch extraction, local (Philippine) recipes using fresh cassava roots, definition of terms and formulas used. (*Summary by T.M.*) 102

0361-9269 SISON, E.C. and ALMIRA, E.C. **Starchy materials as binders in fresh sausages.** Philippine Agriculturist 58(9/10):360-366. 1975. Engl., Sum. Engl., 8 Refs.

Cassava. Cassava flour. Food binders. Food products. Uses.

Binders such as cornstarch, wheat flour, cassava flour, sweet potato starch and nonfat dry milk (control) were added at different levels ranging from 3.5-15% to fresh pork sausage formulations, and the products were cooked and evaluated for eating quality. Statistical analyses of the sensory evaluation scores showed significant differences among the treatments for flavor, juiciness and general acceptability scores; however, there were no significant differences among the av scores for the binders for appearance, juiciness and tenderness. The nonfat dry milk was significantly better than all the other binders except cassava flour, in flavor and general acceptability scores. Results showed that the starchy materials tested can be used up to 10% as binders in fresh pork sausage (*Author's summary*) 102

0362-8159 SISON, E.C., ALMIRA, E.C. and NAVAL, A.B. **Starchy materials as binders in salami sausages.** Philippine Agriculturist 58(9/10).367-372. 1975. Engl., Sum. Engl , 4 Refs.

Cassava. Cassava flour. Food binders. Food products. Uses.

Salami sausage, prepared with various binders such as sweet potato, cassava, wheat, rice and potato flours at levels ranging from 5-15%, were cooked and evaluated for eating quality. Statistical analyses of the sensory evaluation scores showed significant differences among treatments for appearance, flavor and general acceptability scores but no significant differences for juiciness and tenderness. Rice and wheat flours were significantly better than the others for flavor and general acceptability. Among levels, there were significant differences for appearance, flavor and general acceptability scores, with 5-10% receiving the higher scores. Results indicate that among the binders tested, sweet potato and potato flours can be used up to the 10% level only while cassava, rice and wheat flours can be used up to 15% as fillers in salami sausages. (*Author's summary*) 102

0363-7415 SISON, E.C. and ALMIRA, E.C. **Utilization of starchy materials in meat preparation. III. Binders in meat loaf.** Philippine Agriculturist 59(5/6).137-146. 1975. Engl., Sum. Engl., 7 Refs., Illus.

Cassava. Cassava flour. Food binders. Food products. Uses.

All-purpose flour, cassava flour, cornstarch and nonfat dry milk (control), at levels ranging from 10-30%, were added to meat loaf formulations. Products were evaluated for eating quality. Statistical analyses of the sensory evaluation scores showed significant difference among the

treatments for juiciness scores, but no significant differences for appearance, flavor, tenderness and general acceptability. Among binders, nonfat dry milk and all-purpose flour were significantly better than cassava flour and cornstarch for juiciness while all-purpose flour was significantly better for tenderness. Among levels, there were significant differences for flavor, juiciness, tenderness and general acceptability, with 30% receiving the highest scores Considering the cost and shrinkage loss of producing the different formulations, mixture with 30% cassava flour was cheapest whereas that with 30% cornstarch had the lowest % shrinkage. Hence cassava flour and cornstarch at 30% are more economical to use as fillers for meat loaf. (*Author's summary*) 102

0364-9413 TONGKASAME, C. **Anaerobic treatment of tapioca starch waste.** Mag.Sc. Thesis. Bangkok, Thailand. Asian Institute of Technology. Thesis no. 228. 1968. 188p Engl., Sum. Engl., 49 Refs., Illus.

Cassava. Cassava starch. Factories. Wastes. Analysis. Biochemistry. Thailand.

The physical, chemical and biochemical characteristics of wastewater from a cassava starch processing plant were assessed, and the biological treatability of the raw waste was evaluated in anaerobic digesters and anaerobic stabilization ponds The effect of pH, alkalinity adjustment, nutrient addition and loading on efficiencies of the 2 systems was also studied For both anaerobic digestion and stabilization in ponds, it was found that N and P supplementation, as well as pH adjustment of the raw waste, was beneficial prior to anaerobic treatment of the cassava starch waste. However, alkalinity adjustment was found to be more essential; the combination of nutrients and alkalinity gave best results, based on removal of 5-day biochemical oxigen demand (BOD) and volatile solids. In the case of anaerobic digestion, the efficiency of the system, based on gas production rate and removal of BOD and volatile solids, decreased with increased organic loading or with a shorter detention period. This was also true in the studies on anaerobic stabilization of the waste in the ponds. The highest efficiency for anaerobic digestion over the entire study period was obtained in the digester fed with raw waste to which nutrients and alkalinity were added at the longest detention time (30 days) For pond studies, the highest efficiency was obtained in the pond having the same feeding conditions as the digester, but with a detention period of 27 days. Based on the same hydraulic loading, it was found that the efficiency of the pond was higher than that of the digester; moreover, the pond would, in practice, be much easier to operate and maintain than the digester. (*Author's summary*) 102

0365-0084 TRINDADE, S. **Produção de carburante derivado de mandioca.** (*Production of power alcohol from cassava*). Silvicultura 2:171-177. 1977. Port., Sum. Port., Engl., Illus.

Cassava. Ethanol. Industrialization. Economics. Costs. Cassava programs. Brazil.

Little is known about the technical and economic aspects of large-scale alcohol production from cassava. The Centro de Tecnologia Pronom made a study of this type of agro-industrial project using a model with 15 variations covering 4 basic types of problems. The use of cassava or sugar cane as the raw material was compared on the basis of the net energy ratio. Cassava is considered to have a much better potential for increasing crop yield within a short time. It is concluded that there is a great need for more applied research in this area and better managerial capacity. (*Summary by T.R.*) 102 J00

0366-8349 TRUJILLO C., F.A. **Industrialización de la yuca en Colombia; análisis financiero para la producción de chips.** (*Industrialization of cassava in Colombia; financial analysis of the production of chips*). Tesis Mag.Sc. Managua, Nicaragua, Instituto Centroamericano de Administración de Empresas, 1976. 32p. Span., Illus

Cassava. Industrialization. Cassava chips. Factories. Economics. Costs. Statistical analysis. Drying. Small-scale processing. Cassava programs. Colombia.

The feasibility of processing cassava chips is studied when integrated vertically with crop production. The different steps of washing, chipping and drying the roots and the installations required are described and illustrated Required fixed assets and capital investments, as well as variable and fixed costs for 3 production capacities (1, 2 and 5 t fresh roots/day), are presented. An analysis of sensitivity was made to determine the effects of different variables on the internal rate of return It was concluded that the processing of chips is profitable only when more than 2 t of roots are processed because of the marginal cost structure The project is hypersensitive to the price of cassava so the financial success of the project depends on the efficiency of the process (root quality, handling, time from harvest to processing,fast drying on inclined trays). Price stabilization mechanisms are necessary. (*Summary by A.J. Trans. by T.M.*) 102 J00

0367-9411 UDDIN, S. **Anaerobic pond treatment of tapioca starch waste.** Mag. Sc. Thesis. Bangkok, Thailand. Asian Institute of Technology. Thesis no. 440. 1970 140p. Engl., Sum. Engl., 51 Refs., Illus.

Cassava. Cassava starch. Factories. Wastes. Analysis. Biochemistry. Thailand.

Wastes from the production of cassava starch in Thailand have a very high biochemical oxygen demand (BOD) and low pH. The economic position of the industry requires a low-cost waste treatment. Anaerobic ponds are considered the most suitable for the tropics, minimizing land use and plant operational costs This study evaluates design parameters for anaerobic ponds and estimates their performance. The effects of BOD loading, detention time and pH on anaerobic pond performance were evaluated outdoors in 3-ft-deep experimental units using cassava starch waste as influent. Initially, these 3 factors, as well as BOD loading and pH interaction, were significant in BOD removal. Optimum BOD loading on 1st-stage anaerobic ponds was ca. 6720 kg/ha/day, a maximum detention period of 5 days gave best BOD removal Under these conditions BOD removal was 4130 kg/ha/day. Above 6720 kg/ha BOD loading, effluent pH was normally below 6, alkalinity was relatively low and volatile acid concentration was very high Second- and 3rd-stage anaerobic ponds in series with 1st-stage ponds gave lower areal removal than 1st-stage ponds when BOD loadings were lower and detention times similar. However, a 2nd-stage anaerobic pond loaded at 7700 kg/ha/day gave a BOD removal of 2960 kg/ha/day, which was close to 1st-stage BOD removal at a similar loading. Third-stage facultative ponds with lower BOD loadings and longer detention times than 3rd-stage anaerobic ponds gave less areal BOD removals. A prototype design for treatment of 1 mgd of cassava starch waste with a BOD concentration of 3800 mg/liter suggested that 5 stages of anaerobic ponds followed by a 6th-stage facultative pond would give a BOD removal efficiency approaching 99% for a minimum investment. (*Author's summary*) 102

0368-9414 UNKULVASAPAUL, Y. **Evaluation and treatment of wastes from the tapioca starch industry.** Mag Sc Thesis Bangkok, Thailand Asian Institute of Technology Thesis no. 836. 1975. 83p. Engl , Sum Engl., 38 Refs , Illus.

Cassava. Cassava starch. Factories. Wastes. Analysis. Biochemistry. Thailand.

The characteristics and volumes of wastes from four 2nd-grade cassava starch plants were evaluated, and the performance of multistage anaerobic-facultative ponds treating these wastes were studied. Two main sources of process wastes were the wash water and the supernatant from sedimentation tanks. The av volumes of these wastes were 9 and 12 m^3/t of starch produced, respectively. The av 5-day biochemical oxygen demand (BOD) of wash water, supernatant and combined wastewater were 1192, 4148 and 2491 mg/liter, respectively; N and P concentrations were low in both streams. Pilot scale oxidation ponds were constructed at a 2nd-grade starch

plant in Chonburi (Thailand), where a combination of tap and well water is used as process water. Well water contained high chloride concentrations because of the proximity of the well to the sea; consequently, wastewaters from the plant contained high chloride levels. However, this did not appear to be inhibitory to the oxidation ponds. The 1st-stage anaerobic pond was loaded at 7511 lb BOD/acre/day with a detention time of 5.95 days, giving a BOD reduction of 60.5%. Second-, 3rd- and 4th-stage ponds loaded at the same BOD level achieved little further BOD reduction. In order to obtain an effluent with low BOD, it was necessary to keep loadings in the 2nd and 3rd stages low. Second- and 3rd-stage ponds loaded at 500 and 80 lb BOD/acre/day with detention times of 8 and 28.6 days gave BOD removals of 35.9 and 84.9%, respectively, rated on the input BOD to those ponds. From this study it is recommended that 2 anaerobic ponds followed by a facultative pond loaded at 6000, 2000 and 100 lb BOD/acre/day would give a satisfactory total BOD removal. Suspended solids removal was satisfactory in all the systems studied, notwithstanding the detention time. A pilot-scale aerated lagoon was also investigated as treatment for the effluent from the 1st-stage anaerobic pond. At a detention time of 8 days, chemical oxygen demand (COD) reduction was 90.2%, but the effluent contained high suspended solids levels and would require further sedimentation before discharge. (*Author's summary*) 102

0369-9416 VALSECHI, O. **Tapióca.** (*Tapioca*). Solo 44(4):16-19. 1952. Port., 3 Refs.

Cassava. Tapiocas. Processing. Brazil.

The different steps in making tapioca are described: cooking the cassava starch with a moisture content of 25%, drying to form granules and classifying of the granules according to size. The different types of screens used are defined. The process for obtaining pearl tapioca is also given. (*Summary by T.B.*) 102

0370-9258 VITTI, P, PIZZINATTO, A and LEITAO, R.J.J. **Estudo sobre tecnologia de mandioca destinada a alimentacao humana.** (*Technology for cassava to be used for food*). Campinas, Brasil, Instituto de Tecnologia de Alimentos, Projeto ITAL 41.2/75. 1975. 38p. Port., Sum. Port., 33 Refs.

Cassava. Cassava starch. Cassava flour. Pellets. Cassava bread. Biscuits. Wheat flour. Analysis. Gelatinization. Viscosity. Protein content. Food products. Processing. Brazil.

The characteristics of 8 cassava cv. were evaluated for making pellets. The breadmaking qualities of ordinary or pregelatinized flour made from chips were also evaluated in the preparation of breadmaking and biscuits, using 10 and 20%, respectively, and the additives ascorbic acid and calcium stearyl lactylate. Cv. IAC-1012 and 12-839 were outstanding. Best pellets were obtained when using chips with an initial moisture content of 20-25%. There were no noticeable physical or organoleptic alterations (specific vol, taste, texture) when using up to 20% for common biscuits and up to 30% for shortbreads. As compared to ordinary flour, pregelatinized flour was better for breadmaking than for biscuits. (*Author's summary. Trans. by T.M.*) 102 101

0371-9042 WADHWA, N.D. and BABHULKAR, S S **Method, machines and economics of cassava processing in Ghana.** Accra, Ghana, Agricultural Engineers Ltd, 19?? 11p. Engl

Cassava. Cassava chips. Processing. Costs. Economics. Labour. Gari. Cassava starch. Industrial machinery. Ghana.

The processing of cassava to make dry chips, gari and starch in Ghana is discussed with regard to economics (capital investment, operating, raw material and packaging costs) and machinery

required including a locally manufacture chipper (1 to 1½ t chips/h), grater (1½ to 2 t/h), a press and roasters. (*Summary by I.B.Z. Trans. by T.M.*) 102 J00

See also *0260* *0312* *0376* *0391* *0406* *0409* *0410* *0416* *0417* *0421*

I03 Industrial Microbiology

0372-7406 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. Industril 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

0373-1058 BALAGOPAL, C. and MAINI, S.B. **Evaluation of certain species of fungi for single cell protein and amylase production in cassava liquid medium.** Journal of Root Crops 2(2):49-51. 1976. Engl., Sum. Engl., 4 Refs.

Cassava. Industrial microbiology. Protein enrichment. Cassava starch. Culture media. Enzymes. India.

Six species of *Rhizopus* and 4 of *Aspergillus* were grown in 2.5% cassava starch liquid media and incubated at room temp for 5 days. Dry wt of mycelia and TCA-insoluble N in the mycelial mat were estimated. The cultural filtrate was tested for amylotytic activity. *A. niger* NRRL 330 was superior for protein production and amylase activity. Results indicate the possibility of cassava starch as a potential and inexpensive source for single-cell protein and amylase production. (*Author's summary*) I03

0374-1490 BALAGOPAL, C. and MAINI, S.B. **Studies on the utilisation of cassave waste for single cell protein production.** Journal of Root Crops 3(1):33-36. 1977. Engl., Sum Engl., 7 Refs.

Cassava. Waste utilization. Industrial microbiology. Protein enrichment.

The peel of cassava roots is a waste material in the tapioca and starch industries, as well as when the roots are consumed fresh. An attempt was made to convert this waste material to single-cell protein using amylotytic fungi of the genera *Aspergillus* and *Rhizopus*. Mycelial wt and protein status were assessed. *Rhizopus* sp. was superior to the other species although all fungi tested showed amylolytic activity. Protein production was directly proportional to the concentration of starch. (*Author's summary*) I03

0375-9032 GREGORY, K.F. **Cassava as a substrate for single-cell protein production: microbiological aspects.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.72-78. Engl., Sum. Engl , 45 Refs , Illus.

Cassava. Protein enrichment. Industrial microbiology. Fermentation. Silage. Culture media. Analysis. Proteins. Laboratory experiments. Animal nutrition.

Data from several laboratories have shown that filamentous fungi produced on cassava and other substrates are satisfactory as high-protein animal feed. At Guelph, simple low-cost methods for converting cassava to microbial protein were sought. Silage was produced from cassava and inorganic nitrogen with up to 6.4% protein, but no practical way could be devised for doing this in rural, tropical areas. Liquid, aerated fermentation with thermo-tolerant fungi has more promise of having practical value. Whole ground cassava can be used in a nonaseptic system because the fermentation's high temp (45-47°C) and low pH (3.5) inhibit contaminants. Water at ambient temp suffices to remove excess heat. The fungi hydrolyze the starch by their own enzymes and can be harvested by simple filtration. The 3 cultures that gave the best nutritional response with rats contained 44-50% crude protein and 35-38% true protein. The product formed with *Aspergillus fumigatus* I-21A on whole cassava (including nonfermented fiber and peel) contained 37% crude and 27% true protein. Simple conditions for a daily batch production schedule have been defined. Fungi capable of growth at body temp could be an infection biohazard for unusually susceptible individuals. A nonrevertible, asporogenous mutant of *A. fumigatus* I-21 (I-21A), used to avoid risk of infection by spore inhalation, may not be a sufficient safeguard since viable hyphal fragments can occur in an aerosol. "Cold-sensitive" mutants, unable to grow below 40°C but able to grow normally at 45-47°C, were isolated by 5 sequential mutations. Nonrevertible mutants, required for absolute safety, have not yet been obtained. (*Author's summary*) 103 H03

0376-9033 MEIERING, A.G. and AZI, F.A. **Fermentor performance in microbial protein production from cassava.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings. Ottawa, Canada, International Development Research Centre, 1977. pp-79-84. Engl., Sum. Engl., 33 Refs., Illus.

Cassava. Small-scale equipment. Industrial microbiology. Fermentation. Protein enrichment.

A self-aspirating fermentor was developed on the basis of the Waldhof principle. Aeration capacity and microbial growth kinetics were analyzed for the batch and continuous flow process. Design data for a multiple-stage continuous flow system were derived, using the kinetic models and measured batch fermentation results in computer simulations (*Author's summary*) 103 102

0377-1196 NGA, B.H., TAN, E.L. and LEE, T.K. **Protein enrichment of carbohydrate rich substrate by two strains of yeast.** Singapore Journal of Primary Industry 4(1).11-15. 1976. Engl., Sum. Engl., 5 Refs

Cassava. Cassava starch. Fermentation. Industrial microbiology. Protein enrichment. Yeast production. Amino acids. Protein content.

Results are given of studies on protein enrichment of a cassava starch substrate using 2 strains of yeast: *Torula utilis* and *Endomycopsis fibuligera* The initial starch medium had a crude protein content of 0.7%; after 8 days' cultivation of *E. fibuligera,* the protein content of the medium increased > 6-fold and with *T. utilis,* approx 6-fold. A no. of specific amino acids were also greatly enhanced by the cultivation of yeast. (*Summary by T.B.*) 103

0378-4203 OKEZIE, B O. **Improved food uses of cassava (*Manihot utilissima* Pohl): advances in research.** Ph.D. Thesis Ithaca, New York, Cornell University, 1975. 173p. Engl., Sum. Engl., 233 Refs., Illus

Cassava. Gari. Food enrichment. Yeast production. Cassava starch. Proteins. Amino acids. Analysis. Organoleptic examination. HCN content. Fermentation. Hydrolysis. Industrial microbiology. Nutritive value. Laboratory animals.

An improved (proteinized) gari was made by combining freshly ground cassava roots with soy protein concentrate and acid whey powder (CSW). It received good scores on various quality attributes by a taste panel and had a PER of 2.1. Biological quality was considerably improved by low-level methionine supplementation, giving a PER of > 2.4, almost equal to the PER of the reference standard casein product. A similar proteinized gari with single cell protein (SCP) from *Candida tropicalis* and acid whey powder did not prove as acceptable or as biologically available as the CSW. The products showed good stability for 16 wk under a storage condition simulating a tropical environment of high temp and RH in a standard package of aluminum-polyethylene-cellophane lining, sealed with air or under vacuum. Saccharification of cassava starch was successfully carried out with 0.1N HCl at 121°C for 1 h. *C. tropicalis* and *C. utilis* were batch cultivated using the cassava hydrolysates. SCP with a total protein content of about 51 and 48%, respectively, and with a comparatively good protein score, low nucleic acid content and good amino acid profile was produced. The proteins were rich in lysine and many other essential amino acids, except methionine and tryptophan, which were the limiting amino acids. The yeast proteins were extracted with sodium hydroxide and precipitated at their isolectric point (pH 4-4.5) with HCl. The extracted proteins as concentrates had good amino acid profile, with methionine as the limiting essential amino acid. They also had low bulk density, good wettability, emulsion capacity and whippability, which would make them applicable in other food systems. In general the yeast proteins were comparable and in some cases, superior to soybean protein concentrate in certain functional properties. (*Summary by Dissertation Abstracts*) 103 H01

0379-9713 RATTAKUL, B. **Single-cell protein production from cassava starch by yeast.** Ph.D. Thesis. Provo, Utah, Brigham Young University. Department of Microbiology, 1976. 96p. Engl., Sum. Engl., 102 Refs., Illus.

Cassava. Cassava starch. Protein enrichment. Yeast production. Culture media. Enzymes. Temperature. pH. N. Amino acids. Analysis. Biochemistry. Industrial microbiology. Laboratory experiments.

An amylolytic yeast isolated from cassava processing waste and identified as *Endomycopsis fibuligera* was grown alone or in association with *Candida utilis* under a variety of cultural and experimental conditions. Mixed culture of the 2 yeasts produced yields in the range of 45-55% biomass dry wt with 40-50% crude protein content, whereas only 30-35% protein yields were obtained when *E. fibuligera* was grown alone. The protein content of mixed cultures reflects the ratio of cells of *C. utilis* to cells of *E. fibuligera.* Controlled pH, inoculation size as well as dissolved oxygen concentration of culture media influence the cell ratio and cell yield of the mixed cultures A multistage, multistream continuous culture as well as cascade-type continuous culture produced significantly higher yields than were obtained in a single-stage continuous culture at equivalent dilution rates. Amylase and glucoamylase activity were decreased as the dilution rates increased from 0.1 to 0.3 h^{-1}. Oscillation rather than steady state conditions were observed in all

continuous culture experiments. Amino acid composition of the mixed culture compares favorably with other yeast-produced SCP and with the FAO requirement. (*Author's summary*) 103

0380-3072 SALES, A.M. and MENEZES, T.J. DE B. **Produção de biomassa protéica de mandioca.** (*Single-cell protein production from cassava*). Coletânea do Instituto de Tecnologia de Alimentos 7:139-146. 1976. Port., Sum. Port., Engl., 15 Refs.

Cassava. Industrial microbiology. Yeast production. Protein enrichment. Brazil.

Studies were made of the biomass produced by mixed cultures of amylolytic yeasts (*Endomycopsis fibuligera* C-356, *E. capsularis* 62-181 and *Schwanniomyces alluvius* 54-83) with *Candida utilis* and *Rhodotorula gracilis*. *E. fibuligera* with *C. utilis* converted the most carbohydrate to biomass. When urea was used as the N source in a medium containing 30 g/liter of total sugars, a biomass yield of 14.9 g/liter was obtained with a protein content of 56% (dry basis). (*Author's summary*) 103

0381-9035 SANTOS, J. and GOMEZ, G. **Pilot plant for single-cell protein production.** *In* Nestel, B. and Graham, M., eds. Workshop on Cassava as Animal Feed, University of Guelph, 1977. Proceedings Ottawa, Canada, International Development Research Centre, 1977. pp.91-94. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Cassava programs. Protein enrichment. Industrial microbiology. Small-scale equipment. Fermentation. Colombia.

A process for microbial protein production, using cassava as the energy subtrate, was developed and tested on a laboratory scale at the University of Guelph. The microorganism used was the fungus *Aspergillus fumigatus* 1-21A, an asporogenous mutant that could grow under very selective conditions of temp (45°C) and pH (3.5). A pilot plant has been built at CIAT to test the technology developed on a laboratory scale and to produce a sufficient quantity of biomass for practical evaluation in animal feeding, notably in swine. Preliminary results obtained at the pilot plant, suggest the process has potential, once completely safe operational procedures can be established. A feeding trial with fungal biomass obtained at the pilot plant indicates that the product has a good nutritive quality if adequately supplmented with methionine. (*Author's summary*) 103 H03

0382-3049 SANTOS N., J. **Single-cell protein production from cassava at the pilot plant scale.** Mag Sc. Thesis. Guelph, Ontario, University of Guelph, 1977. 81p. Engl., Sum. Engl., 87 Refs., Illus.

Cassava. Industrial microbiology. Protein enrichment. Fermentation. Proteins. Analysis. Feeds and feeding. Nutritive value. Laboratory animals. Small-scale equipment. Cassava starch. Cassava meal. Protein content. Colombia.

Results are given of experiments on the nonaseptic, high temp production of microbial protein from cassava by the fungus *Aspergillus fumigatus* I-21A, conducted at the pilot plant level at CIAT (Palmira, Colombia) as a 2nd-stage in the evaluation of technology developed and tested on a laboratory scale at the University of Guelph (Canada). A layout of the equipment required at this level is included The different steps include washing and rasping of the fresh cassava roots, preparing the culture medium (includes the gelatinization of the starch in the roots), the fermentation process, harvesting of the biomass and sun drying of the final product. Protein yields were not as high as expected from previous experimental work on the laboratory scale, total crude protein content of the final product did not exceed an av of 30% on a DM basis. This

was partially due to incomplete utilization of the carbohydrates. The amino acid profile of this fungal protein compared favorably with that for other protein sources; the most important difference, however, was the low content of the sulfur-containing amino acids, notably methionine. A biological evaluation based on PER and NPR, using growing rats, was performed to ascertain the protein quality of the dried biomass resulting from fermentation with either fresh roots or cassava meal substrates. The effect of methionine supplementation (0.3%) was studied in particular. It was found that the dried product had a good nutritive value since the growth responses in rats were similar to those produced by the casein control, provided the biomass was adequately supplemented with DL-methionine. Exposure of the biomass to the sun, in shallow trays, yielded a dry product with a nutritional value similar to that of freeze-dried biomass. In another rat-feeding trial the nutritive value of biomass (as the sole protein source) from other isolated thermotolerant fungi that might have a potential as alternate cultures was evaluated. Protein level was based on their alpha-amino N content rather than on Kjeldhal N, as used in the previous evaluation. Two of the cultures (*Cephalosporium eichorniae* 152 and *Rhizopus chinensis* 180) gave PER and NPR values that not only exceeded those of *A. fumigatus* I-21A but also equaled those obtained with casein even though it was supplemented with both methionine and tryptophan. On visual inspection, the rats on these fungal diets appeared to be in excellent health. These results suggest that single-cell protein production from cassava is potentially promising for practical application in cassava-producing areas as long as safe operation procedures can be established. (*Author's summary*) 103

0383-2719 SCHMIDELL, W. and FERNANDES, M.V. **Comparação entre hidrólise ácida e enzimática de amido para determinação de açúcares redutores totais.** (*Comparison between acid and enzymatic hydrolysis of starch for determining total reducing sugars*). Revista de Microbiologia 8(3) 98-101. 1977. Port., Sum. Engl., Port., 9 Refs., Illus.

Cassava. Cassava flour. Hydrolysis. Analysis. Sugar content. Industrial microbiology. Brazil.

Acid and enzyme hydrolysis were employed for determining total reducing sugars in cassava flour and during the culture of *Aspergillus niger* NRRL 337 in a medium containing cassava flour as the main carbon source. Enzymatic hydrolysis gave better results because it was not affected by the cellular material, which might not occur when employing acid hydrolysis. Determinations in the cassava flour gave similar results for both methods. (*Author's summary*) 103

0384-4019 SILVA, M.A.A.A. DA **Produção de proteína fúngica em raiz e folha de mandioca** (*Manihot esculenta* Crantz). (*Single-cell protein production from cassava roots and leaves*). Tese Mag. Sc. Piracicaba, Brasil, Universidade de São Paulo. Escola Superior de Agricultura "Luiz de Queiroz", 1978. 129p. Port., Sum. Port., Engl., 91 Refs., Illus.

Cassava. Tubers. Leaves. Industrial microbiology. Protein enrichment. Amino acids. Analysis. Drying. Temperature. Protein content. Brazil.

The main objective of this study was to determine whether cassava leaves could be used as the source of N by microorganisms in single-cell protein production. *Aspergillus niger* IZ-9, *A. wentii* IZ-1625 and *Fusarium* sp. were compared. Although *Fusarium* sp. produced the most biomass in one of the trials, it proved to be unstable and was discarded; of the other 2 microorganisms, *A niger* was better. Of 2 methods for dehydrating leaves (in an oven at 45°C and by lyophilization), better results were obtained with the oven process. Good microorganism development was obtained at pH 3 in a cassava leaf and root medium, at concentrations sufficient to provide 0.12 g N/100 g and 1.5 g carbohydrate/100 g. Max biomass production was attained from 84 h on and crude protein from 60 h on when 5-mm diameter inocula of 4-day-old cultures were used per 50 ml of media. With regard to the profile of essential amino acids, oven dehydration considerably reduced threonine content as compared to lyophilization. Nevertheless, this process offered better growth conditions for *A. niger*, resulting in an increase of almost 100% in the content of

some essential amino acids including threonine, which attained levels equivalent to that of the lyophilized leaf, and methionine, which reached a level higher than that of the lyophilized leaf. (*Author's summary*) I03

See also *0241* *0277*

J00 ECONOMICS AND DEVELOPMENT

0385-1157 **ADULTERATION, THE bug bear of the tapioca industry.** Investor 10(1).29-32. 1978. Engl., Illus.

Cassava. Cassava products. Trade. Legal aspects. Thailand.

Although the future of the Thai cassava industry looks good on the surface, there are serious threats from French grain producers and other cassava exporters. Moreover, Thailand's position is weak because of product adulteration. In 18 shiploads sampled, av sand content was 5.8% (ranging from 3+ to 15%); the EEC limit is 3%. Problems involved between the 2 government inspection agencies and the enforcement of newly established penalties are discussed. (*Summary by T.R.*) J00

0386-8327 ANANTHARAMAN, S.C. **Tapioca has rich food and export potential.** Planters Chronicle 71(3):104-105. 1976. Engl.

Cassava. Production. Cassava programs. India.

The estimated 1980 CEE market for cassava-based feedstuffs is US$3 billion. Three high-yielding varieties developed by the Central Tuber Crops Research Institute in Trivandrum could raise production levels from 10 to 30 t/ha, which would be equal to increasing India's production from 6.4 to 15 million tons. The area planted to cassava would go from 43,000 to 100,000 ha. Cassava has a great potential as an export feedstuff and also for composite flours. The main cassava exporters are Thailand, Indonesia, Brazil, Madagascar and Malaysia. Because of Indian food habits, with the exception of Kerala, cassava cannot be considered for human consumption; its main potential is for export. (*Summary by M.O. de H. Trans. by I.B.Z.*) J00

0387-1378 APRIL, J.E. *et al.* **Cassava's role as a food staple; a cross disciplinary systems analysis of nutrition problems in a cassava dependent culture.** Boulder, USA, University of Colorado, 1974. 135p. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Cassava programs. Developmental research. Human nutrition. Diets. Nutritive value. Economics. Marketing. Consumption. Production. Socio-economic aspects. Nigeria.

The beginning phases of a systems approach to studying food and nutrition in Nigeria are presented. The focus is on a single commodity, cassava; and it is used as a tracing mechanism for describing the structure of the food and nutrition system in southern Nigeria. Food production in

this area can barely keep pace with demand. Per capita income is not increasing fast enough to allow all segments of the population to enjoy complete nutritional satisfaction. There is a need for intervention programs that yield high nutritional payoffs in relation to their costs. Critical characteristics within the system that are important to understanding how it operates are described. Recommendations are made with regard to preliminary interventions that change or accelerate ongoing processes within the system. A foundation is laid for drafting policy decisions that may assist a broader nutritional planning program. This diagnostic project is an effort to show specialists in many fields the value of examining nutrition problems from a systems perspective and to illustrate the value of looking at the impact of any intervention on the entire system. (*Summary by the Agency for International Development*) J00 H01

0388-9228 BAZAN, R. *et al.* **Desarrollo de sistemas de producción agrícola, una necesidad para el trópico.** (*Development of agricultural production systems, a necessity for the tropics*). Fitotecnia Latinoamericana 11(1):53-57. 1975. Span., Sum. Engl., Span., Illus.

Cassava. Developmental research. Cassava programs. Cultivation. Cultivation systems. Intercropping. Beans. Sweet potatoes. Maize. Rice. Costa Rica.

Low productivity of tropical subsistence crops in attributed to the lack of adequate production systems adapted to regional ecological conditions and crops. Small rural farmers cannot use technology requiring large land extensions and high inputs. To develop intensive and economical systems adapted to the need of small farmers, a research project including 54 different systems combining beans, maize, rice, cassava and sweet potatoes was initiated. Data are being collected on biological and economic productivity, the influence of systems on fertility, development and control of pests, diseases and weeds (*Author's summary*) J00 K01

0389-1381 BOONSUE, B. and SINTHUPRAMA, S. **Cassava — a potential cash crop for Thailand.** Thai Journal of Agricultural Science 9(1):67-75. 1976. Engl., 7 Refs.

Cassava. Cultivation. Production. Tuber productivity. Cultivars. Thailand.

The following aspects of cassava are discussed: its history in Thailand, sources of introduced germplasm, av yields of var at the Huai Pong Field Crops Station, production data from 1960-73, national yield and reasons for low yields (use of unimproved var., low soil fertility and no fertilization, poor cultural practices, government restrictions of expanding acreage planted to cassava). (*Summary by T.B.*) J00 D03

0390-1209 CASSAVA AS a competitor of maize and potatoes in the production of starch and allied products. Queensland Agricultural Journal 6(5):313-317. 1916 Engl., Illus.

Cassava. Productivity. Factories. Australia.

Because of a crisis in the sugar cane industry, cassava is recommended as an alternative crop to be planted on these lands. Starch yields of maize, potatoes and cassava are compared; cassava is the cheapest source. A diagram is included of a plant that could process up to 100 t roots/10-h day. (*Summary by T.B.*) J00

0391-8271 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava, production systems program.** *In*___. Annual Report 1976. Cali, Colombia, 1977. pp.B1-B76. Engl., Illus.

Cassava. *Manihot esculenta*. Cassava programs. Plant physiology. Plant development. Leaf area. *Tetranychus urticae*. *Mononychellus tanajoa*. Resistance. Acaricides. *Erinnyis ello*. Insect agents. *Anastrepha pickeli*. Insect control. *Xanthomonas manihotis*. *Erwinia cassavae*. Plant breeding. *Sphaceloma manihoticola*. *Cercospora henningsii*. *Cercospora caribaea*. *Uromyces manihotis*. Dry matter. Tuber productivity. Starch productivity. Storage. Propagation. N. P. K. Cultivation systems. Drying. Tubers. Colombia.

A report is given of CIAT's cassava production systems activities in 1976. Although major emphasis was on development of new technology, greater emphasis than before was placed on international training and cooperative projects. The areas covered are physiology, entomology, pathology, varietal improvement, agronomy, soils, multiple cropping, economics, cassava drying and training. Some highlights were as follows: (1) The cassava plant ideotype should have a LAI of about 3, branch at about 6 mo, have large leaves and a long leaf life. The ideal phenotype for cassava production appears to be similar for different temp zones; however, when temp is below about 22°C, special genotypes are needed. (2) Low to intermediate levels of resistance to the mites *Tetranychus urticae* and *Mononychellus tanajoa* were found. Efficient biological control methods for the hornworm are being tested on farmers' fields with excellent results. (3) Evaluation of material resistant to CBB, *Phoma* sp., *Cercospora* spp. and superelongation was done routinely on promising new material. Studies on bacterial stem rot showed that the causal agent is *Erwinia carotovora* var. *carotovora*. This pathogen penetrates the host via wounds, in this case caused by fruit flies (*Anastrepha* spp.). This bacteria/insect relationship is being studied. The frog skin disease of cassava, which can reduce yields considerably, can be controlled easily by using healthy planting material. Heavy yield losses due to superelongation are greatly reduced by fungicide treatments of stem cuttings to be used for planting material and selection of tolerant varieties. (4) In evaluating thousands of hybrids, it has been found that it is feasible to obtain broadly adapted high-yielding varieties. M Col 1684 has exceptional stability with high yields of over 50 t/ha at CIAT, 44 t/ha at Caribia and 36 t/ha at Carimagua. These zones have pH's ranging from 4.5-7.8, mean temp from 24-28°C, and soils from infertile to highly fertile. (5) Good yields (20-36 t/ha) were obtained on poor, acid soils with moderate levels of fertilizer input. In other areas selected lines consistently outyielded local lines by 75% with extremely low input levels. With improved selection and cultural practices, local lines almost doubled the national av (16 t/ha). (6) Associated cropping systems were found to reduce av yields by about 30%. The basic response of cassava in competition with beans is being studied to design more efficient associations. (7) Natural, more efficient, drying methods are being developed using a modified Malaysian chipper followed by drying on inclined trays. A short intensive cassava production course was held at CIAT for 32 agronomists from 9 Latin American countries. Long-term training in research is given to students from Africa, Asia and Latin America; upon returning to their countries, these professionals form multidisciplinary research teams. CIAT sent seed and planting material to 28 countries this year. The IV Symposium for the International Root and Tuber Crops Society was held at CIAT in Aug. 1976. (*Summary by I.B.Z.*) J00

0392-9704 CHANDRA, S., DE BOER, A.J. and EVENSON, J.P. **Economics and energetics: Sigatoka Valley, Fiji.** World Crops 26(1):34-37. 1974. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Production. Labour. Income. Economics. Cultivation. Socio-economic aspects. Energy productivity. Fiji.

The Sigatoka Valley is a densely populated area of diversified cropping operated by Fijian and Indian smallholders in southwest Viti Fiji. A detailed study was made of 2 sets of farmers in Naduri-Emuri and Naceva during the 1970-71 cropping season. Despite the proximity of the groups (< 2 km) and the virtually identical ecological conditions, major differences in land and labor utilization were evident. These differences are explained by simple measures of biological and economic efficiency of the cropping systems present. The major subsistence crop in the 1st group is cassava and in the 2nd group, rice. Major commercial crops in the 1st are maize and watermelons and in the 2nd, tomatoes and maize. An explanation is given of how the energetics of

the crops grown is reflected in the economics of village resource use and how the different patterns of biological efficiency between the 2 areas have encouraged or retarded income-improving measures in Fijian agriculture. (*Author's summary*) J00

0393-9703 CHANDRA, S., EVENSON, J.P. and DE BOER, A.J. **Incorporating energetic measures in an analysis of crop production practices in Sigatoka Valley, Fiji.** Agricultural Systems 1:301-311. 1976. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Production. Socio-economic aspects. Prices. Marketing. Labour. Energy productivity. Economics. Fiji.

The way in which energetic measures applied to farm level crop production data can be used to explain some differences between 2 distinct ethnic groups in a Fijian farming area and to give some insights into the slow rates of technological progress characteristic of the area is discussed. Applications of the energy efficiency ratio E indicated large differences between the 2 groups and among the various crops produced. Main subsistence crops in one area are rice and pulses and in the other, cassava, sweet potatoes, yams and bananas Market prices for crops were used to derive measures of energy purchasing power or the kJ of food crop energy that can be purchased from the sale of different crops. Again, wide differences were apparent, and a direct relationship between the energy efficiency of a crop and its value was not evident. Cropping intensity was also analyzed in energetic terms. The measures used and the results derived were applied to the most pressing problems population, food supplies, income distribution, dietary preferences and agricultural employment. (*Author's summary*) J00

0394-1380 **THE CHIPS are down and the stakes are high.** Investor 1974: 73-74. 1974. Engl., Illus.

Cassava. Cassava chips. Pellets. Legal aspects. Trade. Thailand.

To protect and strengthen cassava exports, the Thai government issued a decree in June 1974, imposing industrial controls on pellet and chip manufacturers. Officials of the Thai Industrial Standards Institute can check product quality at the factory, in transit and at the warehouse. Objections raised by the Thai Tapioca Trade Association are discussed. (*Summary by T.B.*) J00

0395-9851 COCK, J.H. **A physiological basis of yield loss in cassava due to pests.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.9-16. Engl., Sum. Engl., 10 Refs., Illus.

Cassava. Productivity. Pest damage. Tuber productivity. Leaves. Leaf area. Defoliation. Photosynthesis. Plant development. Colombia.

Although mites, insects and diseases can cause heavy yield losses, cassava is more tolerant to pests than other crops because it does not have critical periods that affect yield-forming organs. The components of the cassava plant that determine yield are the storage roots, apices, leaves, stems and petioles. The ways in which pests affect these components and thus influence yield are discussed. The optimum Leaf Area Index (LAI) for root growth is approx 3; above this level yield decreases markedly. The results are presented of a series of simulated experiments conducted in order to determine (1) the effect of partial or total defoliation on the yield of leafy and nonleafy varieties, (2) the effect of shortened leaf life caused by the attack of *Cercospora* spp., (3) the reduction of the photosynthetic rate due to mites and African mosaic, and (4) leaf damage caused by thrips. When damage to the main apex is not continuous and the other apices that become active are not destroyed, there is no reduction in yield and, in fact, yield may increase substantially

in leafy varieties. Damage caused by bacterial blight, *Anastrepha* spp., *Erwinia* sp. and *Phoma* sp. always reduces yield. When varieties characterized by a flat-topped density-response curve are planted, death of plants at an early age produces only minimal yield reduction if the % of population reduction is less than 50% and the initial plant population is high. (*Summary by S.S. de S. Trans. by T.M.*) J00 D03

0396-1193 COELHO, A.F. **Organização da indústria da mandioca.** (*Organization of the cassava industry*). Lavoura 46:43-47. 1942. Port.

Cassava. Cassava programs. Industrialization. Brazil.

The creation of a centralized enfity (based on shares) to organize the cassava industry in Brazil is proposed as a solution to problems faced by the industry, such as unreasonably high price increases charged by producers, faulty supply of chips, better market possibilities and standardization of product quality. (*Summary by T.B.*) J00

0397-6937 DIAZ, R.O. **Tendencias de la producción mundial y rendimiento de la yuca 1960-1968.** (*World cassava production and yield trends 1960-1968*). Cali, Colombia. Centro Internacional de Agricultura Tropical. Boletin RB-1. 1972. 119p. Span., Engl., Illus.

Cassava. Production. Productivity.

Basic data were compiled in table form on cassava production, and an analysis was made of past trends of the relationship cassava production/population for each of the cassava-producing countries from 1960-68. The tendency of per capita production was estimated by simple linear regression During the period studied, the area planted to cassava increased an av of 200,000 ha/yr; the largest increases were in Africa and S.A. (480 and 124,000 ha, respectively). World production increased 2 million t/yr, but yields did not change. Per capita production increased 7.5 kg/yr in S.A. but decreased for the rest of the world. About 40% of world production comes from S.A. (25% of the area planted) and 36% from Africa (approx 50% of the world area). Brazil produces approx 1/3 of the total world production and 85% of S.A. production. Av world yield is estimated at 8.69 t/ha; Malawi and Brazil have the highest yields (23 and 20 t/ha, respectively). It is concluded that population growth exceeds the increase in cassava production since there is a decreasing trend in per capita production. (*Summary by A.J. Trans. by T.B.*) J00

0398-8359 DIAZ, R.O., PINSTRUP-ANDERSEN, P. and VARON, U. **Aspectos del mercadeo de la yuca.** (*Aspects of marketing cassava*). *In*____ eds Descripción agroeconómica del proceso de producción de yuca en Colombia Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 13p. Span., Illus.

Cassava. Marketing. Consumption. Distribution. Statistical analysis. Colombia.

The following aspects of marketing cassava in Colombia are discussed: utilization, system of sales at the farm level, transportation and final destination. Cassava is grown mainly for human consumption; only in 2 zones is it grown for starch production. One third of the farmers (in 3 zones) sell the crop still in the ground; 1/3 sell the crop at the farm and the rest at the market. Of those surveyed, 70% did not have their own transportation, in the most mountainous regions, more than 1/5 of the small farmers (<10 ha) used animals for transporting the crop. It is concluded that transportation is the limiting factor in marketing cassava, which in many cases makes it necessary to sell the crop at the farm. The feasibility of industrialization should be studied in regions where production can be increased. (*Summary by A.J. Trans. by T.M.*) J00

0399-8772 DIAZ., R.O. **Characteristics of the world's cassava production with emphasis on Latin America.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 29p. Engl., 20 Refs., Illus.

Also in Spanish.

Cassava. Production. Latin America.

A brief analysis is made of the relative importance of cassava production in relation to other agricultural commodities in cassava-producing countries, with emphasis on L.A. World cassava production in 1974 was estimated at 103 million t; Asia and L.A. accounted for 29% each and Africa, 42%. From 1964-74 production increased 2.9%/yr. Area planted was 11 million ha, increasing at a rate of 2.14%/yr. Av yield was 9.3 t/ha; yields were lowest in Africa and highest in L.A. Most production comes from small farms, ≥ 1 ha. About 56% of world production is destined for human consumption. The greatest demand for cassava as animal feed is in the EEC; Thailand supplied 90% of this demand with chips and pellets. The only L.A. exporter is Brazil. Implications of changes in supply and demand are discussed with relation to population growth rate production. It is concluded that the best perspectives for developing the feed concentrates industry is using cassava as a source of energy for domestic consumption; for this reason cassava prices must be reduced to levels competetive with those of other substitute products. The possibility of developing cassava starch industries in producing countries should be looked into. (*Summary by A.J. Trans. by T.M.*) J00

0400-8351 DIAZ, R.O. and PINSTRUP-ANDERSEN, P. **Importancia de la yuca en Colombia.** (*The importance of cassava in Colombia*). *In*____ eds Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 17p. Span., Illus.

Cassava. Production. Productivity. Statistical analysis. Prices. Economics. Colombia.

On the basis of secondary data, the importance of cassava in Colombia and trends over a 20-yr period (1955-74) are discussed with regard to area under cultivation, yield, production and prices. Area planted to cassava tended to increase on the av of 2990 ha/yr, totaling 165,000 ha in 1975. Colombia has the 2nd largest area dedicated to cassava (6.23%) in South America and 10th in the world (1.43%). The country is the 10th largest producer in the world and 3rd in South America. Av increase in production was 28,080 t/hr. Av yields (5.7-8.0 t/ha) are lower than the world av From 1955-72, the increase in the deflated price/t of cassava was slight. Most of the cassava produced (95%) is used for fresh consumption locally. Government policies limit credit, and there is little technical assistance. (*Summary by A.J. Trans. by T.M.*) J00

0401-8358 DIAZ, R.O. and PINSTRUP-ANDERSEN, P **Uso de insumos y nivel tecnológico.** (*Use of inputs and technological level*). *In*___ eds. Descripción agroeconómica del proceso de producción de yuca en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 20p. Span., Illus.

Cassava. Production. Cultivation. Labour. Fertilizers. Insecticides. Herbicides. Cuttings. Statistical analysis. Colombia.

The degree of utilization of inputs in cassava production in Colombia was determined in 5 different zones The use of fertilizers was more common on medium-sized (2-10 ha) and large (>10 ha) farms. Insecticides were used by 73% of the farmers, especially to control leaf-cutter ants; but the use of fungicides was as low as 3-4% in 2 zones. None of the small farmers used herbicides, and only 3% of those surveyed used this input. Approx 18% of the farmers (medium-

and large-scale operations) received credit for cassava production; less than 10% received technical assistance. Use of labour was calculated to average 85.2 man-days/ha. More than half this input was for weeding, small farms using the most An av of 13.8 (ranging from 7-27) man-days/t was estimated. (*Summary by A.J. Trans. by T.M.*) J00

0402-9844 DOLL, J.D. **Weeds: an economic problem in cassava.** *In* Brekelbaum, T., Bellotti, A. and Lozano, J.C., eds. Cassava Protection Workshop, Cali, Colombia, 1977. Proceedings. Cali, Colombia. Centro Internacional de Agricultura Tropical. Series CE-14. 1978. pp.65-69. Engl., Sum. Engl., 13 Refs

Cassava. Weeding. Labour. Productivity. Socio-economic aspects.

Normally, the highest costs in cassava production are for labor, mostly for weeding operations. Although yield losses due to weeds are not so obvious as those caused by insects or diseases, they may reach 25% after 30 days and 50% after 60 days. In Colombia and in other countries with similar labor conditions, cassava growers can easily afford to weed their fields 4 or more times, the first 3-4 mo being the most critical for keeping cassava free of weed competition. Some control measures suggested are (1) integration of chemical and manual control, which eliminates early weed competition and gives higher yields, (2) increased plant populations and (3) mixed cropping, which may also reduce weeding inputs. The socioeconomic advantages and disadvantages of these measures are discussed. The need for people trained in weed science is stressed; research should de done on allelopathy, mixed cropping systems, and on weeds of economic importance in the tropics especially in Latin America (e.g., *Cyperus rotundus, Rottboellia exaltata* and *Bidens pilosa*). (*Summary by I.B.Z.*) J00 D02

0403-1394 L'EVALUATION DE production de differentes cultures vivriéres du Rwanda. (*Evaluation of production of different food crops in Rwanda*). Bulletin Agricole du Rwanda.9(3):171-177. 1976 Fr., Illus.

Cassava. Cultivation. Costs. Labour. Economics. Africa.

The amount of time (h) required for different cultural practices is calculated for french beans, sorghum, potatoes, peas, peanuts, sweet potatoes, cassava and soybeans. The costs of production/kg and /ha, av production/ha (1970-72), labor and total costs for each of these crops are estimated on the basis of 1974 prices. It is concluded that minimum purchasing prices should be established for the small farmer since he sells at very low prices Although the farmer's goal is to meet his family's needs and sell only the surplus, he could be helped to combine crops better in order to obtain a better income (*Summary by S.S. de S. Trans. by T B*) J00

0404-4538 FIGUEIREDO, A.P. DE **Instruções praticas sôbre o cultivo da mandioca.** (*Cassava cultivation*). Campo 8(91):22-25. 1937. Port.

Cassava. Cultivars. Production. Cassava flour. Tapiocas. Trade. Brazil.

The following aspects of cassava are discussed briefly: botanical description, habitat and government decrees regarding the use of cassava in composite flours, alcohol, etc. A list of recommended sweet and bitter Brazilian var. is given. Tables give data on cassava flour and tapioca exports from 1924-34. (*Summary by T.B.*) J00

0405-8352 FRANKLIN, D.L., PINSTRUP-ANDERSEN, P. and DIAZ, R.O. **Metodología y descripción de la muestra.** (*Methodology and description of the sample*) *In* Díaz, R O and Pinstrup-Andersen, P., eds. Descripción agroeconómica del proceso de produccion de yuca

en Colombia. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 13p. Span., Illus.

Cassava. Production. Statistical analysis. Cultivation. Colombia.

A description is given of the sampling methods, data collection, processing and analysis required to estimate the aggregate of cassava producers and production in Colombia. The sample included a total of 283 growers from 5 zones covering 7 states in the country. The trained survey team made 4 visits to each farm: 3 during the crop growing period (<4, 4-8, and 8-12 mo) and 1 after harvest. The data processing system used was SAS developed by North Carolina State University (1972). Averages and frequency of data were calculated; budgetary methods were applied for economic analysis. Yield losses due to different variables were estimated on the basis of quadratic production functions ($Y_i = A + B_i X_i + CX^2$) for the following climatic factors such as rainfall; soil fertility, texture and acidity; economic aspects such as costs of inputs; phytosanitary problems such as diseases, pests and weeds; and cropping system (mono- and intercropping). Average area planted to cassava was 5 ha. on an av of 2.2 plots/farm. Aprox 30% of the farmers did not rotate crops and 60% planted cassava on previously uncultivated land. (*Summary by A.J. Trans. by T.M.*) J00

0406-9715 FUNDACION PARA EL DESARROLLO DE LA REGION CENTRO OCCIDENTAL DE VENEZUELA. **Central procesador de yuca en el Valle de Aroa; estudio de factibilidad.** (*Feasibility study for a cassava processing complex in the Aroa Valley*). Barquisimeto, Venezuela, 1976. 190p. Span., 47 Refs., Illus.

Cassava. Cassava programs. Industrialization. Factories. Marketing. Industrial machinery. Cassava meal. Cassava flour. Pellets. Labour. Costs. Income. Economics. Legal aspects. Processing. Venezuela.

Because of the high prices of imported cereals and world food shortage, cassava — traditionally a subsistence crop — has become increasingly important in Latin America as a substitute for components in foods for human consumption and animal feedstuffs. The technical and economic feasibility of establishing an agro-industrial complex for producing pellets and flour for breadmaking (with emphasis on the latter) were studied in the Aroa Valley, state of Yaracuy (Venezuela). First, general aspects of the feed concentrate industry in Venezuela, biological, agronomic and physiological aspects of cassava, and its by-products are presented. National and international prices and the supply and demand for the 2 products are analyzed. Based on a comparison of 6 industrial processes (D'Andrea, PAVAN, Hubrich, ITAL, Hein-Dobgertin and Scholz), the D'Andrea integral system was selected for its versatility and simplicity and because combustion fumes given off during drying do not come in direct contact with the raw materials since irradiated heat energy is used for drying. Furthermore, there are no problems of dextrin formation and gelatinization of the starch product during drying since temp in the initial phase ranges from 55-60°C. The factory has a capacity of 16,500 t of fresh roots (5500 t of flour) in 275 work days Return on total capital is projected to be 24% and the internal rate of return at 29.8%, without taking into account socioeconomic benefits for the small farmers in the region. Data on prices of raw materials and feed concentrates, machinery requirements, and detailed financial and legal aspects are also included. (*Summary by M.O.de H.*) J00 I02

0407-7919 HAMMOND, A.L. **Alcohol: a Brazilian answer to the energy crisis.** Science 195(4278):564-566. 1977. Engl., Illus.

Cassava. Ethanol. Uses. Cassava programs. Brasil.

The use of ethyl alcohol as a fuel and its potential production from cassava are discussed. The Brazilian alcohol program aims to produce 4 billion liters of alcohol/yr (1.3 million ha sugar cane

or 1-2 million ha cassava) to substitute 20% of the gasoline consumption by the beginning of the 1980-90 decade. Cars can operate on a gasoline-alcohol mixture (4:1) without having to make any adjustments. A fleet of 300 cars driven on pure alcohol is to be tested in São Paulo in 1977. (*Summary by T.B.*) J00

0408-7369 INSTITUT DE RECHERCHES AGRONOMIQUES TROPICALES ET DES CULTURES VIVRIERES. **Rapport sur l'enquete "commercialisation-prix des marches" (annee 1972).** (*Report on marketing survey*). Tananarive, Madagascar, 1973. 22p. Fr., Illus.

Cassava. Marketing. Prices. Malagasy Republic.

The situation of 10 hamlets, spread over 10 zones (in Antsurabe, Ambositra and Fianarantsoa), is studied. The results obtained from Jan.-Dec. 1972 are intrerpreted. The localization of the hamlets, price of the main commercialized products, the selling unit (kilograms, sachs, kapoakas, pieces, etc.) and the kind of buyer are studied. Cassava is among the commercialized products. The evolution of cassava prices is irregular, prices depending on the market. Other factors that affect prices are regulations and price control, and the food needs of people and animals. (*Summary by I.B.Z.*) J00

0409-8402 JACKSON, E.A. **Brazil's national alcohol programme.** Process Biochemistry 11(5):29-30. 1976. Engl., 8 Refs.

Cassava. Cassava programs. Alcohol. Production. Brazil.

General aspects of Brazil's National Alcohol Program and future projections are discussed. Some 120 new distilleries are scheduled with an av capacity of 120,000 liters anhydrous alcohol/day. The autonomous distillery (producing its own raw material) will be most important in the future. The advantages and disadvantages of using sugar cane and cassava are discussed in detail. (*Summary by T.M.*) J00 I02

0410-1161 JONES, W.O. **Manioc in Africa.** Stanford, California, Stanford University Press, 1969. 315p. Engl., 488 Refs., Illus.

Cassava. History. Plant geography. Maps. Cultivation. Processing. Cassava meal. Cassava starch. Tapiocas. Foofoo. Gari. Chickwangue. Dumboi. Human nutrition. Trade. Marketing. Consumption. Prices. Socio-economic aspects. Production. Economics. Animal nutrition. Cultivation systems. Africa.

This book is a study of the economics of cassava production, consumption and trade in Africa. Chapter titles are as follows: (1) Manioc. The plant, culture, manioc in Indian America; (2) Africa: land, climate and people; (3) Introduction and spread of manioc; (4) Contemporary methods of cultivation. Clearing and preparing the seedbed, rotations, European innovations, manioc as a rotation crop, varieties; (5) Methods of preparation. Congo, Guinea, East Africa; protein, vitamins and minerals in manioc products. (6) Congo; (7) Guinea: production; (8) Guinea: consumption and trade; (9) East Africa; and (10) Manioc in a developing economy. (*Summary by T.B.*) J00 D00 H01 I02

0411-1166 KATYAL, S.L. and DUTTA, C.P. **Present status of tuber crops research in India.** Journal of Root Crops 2(2):53-55. 1976. Engl.

Cassava. Research. Cassava programs. India.

The most important tuber crops in India are cassava and sweet potatoes In 1974 some 353,000 ha were planted to cassava, mainly in the state of Kerala, producing 5,216,000 t of roots, At the Central Tuber Crops Research Institute, created in 1963 to intensify research on these crops, some 1200 native and 250 exotic collections are maintained. Yearly, 30,000 seedlings of hybrid and open-pollinated populations are screened. Three promising hybrids (H 97, 165 and 226) have been released to farmers. A preplanting treatment of cuttings with growth regulators was effective in reducing HCN content in the roots and increased root no. by 20%. Recommended planting dates, spacing, cutting length and planting position, NPK fertilizer rates and intercropping systems (with peanuts and cowpeas) are given for this state. Cassava mosaic and leaf spot (*Cercospora henningsii*) are 2 important diseases. (*Summary by T.B*) J00

0412-0214 KHON KAEN UNIVERSITY. FACULTY OF AGRICULTURE. THAILAND. **Cassava/nutrition project, annual report 1975/76.** Khon Kaen, Thailand, 1977. pp.1-35. Engl.

Cassava. Cassava programs. Animal nutrition. Poultry. Production. Trade. Thailand.

This progress report covers the 1st 16 mo of the Cassava/Nutrition Project in Thailand, the main objectives of which are to improve the quality of Thai export products and to expand domestic consumption. Background data are given on Thai production (1965-76) and exports (1968-76). Highlights discussed include the general preparations for the experiments with animals (installation of pelletizing plant, preliminary evaluation of nutritive value of Thai cassava products, survey of prices of some primary Thai commodities, biological evaluation of cassava products with broilers) and research activities involved in subproject 1 (determination of basic chemical parameters of cassava root products of different origin, processing technology and quality) and subproject 2 (substitution of cassava for cereals and their milling by-products in compound animal feeds for broilers, pullets, pigs and dairy cattle). (*Summary by T.B.*) J00 H03

0413-9225 KOONLIN, T. **Increasing the potential of cassava through improved processing techniques and nutritional enrichment.** *In* MacIntyre, R., ed. Interdisciplinary Symposium on Interaction of Agriculture with Food Science, Singapore, 1974. Proceedings Ottawa, Canada, International Development Research Centre, 1974. pp.121-129. Engl, Sum. Engl., Fr., 16 Refs

Cassava. Cassava programs. Processing. Production. Dietary value. Developmental research. Food energy.

The potentials of cassava as a basic food are described; its importance as a calorie producer, especially in poverty-stricken areas of the world, is stressed. Efficient local methods of processing should be made known more widely. Nutritional quality can be upgraded at moderate costs using modern enrichment techniques. (*Summary by I.B.Z*) J00 H01

0414-3130 LOURIDO, L.C. **Una metodología para estimar los beneficios y los costos esperados en un programa de investigación agrícola aplicada: el añublo bacterial en la yuca.** (*Methodology for making a cost/benefit analysis in an applied agricultural research program: bacterial blight in cassava*).Tesis Econ. Bogotá, Colombia, Universidad de los Andes, 1974. 99p. Span., Sum. Span., 11 Refs., Illus.

Cassava. Developmental research. Experiment design. *Xanthomonas manihotis*. Production. Costs. Productivity. Economics.

Preliminary results are given of an ex-ante analysis of the probable benefits of 2 possible alternatives for solving the problem of CBB in cassava: (1) eradication of the disease through the use of disease-free planting material and adequate cultural practices, and (2) the development by 1978 of immune or resistant var. by an intensive breeding program. First a detailed analysis is made of several ex-post and ex-ante methods used in other crops. The impact of CBB on production is then calculated, based on a CIAT survey of 5 major cassava-producing zones in Colombia. Estimated reduction in national production was 6.64% in 1973. Of the var. being used by farmers, only 3 were found to be tolerant (Llanera, Chirosa Negra, Chirosa Blanca); none, resistant or immune. Disease impact depended on time of attack. Three hypothetical curves based on different rates of adoption of these alternatives were used to estimate the probable costs/benefits. For the 1st alternative, there would be positive benefits (ranging from 3.81-6.37), depending on the rate of adoption. This evaluation would be valid only for those countries with a high % of infected planting material. As for the 2nd alternative, the range of probability would be 4.1-11.1% for obtaining immune var. and 4.5-12.3% for resistant var. (*Summary by T.B.*) J00 E02

0415-9801 LYNAM, J. **Cassava.** *In* Latin America: trend highlights on beans, cassava, beef, corn, rice, swine and fertilizers. Cali, Colombia, Centro Internacional de Agricultura Tropical. Internal Document Econ 1.3. 1978. pp.8-14. Engl., 1 Ref., Illus.

Cassava. Tubers. Cassava flour. Pellets. Prices. Trade. Production. Productivity. South America. Caribbean. Latin America.

The trends of world cassava production, yield, consumption, trade and prices are discussed for the period 1963-75. Data are given in table form. (*Summary by T.B.*) J00

0416-9707 McCANN, D.J. and SADDLER, H.D.W. **A cassava-based agro-industrial complex. I. Financial considerations. II. Technological considerations.** Process and Chemical Engineering 28(4).23-27. 1975, 28(5).37-40 1975. Engl., 23 Refs , Illus

Cassava. Cassava programs. Developmental research. Industrialization. Costs. Cassava starch. Proteins. Leaves. Industrial microbiology. Ethanol. Factories. Processing. Transportation. Economics. Australia.

Financial and technological considerations are discussed for establishing a cassava agro-industrial complex to produce annually 63,000 t leaf protein concentrate, 100,000 t single-cell protein for human and animal consumption, 439,000 t starch, 100,000 t alcohol and other products such as dextrins and glucose syrups. Agronomic aspects, markets, growing, harvesting and transportation costs for 35,000 ha of cassava, toxicity and energy requirements for processing are also dealt with briefly Viability of this complex depends largely on the size of operation undertaken and starch yields, which should be $>$25% (fresh wt basis). Additional research is needed with regard to cassava agronomy under Australian conditions and on all processes except that for starch. (*Summary by T.B*) J00 I02

0417-1170 NGODDY, P.O. and KAPLINSKY, R. **Operational instruments in agroindustrial planning: choice of technology in gari manufacturing in Nigeria.** ITCC Review 5(2):56-70. 1976. Engl., Illus.

Cassava. Gari. Processing. Socio-economic aspects. Small-scale processing. Industrialization. Costs. Cassava programs. Nigeria.

In order to improve the utilization of resources, an integrated technological/socioeconomic analysis was made of the technology to be used in gari manufacturing in Nigeria. Prior to 1950,

the process of gari making was basically manual; since that time, 2 technologies were developed. a fully mechanized operation (the Newell Dunford Mark III plant) and an intermediate one (FABRICO machine). In the latter, peeling and pressing operations utilize human power. Unfortunately, neither machine had been in full commercial production at the time of this economic analysis, in which the optimal operation is that which has the lowest unit-output costs. When the efficiency of the 2 systems was compared at all wage and interest combinations, it was found that the ND technology was favored only at full-capacity utilization. The socioeconomic implications of these 2 technologies are also studied. It is concluded that notwithstanding the economic efficiency of the fully mechanized ND technique, it is a higher unit-cost producer (20%) in comparison to the intermediate FABRICO technique; thus the optimal choice should be the intermediate method. (*Summary by T.B.*) J00 I02

0418-8188 NORMANHA, E.S. A mandioca no Brasil e no mundo. (*Cassava in Brazil and in the world*). *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.2-14 Port

Cassava. Cultivation. Production. Trade. Cassava products. Marketing. Brazil.

Historical notes are given on the origin and geographical distribution of cassava in Brazil; as well as on research work done, dissemination of the crop, pests and diseases, and industrial uses (ethyl alcohol, starch) Tables give data on exports (1971-74) and production in Brazil by region (1970). Data are also given on cassava cultivation, factors limiting to production and uses in some other countries . Brief mention is made of several international institutions that work on cassava. (*Summary by I B.Z.*) J00

0419-8361 PINSTRUP-ANDERSEN, P. and DIAZ, R.O. Análisis económico de la producción de yuca. (*Economic analysis of cassava production*). *In*___. eds. Descripción agroeconómica de la producción de yuca en Colombia Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 23p. Span , Illus

Cassava. Production. Economics. Costs. Income. Productivity. Statistical analysis. Colombia.

An economic analysis is made of cassava production in Colombia, based on yields obtained by farmers surveyed in 5 different regions. Yields tended to be greater as farm size increased, averaging 8 and 14 ton/ha in the best zone for small and large farmers, respectively Av yield was estimated at 6.2 t/ha, which is lower than the official national av of 8 t. There were marked variations in prices received by the farmers from one zone to another, but farm size did not affect price. Costs varied, tending to be higher for large farms, but total costs per ton were lower. Data on land and production costs, as well as net income per zone, are given. The rate of return on capital investment tended to increase as farm size increased. (*Summary by T.M.*) J00

0420-1379 THE PRECIOUS root; Thailand's tapioca industry. Investor 1971 993-995. 1971. Engl., Illus.

Cassava. Trade. Cassava starch. Pellets. Processing. Thailand.

An analysis is made of the cassava industry in Thailand. Problems include lower yields due to exhaustion of the soil (fertilizers have never been used), poor organization within the industry (small farmer cooperatives are recommended), competition from Indonesia and Malaysia, and declining world demand for human and industrial consumption. On the positive side, the demand for pellets as a livestock feed in the EEC is very promising. (*Summary by T.B*) J00

0421-5022 RANGEL, J. DE C. **O preparo da raspa da mandioca para exportação e industrialização.** (*Preparation of cassava chips for exportation and industrial purposes*). Revista da Sociedade Rural Brasileira 17(207).24-29. 1937. Port.

Cassava. Cassava chips. Processing. Trade. Brazil.

Aspects of drying cassava roots and the costs involved are discussed briefly, with emphasis on drying the roots as soon as they are harvested. The advantages of doing this under a cooperative system are expounded. (*Summary by T.B.*) J00 I02

0422-8767 RAVOOF, A.A. *et al.* **Cassava: a source of food, feed and fuel.** *In* Symposium on Feedingstuffs for Livestock, Kuala Lumpur, Malaysia, 1977. Kuala Lumpur, Malaysia, Malaysian Agricultural Research and Development Institute, 1977. Preprint no. 8 6p. Engl., Sum. Engl , Mal , 4 Refs.

Cassava. Cassava programs. Cultivation. Uses. Malaysia.

Cassava, which can yield 50 t/ha or more on mineral or peat soils in Malaysia, appears to be tolerant to high acidity in peat soils and could probably be grown in rotation with pineapple. Although cassava meal is rich in energy, it is poor in protein, minerals and vitamins Its competitiveness as an animal feed in Malaysia depends on the cost of additives required to balance the diet. On the other hand, cassava leaf meal is rich in protein, minerals, vitamins and pigments and is comparable to or can be substituted for alfalfa leaf meal. Possibilities for growing cassava on the large acreages of undeveloped peat soils in Malaysia to provide raw materials for producing ethanol (from roots) and animal feed (leaf meal) are discussed. (*Author's summary*) J00

0423-1389 ROMERO T., R. **Summary of study of post-harvest losses of cassava in the Dominican Republic.** Santiago de los Caballeros, República Dominicana, Instituto Superior de Agricultura. Centro de Investigaciones Económicas y Alimenticias, 1977. 20p. Span., Illus.

Cassava. Production. Marketing. Economics. Dominican Republic.

A study was made of losses of cassava roots between the time they are harvested to the time they are consumed. Observations were made at the producer level, during transport to the market and at the wholesale, retail and consumer levels. Losses totaled 17.37% (8.8% at the producer level). Macro- and microeconomic evaluations are made. Possible ways to reduce these postharvest losses are given. (*Summary by T.B.*) J00

0424-3047 SAINT JUNIOR, W.S. **The social organization of crop production: cassava, tobacco and citrus in Bahia, Brazil.** Ph.D. Thesis. Ithaca, N.Y. Cornell University. Latin American Studies Program. Dissertation Series no. 76. 1977. 373p. Engl., Sum. Engl., 224 Refs., Illus.

Cassava. Production. Socio-economic aspects. Cultivation. Marketing. Labour. Costs. Economics. Brazil.

An understanding of organizational and institutional arrangements inherent in crop production systems is necessary to develop agrotechnologies that will not increase inequality. A methodology for the study of small-farm agriculture was elaborated based on a combination of ecological and Marxian perspectives, the study of traditional agriculture, the determination of limiting factors

and the creation of problem-specific typologies. A farmer's choice of crops is viewed as a major technological decision with social organizational and institutional ramifications: producer-crop, producer-producer, producer-community and producer-state relations. Thus crop production systems were defined on the basis of the farm's predominant crop in terms of arable land occupied. The study was conducted in the Reconcavo area of NE Brazil (Bahia). Based on a stratified random sample of 182 farmers, 3 major crop production systems were identified. cassava, a subsistence crop; tobacco, an export crop; and citrus, a cash crop for domestic urban consumption. The 3 hypotheses of the study were confirmed: (1) different crop production systems are characterized by different modes of agricultural production, (2) differences in quality of life exist among these systems, and (3) some systems display higher rates of emigration. The process of structural change in local agriculture was analyzed to determine its causes and possible future trends. Major causes identified were government social welfare policy, introduction of a new forage grass, government agricultural policy, decreased isolation and major changes in fertilizer supply. Some factors created a disequilibrium in the social relations and ecological balance of the traditional production system whereas others provided strong incentives for change once weaknesses appeared. Present expansion of modern commercial agriculture has brought about shift in political power from rural landowners to urban commercial groups. Concurrently, local patron/client relations are being replaced by state patronism. Future trends are also discussed. (*Summary by T.B.*) J00

0425-1182 SÃO PAULO. SECRETARIA DA AGRICULTURA. INSTITUTO DE ECONOMIA AGRICOLA. Mandioca. (*Cassava*). *In* _____. Prognóstico 77/78. São Paulo, Brasil, 1977. pp.117-127. Port., Illus.

Cassava. Production. Productivity. Cassava flour. Cassava meal. Cassava starch. Trade. Prices. Europe. Brazil.

Although Brazil is the world's largest producer of cassava, its situation on the world market is poor in comparison to Thailand, the 5th largest producer. Data are given on area under cultivation, production and yield in the state of São Paulo from 1972-77; prices (real and adjusted) received by the farmer from 1950-77; and av prices of cassava by-products on the S.P. market from 1976-77. Perspectives for 1977-78 are optimistc with regard to the use of cassava for making alcohol. (*Summary by T.B.*) J00

0426-0984 SUBRAHMANYAN, V. A note on the production of soji, sago and flour from tapioca in Mysore. Mysore Agricultural Journal 27(3).74-77. 1951. Engl.

Cassava. Cassava flour. Production. Tapiocas. India.

The semi-industrial production of soji flour and tapioca from cassava by the Central Food Technological Research Institute is proposed to provide low-cost carbohydrates and certain essential minerals lacking in the rice diets of the people of Mysore (India). Some popular recipes using cassava and sweet potatoes are given. (*Summary by I.B.Z.*) J00

0427-9230 SUPERINTENDENCIA DO DESENVOLVIMENTO DO NORDESTE (Brasil). Estrutura dos custos agrícolas, industriais e comerciais. Produto: farinha de mandioca. (*Agro-industrial cost structure for cassava flour*). *In*_____.Pesquisa e comercialização de produtos agrícolas. Recife, Brasil, 1967. pp.43-48. Port.

Cassava. Cassava flour. Costs. Cultivation. Processing. Prices. Brazil.

Per-hectare costs are given in table form for growing and transporting cassava in Brazil in 1967. The cost of processing 15,000 kg of roots is given for mechanized, motorized and manual operations. (*Summary by T.B.*) J00

0428-9229 SUPERINTENDENCIA DO DESENVOLVIMENTO DO NORDESTE (BRASIL). **Importância econômica dos principais produtos no estado de Sergipe. Farinha de mandioca.** (*Economic importance of the principal products in the state of Sergipe. Cassava flour*). *In*____. Pesquisas e comercialização de produtos agrícolas Recife, Brasil, 1967. pp 21-29. Port.

Cassava. Cultivation. Cassava flour. Production. Productivity. Brazil.

Although cassava is the principal crop in the state of Sergipe (Brazil), cultural practices are rudimentary. All production is destined for making flour. Cultivation is unstable due to great fluctuations in price. Data on area, production and av yield are given for the different municipalities from 1956-65. The major center of production in 1965 was Itabaina. 42.4% of the area planted and 55.2% of the production. The main consumer is the capital city, Aracaju. The var. Catarina and Escurrida are outstanding. There is a great need for introducing better cultural practices, especially fertilization, intercropping and optimal planting density, through technical assistance for the small farmer. (*Summary by I.B.Z. Trans. by T.M.*) J00

0429-9570 VALLE, D.C. DO **Melhoramento da mandioca (*Manihot esculenta* Crantz).** (*Cassava improvement*). *In* Curso Intensivo Nacional de Mandioca, 1o., Cruz das Almas, Brasil, 1976. Cruz das Almas, Bahia, Brasil, Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Mandioca e Fruticultura, 1976. pp.165-175. Port., 9 Refs.

Cassava. *Manihot esculenta.* **Cassava programs. Plant breeding. Germplasm.**

Theoretical aspects of improving cassava including components of productivity are briefly discussed for short- and long-term programs. Formulas for calculating ideal root production are given. A long-term breeding program should emphasize the obtention of cv. with greater efficiency of utilization of solar energy. There are 3 physiological limitations: inefficient light interception, distribution of assimilates in the leaves and roots, and inefficient conversion of light energy into carbohydrates. This program should have 4 stages: (1) organization of a germplasm bank of *Manihot* spp. and *M. esculenta* var., (2) preliminary screening of cv. based on morphological, morphogenetic and agronomic characteristics, (3) development of technology for investigating factors affecting the aforementioned physiological limitations, and (4) controlled interspecific hybridization. (*Summary by T.M.*) J00 G01

0430-1822 VILLALOBOS A., L.A. and MORERA A., F. **La industria harinera en Costa Rica y sus grandes posibilidades.** (*The flour industry in Costa Rica and its potential*). Revista de Agricultura (Costa Rica) 35(10):312-318. 1963. Span.

Cassava. Cassava flour. Production. Marketing. Composite flours. Costa Rica.

Cassava must be consumed or processed as soon as it is harvested since it can be stored only for 2-3 days. Transportation is difficult because of the volume and consistency of the product, therefore, cassava flour factories should be located as near as possible to the production zones. All these factors influence product cost. Mixing wheat and cassava flour is feasible provided that the quantity of cassava does not exceed 10%; however this bread is hard and not well liked by consumers. Good flour should contain from 12.5-14% protein, and cassava flour contains less than 10%. In addition, it is not possible to produce cassava starch at less cost than imported wheat flour. (*Summary by T.M.*) J00

0431- 3044 WALTERS, P. **Manioc poised for major UK compound role?** AgriTrade 1978:20-23, 62. June 1978. Engl , Illus.

Cassava. Cassava products. Pellets. Trade. Prices. Europe.

The future of cassava as a cereal substitute in the UK is discussed. Because of current policies and rises in cereal prices, it is now feasible to use cassava. Important limiting factors are the extra shipping costs through Rotterdam because of lack of proper facilities, the price of soybean meal required to supplement cassava-based diets and the poor quality of pellets. (*Summary by T.B.*) J00

0432-9226 WILSON, L.A. **Improvement and development of tropical root crops.** *In* MacIntyre, R., ed. Interdisciplinary Symposium on Interaction of Agriculture with Food Science, Singapore, 1974. Proceedings. Ottawa, Canada, International Development Research Centre, 1974. pp 65-92. Engl., Sum. Engl., Fr., 75 Refs , Illus

Cassava. Cultivation. Production. Productivity. Cassava programs. Development. Plant physiology. Cultivars. Selection. Plant development. Uses.

An extensive review of tropical root crop improvement research is presented Crops include sweet potatoes, cassava, yams and the edible aroids taro and cocoyams. Emphasis is placed on important alternatives in the utilization of these crops, which must be considered when studying methods of improving yield potential. Botanical aspects and current world production are reviewed, as well as the strategies and technologies for increasing the yield potential of these crops. (*Author's summary*) J00

See also 0078 0079 0242 0294 0296 0321 0322 0356 0365 0366 0371

K01 Rotational Schemes and Intercropping

0433-9549 NITIS, I.M *Stylosanthes* as companion crop to cassava (*Manihot esculenta*). Denpasar, Bali. Udayana University. Faculty of Veterinary Science and Animal Husbandry. IFS Research Grant Agreement no. 76 1977. 88p. Engl., Sum. Engl , 31 Refs., Illus.

Cassava. *Stylosanthes* Inter-cropping. Field experiments. Fertilizers. N. P. K. Growth. HCN content. Protein content. Starch content. Dry matter. Tuber productivity. Nutrient uptake. Sheep. Digestibility. Indonesia.

Three completely randomized block experiments were carried out on a silt loam, yellowish brown Latosol, pH 6-6.5, at Petang, Bali (Indonesia) to study the cassava/*Stylosanthes* association in an attempt to increase livestock feed quality and quantity without greatly affecting cassava yield. Cassava cuttings (25 cm) were planted vertically, 10 cm deep, at 80 x 80 cm, the spacing most used by local farmers. The *Stylosanthes* seed was inoculated with a cowpea-type *Rhizobium* strain and sown at a rate of 4 kg/ha, 3 wk after the cassava. Seeds were drilled into 5 holes forming a cluster at the diagonal crossings of the 4 cassava plants. Once established the *Stylosanthes* was thinned to 5 plants/cluster and the cassava to 1 shoot/cutting. Experiment 1 studied the effect of cutting height (5, 10 and 15 cm) and intervals (4, 8 and 12 wk) of *Stylosanthes guyanensis* cv. *schofield* on cassava var. Valenca, which was also grown in monoculture, with and without N fertilizer. In experiment 2, the response to fertilizer was evaluated: 0, PK and NPKT (trace elements) for cassava + *Stylosanthes* and *Stylosanthes* alone; and 0, N, NPK and NPKT for cassava alone. In experiment 3, *Stylosanthes* was evaluated as a source of N for cassava. Cassava in monoculture was given 7 levels of urea (0-160 kg/ha) and compared to cassava + *Stylosanthes*. Each experiment was replicated 10 times. In vitro DM digestibility and organic matter digestibility were determined according to Minson & McLeod's method (1972), using fat-tail sheep as the source of inoculum. As a companion crop, *Stylosanthes* was beneficial because of the increased N supply for cassava, equivalent to about 20 kg urea/ha. With PKT fertilizer, the N supplied by *Stylosanthes* reached the equivalent of 160 kg urea. In association, cassava root and shoot yields increased 0.39 and 0.43 t DM/ha, respectively. The extra green feed produced by *Stylosanthes* ranged from 0.14-0.39 t DM/ha. Measured in terms of protein, starch, HCN and in vitro digestibility (organic matter and DM), the nutritive values of cassava and *Stylosanthes* were not significantly affected ($P > 0.05$) by the association By adjusting cutting intervals and cutting height, both the quantity and quality of food and feed produced increased. (*Summary by T.B.*)
K01 H03

0434-7194 OKA, H. Upland farming and cassava cultivation in Lampong, southern Sumatra. Nogyo Gijutsu 29(12):546-549. 1974. Jap., Illus.

Cassava. Inter-cropping. Cultivation. Indonesia.

The main crops in the Lampong district are upland rice (47%), maize (32%), cassava (12%) soybeans (5.6%) and sweet potatoes (1.7%). Farm holdings are small (av 1.5 ha), and most farmers do not use fertilizers, chemicals or machines. Cassava is used in mixed cropping systems with maize and upland rice. It is harvested at 10 mo and used for starch, gaplek, pellets and food. Yields are 10-20 t/ha on infertile soils and 20-30 t/ha on fertile soils. (*Summary by Y.U.*) K01

0435-9149 THAMBURAJ, S. and MUTHUKRISHMAN, C.R. **Studies on intercropping in tapioca (*Manihot esculenta* Crantz).** Madras Agricultural Journal 63(3):198-199. 1976. Engl.

Cassava. Cultivation systems. Inter-cropping. Tuber productivity. Costs. India.

In Tamil Nadu (Coimbatore, India), cassava var. Malavella was grown on ridges and intercropped with the following catch crops: Bellary onion, cowpeas, peanuts, mung beans and *Dolichos lablab*. Bellary onion was the most suitable, affecting cassava yields only slightly (1.1% reduction). A cost/benefit analysis is given in table form. (*Summary by T.M.*) K01

0436-9039 WILSON, G.F. and ADENIRAN, M.O. **Intercropping of cassava with vegetables.** *In* Symposium on Intercropping in Semi-Arid Areas, Morogoro, Tanzania, University of Dar es Salaam, 1976. Intercropping in semi-arid areas; Report. Ottawa, Canada, International Development Research Centre, 1976. p.24. Engl.

Cassava. Inter-cropping. Nigeria.

Where cassava is a staple, diets are low in essential vitamins, minerals and proteins so intercropping with vegetables is recommended. Results are given of an experiment in which cassava was intercropped with a sequence of 3 vegetables (tomatoes, okra, french beans). Okra and bean yields were suppressed, perhaps because of the lack of tillage. Land equivalent ratios showed that this system was more efficient than any of the crops alone. (*Summary by T.M.*) K01

See also 0020 0042 0085 0114 0388 0391

Z00 GENERAL

0437-3812 **BRUNO, A. Le utilizzazioni della manioca.** (*Utilization of cassava*). Rivista di Fisica, Matematica e Scienze Naturali 1932:73-84. 1932. It.

Cassava. Cassava products. Uses. Animal nutrition. Human nutrition. Trade.

The utilization of cassava in local, small-scale operations, as well as large-scale industry, is described. Locally, the leaves and tender shoots are used for both human and animal feeding. The importance of chips is pointed out; they can be dried for making meal and flour or cooked and used for making cakes, breads and polenta. The juice from the roots is used for preparing sauces and alcoholic beverages; grated cassava has therapeutic uses. The advantages of using cassava meal in animal feeding are given. Industrial applications include starch, tapioca, alcohol and other by-products, as well as dried chips for exporting. (*Summary by I.B.Z. Trans. by T.M.*) Z00

0438-4438 **LA CULTURE du manioc en Annam.** (*Cassava cultivation in Annam*). Bulletin Economique de l'Indochine no. 10:403-405. 1899. Fr.

Cassava. Cultivation. Indochina.

General information is given on cassava cultivation in Annam (Vietnam) where the crop is grown on sandy, well-aired soils Cuttings are planted at an angle, in pairs, to facilitate harvesting, which is done before the rainy season to prevent root rot. Yields range from 40-50,000 kg/ha The roots are made into meal or chips to be used for food; the leaves are eaten as a vegetable Cassava is also used for medicinal purposes. (e.g. poultices) The crop is attacked by red ants and certain wild animals. (*Summary by I.B.Z. Trans. by T M*) Z00

0439-4491 **PERRET. Culture et préparation du manioc.** (*Growing and preparing cassava*). Revue des Cultures Coloniales 3:6-13. 1898. Fr., Illus.

Cassava. Cultivation. Processing.

The differences between sweet and bitter cassava are discussed. Ideal conditions for growing cassava are discussed. Cuttings of 20 cm are planted at 1 m. Yields may be as high as 125,000 or as low as 12,500 kg/ha/yr. Leaves and young stems are used for feeding animals. From 12-50% cassava flour can be used in breadmaking. The processing of bitter cassava to make industrial starch, cassareep and tapioca is discussed. The equipment used for making pearl tapioca is shown. (*Summary by T.M.*) Z00

0440- 8728 RAMAKRISHNAN, C.K., REMA DEVI, L. and RAMANATHA MENON, M. **Different tuber/rhizome as substitute for potato in the fungal culture medium.** Agricultural Research Journal of Kerala 13(2):199-201. 1975. Engl , Sum. Hindi., 1 Ref.

Cassava. Uses. Culture media.

Several locally available, inexpensive roots, tubers and rhizomes were studied as substitutes for potato in the preparation of the cultural medium for the following fungi: *Helminthosporium halodes, Trichoconis padwickii* and *Corticium sasakii*. Media were prepared as in the case of PDA (e.g., 200 g peeled cassava, 20 g dextrose, 20 g agar and 1000 ml distilled water). The cassava medium was the best and can be readily substituted for PDA. (*Summary by T.M.*) Z00

0441- 2876 SCHWERIN, K.H. **The bitter and the sweet. Some implications of techniques for preparing manioc.** Albuquerque, University of New Mexico, 1971. 52p. Engl., Sum Engl , 54 Refs., Illus

Paper presented at Annual Meeting of the American Anthropological Association, 70th., New York, 1971.

Cassava. Sweet cassava. Bitter cassava. History. Processing. Cassava products. Maps. South America.

A survey was made of the South American cultures using cassava in order to determine the variety and distribution of techniques for processing the roots. These data are then used to determine whether or nor and to what extent processing techniques are related to classification of varieties (particularly the distinction between bitter and sweet), as made by both native cultivators and European explorers and ethnographers. (*Author's summary*) Z00

0442- 9271 SETZER, J. **A facilidade dos criadores produzirem cana e mandioca.** (*Facilities for cattle raisers to grow sugar cane and cassava*). Revista dos Criadores 46(552):21-24. 1976. Port., 1 Ref.

Cassava. Cultivation. Uses. Brazil.

Cattle raisers are recommended to grow sugar cane and cassava for alcohol production in combination with a more intensive cattle feeding system based on grasses, especially elephant grass (*Pennisetum purpureum*). The cultivation of sugar cane is very similar to that of the grasses. Cassava has the advantage that it can be grown on poor and hilly soils. In addition, cattle manure can be used to fertilize these crops. Economic aspects are also discussed. (*Summary by T.B.*) Z00

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ABBREVIATIONS USED

A	Angstrom(s)
ABA	Abscisic acid
ac	Acre(s)
a.i.	Active ingredient
alt	Altitude
AMD	African mosaic disease
AMV	African mosaic virus, Alfalfa mosaic virus
approx	Approximate(ly)
atm	Atmosphere
ATP	Adenosine 5'-triphosphate
av	Average
BBMV	Broad bean mosaic virus
BCMV	Bean common mosaic virus
BGMV	Bean golden mosaic virus
BGYMV	Bean golden yellow mosaic virus
BOD	Biochemical oxygen demand
BPMV	Bean pod mottle virus
BRMV	Bean rugose mosaic virus
BSMV	Bean southern mosaic virus
BV	Biological value
BYMV	Bean yellow mosaic virus
°C	Degrees Celsius (centigrade)
ca.	About (circa)
CBB	Cassava bacterial blight
CLV	Cassava latent virus
CM	Cassava meal
cm	Centimeter(s)
cv.	Cultivar(s)
DM	Dry matter
DNA	Deoxyribonucleic acid
EC	Emulsifiable concentrate
EDTA	Ethylenediaminetetraacetic acid
e.g.	For example
°F	Degrees Fahrenheit
ft-ca	Foot candles (10.76 lux)
FYM	Farmyard manure
GA	Gibberellic acid
gal	Gallon(s)
GE	Gross energy
GLC	Gas-liquid chromatography
gm	Gram(s)
h	Hour(s)
ha	Hectare(s)
HCN	Hydrocyanic acid
HDP	Hydroxypropyl distarch phosphate (modified cassava starch)
HI	Harvest index
IAA	Indoleacetic acid
i.e.	That is
IU	International unit
kcal	Kilogram-calorie(s)
kg	Kilogram(s)
km	Kilometer(s)
KNap	Potassium naphthenate
kR	Kiloroentgen(s)
LAI	Leaf area index
lb	pound(s)
LD_{50}	Mean lethal dose
lx	Lux
M	Molar
m	Meter(s)
max	Maximum
ME	Metabolizable energy
mg	Milligram(s)
min	Minimum
ml	Milliliter(s)
mm	Millimeter(s)
mol wt	Molecular weight
NAD	Nicotinamide adenine dinucleotide
NADH	Nicotinamide adenine dinucleotide, reduced form
NAR	Net assimilation rate
nm	Nanometer(s) (10^{-9}m)
no.	Number(s)
NPR	Net protein ratio
NPU	Net protein utilization
oz	Ounce(s)
P	Probability
PER	Protein efficiency ratio
pH	Hydrogen ion concentration

pphm	Parts per hundred million
ppm	Parts per million
R_f	Retardation factor - chromatography
RH	Relative humidity
RNA	Ribonucleic acid
s	Second
$S_{20,w}$	Sedimentation coefficient corrected to water at 20°C
SBM	Soybean meal
SCP	Single cell protein
sp.	Specie
spp.	Species
t	Ton(s)
TDN	Total digestible nutrients
temp	Temperature
TLC	Thin-layer chromatography
TMV	Tobacco mosaic virus
UMS	Unmodified cassava starch
UV	Ultraviolet
var.	Variety(ies)
vol	Volume
VPD	Vapor pressure deficit
WP	Wettable powder
wt	Weight
yr	Year(s)
α	*alpha*
β	*beta*
γ	*gamma*
δ	*delta*
ϵ	*epsilon*
2,4-D	2,4-dichlorophenoxyacetic acid
/	Per
μ	Micro
%	Percent(age)
$>$	More than, greater than
$<$	Less than
$\leqslant$	Equal to or less than
$\geqslant$	Equal to or greater than
$\pm$	Plus or minus

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