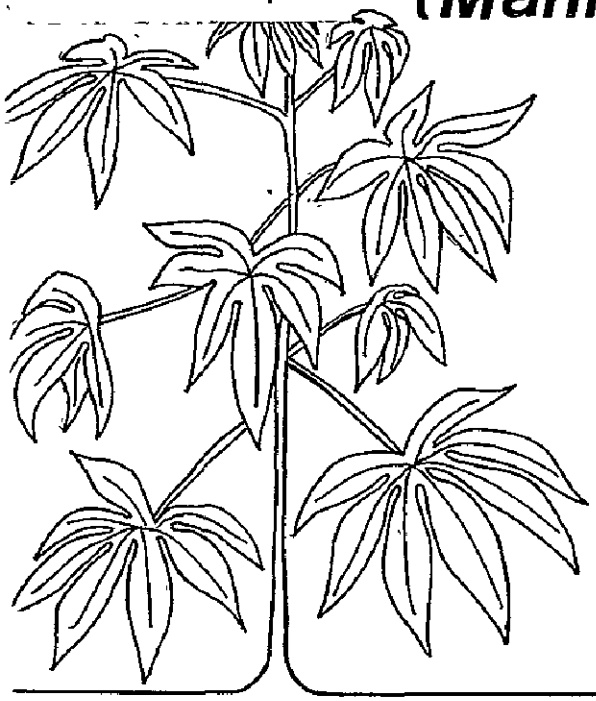
acts on CASSAVA

[*Manihot esculenta* Crantz]



Volume V

Series 08EC-5
December, 1979

Cassava Information Center

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

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Series 08EC-5
December, 1979

ABSTRACTS ON CASSAVA

(*Manihot esculenta*, Crantz)

VOLUME V

CASSAVA INFORMATION CENTER
CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL

FOREWORD

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CIATs 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 CIATs core budget. Special mention should be made, however, of the scientific and technical collaboration of CIAT scientists who work in close collaboration with our documentalists and information processors.

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Fernando Monge, PhD
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A00 BOTANY, TAXONOMY AND GEOGRAPHICAL DISTRIBUTION

0001-10464 ALLEM, A.C. **Notas taxonômicas sobre as tribos Phyllantheae, Dalechampieae e Manihoteae (Euphorbiaceae) no Rio Grande do Sul, Brasil.** (*Taxonomic notes on the tribes Phyllantheae, Dalechampieae and Manihoteae found in Rio Grande do Sul, Brazil*). Iheringia (Série Botânica) 22:3-15. 1977. Port., Sum. Port , Engl., 24 Refs.

Cassava. *Manihot*. Taxonomy. Brazil.

A short description is given of the genera *Phyllanthus, Dalechampia* and *Manihot*. Taxonomic keys and notes are given for *M. hunzikeriana* Martinez-Crovetto, *M. esculenta* Crantz and *M. flabellifolia* Pohl. (*Summary by T.B*) A00

0002-10484 ALLEM, A.C. **Notas taxonômicas e novos sinônimos em espécies de *Manihot*. II (Euphorbiaceae).** (*Taxonomic notes and new synonyms in Manihot species. II. Euphorbiaceae*). Revista Brasileira de Biologia 38(3):721-726. 1978 Port., Sum. Port., Engl., 4 Refs., Illus.

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

Taxonomic notes and reduction to synonymy are recorded for *Manihot tristis* Mull.Arg., a native species of Brazil, Surinam and Venezuela, found growing in rocky outcrops. (*Author's summary*) A00

0003-9985 JENNINGS, P.R. and COCK, J.H. **Centres of origin of crops and their productivity.** Economic Botany 31(1):51-54. 1977. Engl , 3 Refs.

Cassava. Productivity. Plant geography.

All our major crops have their centers of origin (CO) in less-developed areas; they generally tend to yield better outside the CO. Lower productivity in the CO is due to greater biological constraints and primitive agricultural systems, where competitive, vigorous varieties and mixed cropping are required for stable productivity. World research on these crops should be done in the CO, where most of the problems are found; then when technology is transferred, it will have a greater impact. Rice and wheat are cited as examples. Genetic diversity must be maintained to avoid serious insect and disease damage. Since cassava has its CO in America, it should find greater success in Asia and Africa. (*Summary by T.B.*) A00

0004-11730 ALLEN, A.C. **Notas taxonômicas e novos sinônimos em espécies de *Manihot*. I. (Euphorbiaceae).** (*Taxonomic notes and new synonyms in species of Manihot. I. Euphorbiaceae*). Revista Brasileira de Biologia 37(4):825-835. 1977. Port., Sum. Port., Engl., 12 Refs., Illus.

Cassava. *Manihot*. Taxonomy. Brazil. Argentina. Paraguay. Bolivia.

Taxonomic notes and reductions to synonymy are made for species of *Manihot* [*M. hassleriana* Chodat, *M. katharinae* Pax, *M. anisophylla* (Gris.) Mull. Arg.], occurring in S. Brazil, Argentina, Paraguay and Bolivia. (*Summary by T.B.*) A00

0005-4992 CIFERI, R. **Fondamenti per una classificazione subspecifica della *Manihot esculenta* Crantz.** (*Bases for a subspecific classification of Manihot esculenta Crantz*). Archivio Botanico 18(1):27-35. 1942. Ital.

Cassava. *Manihot esculenta*. Taxonomy.

Based on abundant material collected from tropical America, especially the Dominican Republic, a subspecific classification is proposed for *Manihot esculenta:* subsp. *flabellifolia* and subsp. *grandifolia*. The principal characteristics considered are grouped according to (a) shape of the leaf segment, (b) appearance and number of stem nodes, (c) shape of the thickened roots. (*Summary by I.B Trans. by T.B.*) A00

0006-11287 ROGERS, D.J. **Notes for CIAT cassava program review conference.** Boulder, University of Colorado, 1972. 5p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. *Manihot*. Research. Taxonomy.

A brief discussion is given of research efforts on basic botanical research on the genus *Manihot*, variations occurring within the cultivated *M. esculenta* complex, the development of computer programs for these studies and integrated research systems. The need for different training programs in this area is emphasized. (*Summary by T.B*) A00

0007-11284 UNIVERSITY OF COLORADO. ***Manihot* research at the taximetrics laboratory.** Boulder, University of Colorado, 1972. 6p. Engl., 20 Refs.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Germplasm. Cassava programs. Genetics. Taxonomy. USA.

Major areas of current research on *Manihot* at the Taximetrics Lab are as follows: computer-aided classification of the cv. of *M. esculenta* for developing a universal catalog and delimitation of the closed gene pools of *Manihot*, computer information bank of *Manihot* germplasm resources; systems analytic studies of cassava-based nourishment-generating system capable of functioning in ecologically and economically impoverished areas. Some of their publications on this subject are listed. (*Summary by F.G. Trans. by T.B.*) A00 G01

B00 PLANT ANATOMY AND MORPHOLOGY

0008-9573 YBERT, J.P. **Observation du pollen de *Manihot* sp. (Euphorbiaceae) au microscope électronique a balayage.** (*Observation of the pollen of Manihot sp. with the scanning electron microscope*). Bulletin de la Société Botanique de France 122:131-133. 1975. Fr., 6 Refs., Illus.

Cassava. *Manihot*. Pollen. Laboratory experiments.

The different components of cassava pollen (exine, endexine, columella, tectum) are described and illustrated with photos from a scanning electron microscope. The pollen is spherical and periporous, with large operculate pores ($\phi = 120 \mu m$). These observations coincide with those made by other authors using a conventional transmission electron microscope. (*Summary by S.S. de S. Trans. by T.B.*) B00

0009-4483 BOLDINGH, I. **Vijf tabellen voor het determineeren van 25 voor den landbouw belangrijke cassave - variëteiten.** (*Five keys for identifying 25 important cassava varieties*). Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw, Onderafdeeling Zaadteelt van Eénjarige Gewassen no. 52. 1926. 28p Dutch.

Cassava. Cultivars. Identification. Leaves. Stems. Petioles. Tubers. Java.

The following characters were studied as a basis for identifying 25 cassava cv.: pubescence or absence of on leaf petioles; color of the stipules, young leaves, petioles, young stems, epidermis and cambium, and root cortex and phellogen; and the ratio of the central leaf lobe length/width. On the basis of these data, five identification keys were compiled. (*Summary by J.V.*) B00 G01

See also 0088 0290 0294

C00 PLANT PHYSIOLOGY

0010-10062 IKE, I.F. and THURTELL, G.W. **The relationship between steady-state transpiration rates and leaf water potential in cassava (*Manihot esculenta* cv. Llanera).** Canadian Journal of Botany 56:1537-1539. 1978. Engl., Sum. Engl., 13 Refs., Illus.

Cassava. Leaves. Transpiration. Osmotic potential. Resistance. Cultivars. Growth-chamber experiments.

The relationship between leaf water potential (Ψ_L) and transpiration rate (T) was investigated using indoor-grown cassava plants (Llanera). Leaf water potentials were measured with in situ dew-point hygrometer and transpiration rates by gas exchange analysis technique. Regression analyses of the data showed that T was consistently linearly related to Ψ_L ($r^2 = 0.94$). This implies that plant resistance to flow was constant and hence that an Ohm's Law analog is valid for the transpiration range studied. Extrapolated values of leaf water potential at zero transpiration were close to the osmotic potential of the nutrient solution. Calculated resistance values (slope of regression line for individual plants) varied between 2.90 and 3.05 bars $dm^2\ h\ g^{-1}$ (1 bar = 100 kPa). (*Author's summary*) C00

0011-10047 LIU, M.C. and CHEN, W.H. **Organogenesis and chromosome number in callus derived from cassava anthers.** Canadian Journal of Botany 56:1287-1290. 1978. Engl., Sum. Engl., Fr., 15 Refs., Illus.

Cassava. Anthers. Chromosomes. Plant-growth substances. Light. Culture media. Laboratory experiments.

Expt were performed to induce callus formation and organogenesis in anther culture of cassava. Callusing was achieved on a modified Murashige & Skoog medium (MSB) supplemented with 4 44 μM 6-benzylaminopurine (BAP) and 4.52 μM 2,4-D No callus was formed from anthers pretreated at 4°C for > 48h or on a medium containing 4 g/l activated charcoal. Callus on MSB with 4.44-8 88 μM BAP alone formed roots only BAP (8.88 μM) in combination with NAA (10.74 μM) resulted in chlorophyll formation in callus. ABA acted as an antagonist to NAA in reducing the frequency of callus greening when the latter was applied jointly with BAP. Chromosome counts of mitotic figures from callus cells ranged from 34-38, indicating that the calli were derived from the somatic tissues of the anthers (*Author's summary*) C00

0012-11253 KARTHA, K.K. and GAMBORG, O.L **Meristem culture techniques in the production of disease-free plants and freeze-preservation of germ plasm of tropical tuber crops and grain legumes.** *In* Maraite, H. and Meyer, J A , eds International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.267-283. Engl., Sum. Engl., 37 Refs

Cassava. Apical meristems. Plant tissues. Growth-chamber experiments. Plant-growth substances. Cassava African mosaic virus. Disease control. Culture media. Shoots.

Shoot apical meristem culture is becoming increasingly important for the asexual propagation of cultivated plants resulting in the recovery of true-to-type progenies and elimination of systemic viral infections. Techniques have been developed to regenerate complete plants from the shoot apical meristems of peas, chick peas, soybeans and cowpeas. As regards cassava, a procedure has been developed for regenerating plants free of AMD by the in vitro culture of the shoot apical meristems of cassava on Murashige and Skoog medium supplemented with 5 x 10^{-7} M benzyladenine, 10^{-6} M naphthaleneacetic acid and 10^{-7} M gibberellic acid. Plant regeneration averaged 90-95%, and 60% of the regenerated plants were mosaic symptom-free when explants of 0.4 mm in length were cultured. Growing diseased cuttings at 35°C for 30 days resulted in the production of plants without symptoms; from such plants meristem tips of 0.8 mm were cultured and 100% mosaic disease-free plants regenerated. Graft transmission expt carried out monthly confirmed the absence of the causal agent in plants regenerated by meristem culture techniques. Currently, expt are under way to freeze-preserve cassava meristems in liquid N. (*Extracted from author's summary*) C00 E04

0013-11252 TILQUIN, J.P. **Régénération et multiplication rapide du manioc par culture d'entrenoeuds et de cals.** (*Regeneration and rapid multiplication of cassava by internode and callus culture*). *In* Maraite, H. and Meyer, J.A., eds International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.297-306. Fr., Sum. Engl., 7 Refs., Illus.

Cassava. Propagation. Tissue culture. Culture media. Plant-growth substances:

Induction of callus formation from cassava tissues is easily done with small levels of cytokinin and auxin. Gibberellins have at 1st a promoting action on organogenesis; after 2 wk on Kartha medium their action becomes negative. For this reason it is recommended to transfer the calli after this period on the same medium without gibberellins. Attempts to induce the development of several plantlets/callus and to suppress the dominance of apical meristem were unsuccessful. (*Author's summary*) C00

0014-10444 BOERBOOM, B.W.J. **A model of dry matter distribution in cassava** (*Manihot esculenta* **Crantz**). Netherlands Journal of Agricultural Science 26:267-277. 1978. Engl., Sum. Engl., 9 Refs , Illus.

Cassava. Dry matter. Plant physiology. Tubers. Timing. Plant physiological processes.

Results of an expt were analyzed and data obtained from literature, recalculated, to determine which factors control DM distribution in the cassava plant Under given conditions for long periods, possibly for the storage life of cassava, DM distribution over storage roots and shoots proved to be constant. Based on this finding a model was developed and 2 parameters introduced: ESRP, efficiency of the plant at producing storage roots, and ISS, initial plant wt at which storage root production starts. The model was used to visualize genetic differences and the effect of environmental conditions on DM distribution. The relation between HI and ESRP is discussed. It is recommended that ESRP be used instead of HI as a selection trait. Selection material on ESRP can be screened rather early in the growth cycle as storage root wt is linearly related to plant wt. (*Author's summary*) C00 C03

0015-11000 COCK, J.H. *et al.* **The ideal cassava plant for maximum yield.** Crop Science 19.271-279. 1979. Engl, Sum. Engl., 18 Refs., Illus.

Also in Spanish

Cassava. Leaves. Leaf area. Growth. Roots. Timing. Plant development. Plant physiological processes. Branching. Productivity. Simulation model. Colombia.

A series of trials were carried out using cassava. Crop growth rate increased with leaf area up to LAI 4, root growth rate increased up to LAI 3-3.5, then declined. LAI is determined by leaf size, leaf formation rate and individual leaf life. Leaf size reached a max 4 mo after planting and then decreased; the max was a varietal character. Leaf life was reduced by shading but in full daylight was determined by the var. Leaf formation rate/shoot apex showed little genetic variation and declined with time; large differences in leaf formation rate/plant were determined by differences in branching pattern. Top growth had preference over root growth, and root sink was not limiting when root no./plant was $\geqslant 9$. A computer program was written to implement a dynamic growth model, which suggests that high-yielding plants will branch late in life and possess large leaves and long leaf life. Potential yields of >25 t/ha/yr dry roots are obtainable at 400-500 g cal cm^{-2} day radiation (*Author's summary*) C00 D03

0016-4920 IKE, I.F., THURTELL, G.W. and STEVENSON, K.R. **Evaluation of the pressure chamber technique for measurement of leaf water potential in cassava (*Manihot* species).** Canadian Journal of Botany 56:1638-1641 1978. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. Leaves. Laboratory experiments. Plant physiology.

The pressure chamber technique was evaluated as a method for estimating leaf water potential in cassava. Xylem pressure potentials (Ψ_P) measured with the pressure chamber were compared with leaf water potential (Ψ_L) obtained for the same leaf with the in situ dew-point hygrometer. In both var. studied, Ψ_L and Ψ_P were linearly related ($r^2 = 0.87$ and 0.98 for CMC9 and CMC40, respectively). The length of petiole exposed outside the chamber affects the Ψ_L / Ψ_P relation and should be kept at between 1-3 cm for better agreement. In CMC40, Ψ_P was consistently lower (drier) than Ψ_L by about 1.0 bar (1 bar = 100kPa) in the entire range of water potential studied, but was not the case in CMC9. The reason for this difference is unclear but may be due to a filling of tissues other than xylem tissue during the measurement of Ψ_P in CMC40. Av xylem osmotic potentials (Ψ_S) were low (-1.0 ± 0.2 bars and -1.0 ± 0.4 bars for CMC9 and CMC40, respectively). It is therefore unnecessary to correct for Ψ_S when using the pressure chamber to estimate leaf water potentials in cassava. (*Author's summary*) C00

0017-11280 COCK, J.H. **Cassava physiology program review, 1972.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1972. 4p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Plant physiology. Colombia.

Initial research on the physiology of the cassava plant will study the growth cycle of a heavy- and a medium-branched var. The effect of LAI, N and planting density will be determined as well. Other expt will study plant response to N, mineral requirements, induction of flowering, planting dates and the development of rapid propagation systems. (*Summary by T.B.*) C00

0018-11741 BARROS, R.S , MERCES, W.C. and ALVIM, R. **Sink strength and cassava productivity.** HortScience 13(4):474-475. 1978. Engl., Sum. Engl , 4 Refs., Illus.

Cassava. Plant physiological processes. Leaf area. Dry matter. Planting. Spacing. Growth. Plant assimilation. Productivity. Brazil.

In cassava cv. Mamão at 4 plant densities, rate of DM production was found to be a linear function of LAI up to 80 days after planting and thereafter associated with NAR up to final harvest at 280 days. Av rates of DM production were 6.25, 5.92, 5.01 and 4.35 g/m²/day for 10,000, 20,000, 40,000 and 80,000 plants/ha, resp. Shoot:root ratio increased with increasing plant density. (*Summary by Field Crop Abstracts*) C00 D03

0019-11740 MARRIOTT, J., BEEN, B.O. and PERKINS, C. **The aetiology of vascular discoloration in cassava roots after harvesting: association with water loss from wounds.** Physiologia Plantarum 44(1):38-42. 1978. Engl., Sum. Engl., 18 Refs., Illus.

Cassava. Tubers. Deterioration. Plant tissues. Analysis. Post-harvest losses. Etiology.

When root pieces of cassava cv. Yellow Heart and Cuba Sweet, with an area of periderm removed or with a transverse cut uncovered, were held at low humidity and at 22°C, vascular discoloration consistently developed within 2 days. Vascular discoloration was prevented when injured pieces were stored at high humidity or when wounds were covered by a semipermeable film. When pieces were injured by removal of periderm, at high humidity the respiratory rate was unaltered, but at low humidity an increase in respiratory rate occurred after 1 day. When pieces were injured by a transverse cut, at high humidity respiratory rate increased during the 1st day but decreased thereafter, whereas at low humidity the initial increase was followed by a further increase in respiratory rate after 2 days. It is suggested that vascular discoloration and a respiratory increase may occur in freshly harvested cassava roots as a result of stress produced locally by high rates of water loss at cuts and abrasions. (*Author's summary*) C00 D04

See also 0116 0224 0246

C01 Plant Development

0020-9936 INDIRAMMA, P. **Tuberization and starch deposition in cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.34-36. Engl.

Cassava. Tubers. Starch content. Plant-growth substances. Tuber development. Photoperiod.

The development of tuberous roots in cassava is described Results are given of expt studying the effect of no. of buds on root formation, application of sugars on root formation, excision of buds and application of sugars on starch deposition in roots, effect of growth regulators on rooting and starch deposition, varietal differences in rooting and starch deposition, the influence of photoperiod on tuberization, and starch content in relation to plant maturity. (*Summary by T.B.*) C01

0021-11223 IYENGAR, E.R.R. *et al.* **Growth, yield and chemical composition of tapioca varieties to sea water salinity.** Sakyu Kenkyu 23(2): 1-6. 1977. Engl., Sum. Engl., 13 Refs., Illus.

Cassava. Laboratory experiments. Saline water. Cultivars. Plant height. Tuber productivity. Dry matter. Starch content. Leaves. Tubers. Mineral content.

Effect of sea water dilutions on cassava was studied on a sandy substrate at Bhavnagar (India). Abrupt imposition of salinity reduced plant growth, exhibited by significant reduction in stem length. Yield potential decreased with increased salinity levels; starch and DM % did not alter very much. Mineral accumulation and salinization at different soil depths due to sea water are discussed. (*Author's summary*) C01 C03

0022-11224 SPEAR, S.N., ASHER, C.J. and EDWARDS, D.G. **Response of cassava, sunflower, and maize to potassium concentration in solution. I. Growth and plant potassium concentration.** Field Crops Research 1:347-361. 1978. Engl., Sum. Engl., 39 Refs., Illus.

Cassava. Laboratory experiments. K. Growth. Nutrient uptake. Mineral content. Leaves. Stems. Shoots. Roots. Dry matter. Cultivars. Australia.

Twelve cassava cv. and one each of sunflower and maize were grown for 27 days at 8 constant solution K concn ranging from 0.5-8024μM. All species required a min solution concn of 2-6μM K to produce max yield. At concn $>$ 122μM the yield of most cassava cv. declined and at 8024 μM K all cv. displayed Mg-deficiency symptoms. A limited variation among species and cv. was observed in the min tissue concn necessary for healthy growth. Large differences in DM % existed among species, plant parts and K treatments. Because of this, trends in K concn expressed on a dry wt basis in some instances did not accurately reflect trends in K concn in the fresh tissue. Although all 3 species produced max DM yield at similar solution K concn, at suboptimal concn cassava regulated its growth more successfully in relation to K supply than did sunflower or

maize At 0.5 μM K cassava continued to grow slowly with less reduction in relative yield, less pronounced deficiency symptoms and a smaller gradient in tissue K concn from older to younger leaves than the other species. Continued slow growth of cassava at low solution K concn was aided by greater increase in the relative size of the root system. (*Author's summary*) C01 D01

0023-4006 SILVA, S. DE O. E **Capacidade de produção e características de raízes e ramas de 60 variedades de mandioca** (*Manihot esculenta* **Grantz**). (*Productive capacity and characteristics of roots and branches from 60 cassava varieties*). Tese Mag. Sc. Viçosa, Minas Gerais, Brasil, Universidade Federal de Viçosa, 1977. 47p. Port., Sum. Port., 38 Refs.

Cassava. Tuber productivity. Cultivars. Starch content. Branching. Stems. Tubers. Soil analysis. Field experiments. Plant development. Statistical analysis. Plant height. Brazil.

In addition to evaluating root and stem production and root starch content in 60 cassava var. over a 1-yr period in Viçosa, a study was made of the characteristics of the aerial part and the roots. Correlations between root production and the variables branch production, stem diameter 5 cm from the ground, plant height, extension and height of branching were studied. A list is given of var. outstanding for root and stem production and starch content. There was a positive correlation between root production and production of branches, plant height and extension of branching, the last 2 being the closest. There was also a positive correlation between branch production and stem diameter, plant height and extension of branching. (*Summary by T.B.*) C01

0024-10944 THOMAS, A. **Multi-tier tuber production in tapioca.** Kisan World 4(7)·38. 1977. Engl

Cassava. Cuttings. Tuber development. Tuber productivity. Field experiments. India.

An expt was conducted at the College of Agriculture, Kerala to induce thickened root formation at different parts of the cuttings and to compare performance with conventional planting. 20-cm cuttings of var. Malayan-4 were planted vertically in mounds At 3 mo a cut was made at the internode, 6 cm above the zone of root formation, removing a 1 x 1 5 cm piece of bark. The layered area was earthed up and watered. In a 2nd group the same treatment was carried out, but the rooting hormone seradix was applied to the cut. Av yields of roots were 1.4 and 1.34 kg/plant, respectively, for the 2 treatments, as compared to 1 1 kg for the control. (*Summary by T.B.*) C01 D02

0025-10051 BRUIJN, G.H. DE **Influence of day length on the flowering of cassava.** Tropical Root and Tuber Crops Newsletter no. 10.1-3. 1977. Engl., 6 Refs.

Cassava. Photoperiod. Flowering. Plant height. Branching. Timing. Ivory Coast.

Expt in Ivory Coast, Nigeria and Australia show that there is a photoperiodical influence on flowering in cassava, a long-day plant. Differences exist in day-length response curves of cv Knowledge on flowering behavior is important not only for breeding work but also for distribution of promising cv. to other regions since the onset of flowering causes branching and can thus influence plant shape. (*Summary by T.B.*) C01

0026-9953 MUTHUKRISHNAN, C.R. *et al.* **Effect of certain growth regulators on tapioca (*Manihot esculenta* Crantz) and sweet potato (*Ipomoea batata* Labm.).** Journal of Root Crops 2:52-56. 1976. Engl., Sum. Engl., 10 Refs.

Cassava. Plant-growth substances. Tuber productivity. Plant height. Starch content. *Ipomoea batata*. Field experiments. Ascorbic acid. Sugar content. India.

The possibility of improving cassava and sweet potato yields with plant growth regulants was investigated at Tamil Nadu Agricultural University, Coimbatore (India). Cassava cv. Malavella was sprayed with Phosphon-D (2000 ppm),maleic hydrazide (2000 ppm), Alar (1000 ppm) and ethephon (250-500-1000-2000 ppm) The 1st 2 products had a negative effect on yield. Alar increased yield 19.75% and starch content, 26.3% over the unsprayed control. At 250 and 500 ppm, ethephon increased yields 17.9 and 20.3% and starch content; 31.8 and 95.5%, respectively. Except for Phosphon-D, these treatments reduced ascorbic acid content. (*Summary by T.B.*) C01 C03 D03

0027-9961 MAINI, S.B., INDIRA, P. and MANDAL, R.C. **Studies on maturity index in cassava.** Journal of Root Crops 3(2) 33-35. 1977. Engl., Sum. Engl., 3 Refs.

Cassava. Agronomic characters. Maturation. Tuber productivity. Carbohydrate content. Cultivars. Dry matter. Growth. Harvesting.

The morphological characters studied (av plant height, av no. of leaves retained and shoot wt/plant, av no. of storage roots/plant, av root wt and % of DM) were not correlated with plant maturity. It was possible to determine the maturity index by recording root yield and carbohydrate content. The stage at which carbohydrate content decreases can be taken as a criterion of maturity since yield does not decrease at any stage of growth. (*Summary by T.B.*) C01 D03

0028-9962 INDIRA P., KURIAN, T. and MAINI, S B. **Flowering behaviour in cassava (*Manihot esculenta* Crantz) as influenced by growth regulators.** Journal of Root Crops 3(2):37-40. 1977. Engl., Sum. Engl., 4 Refs

Cassava. Flowering. Plant-growth substances. Branching.

Foliar application of growth regulators such as IAA, NAA, ethrel, TIBA and kinetin were found effective in accelerating (45 days earlier than control plants) as well as promoting flowering in a poor-flowering S-1315. The effect was more pronounced with NAA, IAA (50 ppm) and ascorbic acid at 100 ppm concentration. (*Author's summary*) C01

0029-9937 RAMANUJAM, T. **Growth physiology of cassava.** *In* Hrishi, N. and Gopinathan, Nair, R , eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.31-33. Engl.

Cassava. Growth. Plant physiology. Agronomic characters. Leaf area. Productivity. Plant development.

The role of physiology in genetic improvement is discussed in relation to morphological characters and productivity, growth and development, and growth analysis. The following physiological parameters are defined: LAI, LAD, CGR and HI. (*Summary by T.B.*) C01

0030-11727 BISARIA, A.K., SHARMA, R.A. and BISARIA JUNIOR, A.K. **Individual and combined effects of chlorflurenol and indole-3-butyric acid on rooting of stem cuttings in** *Manihot esculenta* **Crantz.** Bangladesh Journal of Botany 6(1/2):51-55. 1977. Engl., Sum. Engl., 21 Refs.

Cassava. Cuttings. Rooting. Plant-growth substances. India.

Cassava stem cuttings were treated at Hindu College, Moradabad, with 0, 25, 50 and 100 ppm each of chlorflurenol (CFL) or indole-butyric acid (IBA) at the basal ends; CFL at 25 ppm was also combined with all concn of IBA. Although CFL improved rooting at all concn, IBA was more effective. The inhibitory effect of CFL was reversed by IBA in combinations. CFL increased the no. of lateral roots, but root length was decreased at 25, 50 and 100 ppm. CFL also induced sprouting of buds on stem cuttings. IBA increased the no. of roots, lateral roots and root length, but the effect on bud sprouting was sluggish (*Author's summary*) C01

0031-11743 SPEAR, S.N., ASHER, C.J. and EDWARDS, D.G. **Response of cassava, sunflower, and maize to potassium concentration in solution. II. Potassium absorption and its relation to growth.** Field Crops Research 1:363-373. 1978. Engl., Sum. Engl., 20 Refs., Illus

Cassava. Nutritional requirements. Laboratory experiments. Culture media. K. Absorption. Nutrient uptake. Leaves. Stems. Tubers. Cultivars. Growth. Australia.

The effect of increasing K concn from 0.5 to 8024 μM on the absorption, distribution and utilization of Ca and Mg by cassava (12 cv.), sunflower and maize (1 cv.) was studied in nutrient solution tests conducted in Australia at constant concn of Ca (753 μM) and Mg (147 μM). Increasing the K concn from 0.5 to 6 μM increased Ca absorption in 5 cassava cv. but had no effect on the other cassava cv., sunflower and maize. Mg absorption decreased with increasing solution K concn, particularly from 0.5 to 122 μM. K-induced Mg-deficiency symptoms in cassava were found to be associated with lower Mg absorption rates, together with a greater retention of Mg in the roots. (*Summary by Abstracts on Tropical Agriculture*) C01

0032-11715 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Un tipo ideal de planta de yuca para rendimiento máximo; unidad audiotutorial.** (*An ideal cassava plant for maximum yield: audiotutorial unit*). Cali, Colombia, 1979. 76 diap. color 5 x 5 cm ; cinta magnetofónica 29'05"; acompañada de guión 17p y guía de estudio 32p. Span , 15 Refs , Illus.

Cassava. Plant physiology. Leaves. Leaf area. Tubers. Tuber productivity. Growth. Photosynthesis. Timing. Cultivars. Plant development. Simulation models. Colombia.

This audiotutorial unit (cassette, printed script, 76 color slides, study guide, self-evaluation test), prepared by the Communications Support Unit at CIAT, is available for use with a manually or automatically synchronized slide projector/cassette tape recorder. Each unit is available from the Distribution Office at a cost of US$50; photocopies of the study guide alone can be obtained from the Cassava Information Center. The objective of this unit is to present some of the results of research conducted by the Physiology Section of CIATs Cassava Program. First the LAI and the morphological components of the same (leaf size, life and no./unit area) are studied; then growth rate or rate of DM accumulation and dependence on leaf area are analyzed. Based on a mathematical model for the development of a cassava plant, it is possible to predict the effects on yield of variations in one or more of its components, thus determining what could be considered as an ideal plant type. (*Summary by CIAT*) C01

0033-11744 SPEAR, S.N., EDWARDS, D.G. and ASHER, C.J. **Response of cassava, sunflower, and maize to potassium concentration in solution. III. Interactions between potassium, calcium, and magnesium.** Field Crops Research 1:375-389. 1978. Engl., Sum. Engl., 49 Refs., Illus.

Cassava. Nutritional requirements. Laboratory experiments. Culture media. K. Ca. Magnesium. Absorption. Translocation. Plant tissues. Mineral content. Leaves. Shoots. Stems. Tubers. Australia.

In Australia, 12 cv. of cassava, 1 of maize and 1 of sunflower, grown in nutrient solutions under a range of K concn (0.5 to 8024μM), were investigated for absorption, distribution and utilization of K. Cassava absorbed less K than maize and sunflower at all concn The greater relative root size of cassava and the ability to increase size of the root system at low K concn partially offset the low absorption rates/unit root wt. At all K concn cassava utilized K more efficiently than either sunflower or maize in the production of DM. (*Summary by Abstracts on Tropical Agriculture*) C01 C03

See also 0068 0113 0129 0135

C03 Chemical Composition, Methodology and Analyses

0034-4241 PIERIS, N. and JANSZ, E R. **Cyanide liberation from linamarin. II. Purification and some properties of the cyanide liberating enzymes of manioc rind.** Journal of the National Science Council of Sri Lanka 4(1):29-47. 1976. Engl., Sum. Engl., 14 Refs , Illus

Cassava. Cyanides. Linamarin. Enzymes. Analysis. Linamarase. pH. Temperature. Laboratory experiments. Protein content.

The cyanide-liberating activity in crude extracts of cassava peel, subjected to purification, was studied using acetone and ammonium sulfate precipitation and Sephadex-gel and DEAE-cellulose chromatography. Two enzymes (linamarase A and B), capable of liberating cyanide from the major cyanogenic glucoside, linamarin, were separated. Although the K_m values of the 2 enzymes were similar, their temp optima, activation energies and electrophoretic mobilities showed distinct differences. The pH activity curves and temp stability characteristics showed only very minor differences. (*Author's summary*) C03

0035-4242 PIERIS, N. and JANSZ, E.R. **Cyanide liberation from linamarin. III. Separation of the linamarases of manioc rind by DEAE-cellulose chromatography.** Journal of the National Science Council of Sri Lanka 4(2):139-147. 1976. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Linamarin. Linamarase. Cyanides. Analysis. Enzymes. Biochemistry. Timing. Laboratory experiments.

Previous studies showed that cassava peel contained 2 linamarin-hydrolyzing enzymes, linamarase A and B. Studies using DEAE-cellulose chromatography of peel extracts of 8 cassava cv. showed the presence of 4-6 cyanide-liberating activity peaks, the major ones being due to linamarase A and B in all but one case. It was also shown that linamarase A could be a subunit of B Some properties of linamarase C and D are also described. (*Author's summary*) C03

0036-10457 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. Analysis. Cortex. Laboratory experiments. Tubers. Plant tissues.

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 is increased 350-fold with 35% recovery The K_m s for linamarin and *p*-nitro-phenyl *B*-D-glucoside are 1.45×10^{-3} *M* and 0.46×10^{-3} *M*, respectively. The pH optimum in 50 mM NaPi is pH 6 and the specific activity is 26.5 nkat/mg. The enzyme can be prepared from cassava peel using the same procedure and has similar properties. (*Author's summary*) C03

0037-10055 COOKE, R.D., HOWLAND, A.K. and HAHN, S.K. **Screening cassava for low cyanide using an enzymatic assay.** Experimental Agriculture 14:367-372. 1978. Engl., Sum. Engl., 15 Refs., Illus.

Cassava. Cyanides. Selection. Tubers. Cultivars. Productivity. Leaves. Composition.

A quantitative determination was made of the cyanide contents of the peeled roots of 108 cassava clones that had been previously selected as low-cyanide by the picrate leaf test and compared with qualitative picrate leaf-test scores used for rapid screening The correlation coefficient between root cyanide content (dry wt basis) and leaf-test score was $r = 0.36$ ($P < 0.01$). The picrate leaf test is useful for screening large no. of clones in early stages of breeding but needs augmenting by more accurate methods There was no significant correlation between root cyanide content and dry root yield ($r = 0.18$). Cyanide content varied considerably between roots of the same plant and plants of the same cv. grown under the same conditions. Possible improvements in the effectiveness of the cyanide screening procedure are discussed. (*Author's summary*) C03

0038-11213 RAJUKKANNU, K. *et al.* **Uptake and persistence of aldicarb (Temik) residues in cassava tubers (*Manihot esculenta* Crantz).** Pesticides 12(3):29-30. 1978. Engl., Sum. Engl , 6 Refs.

Cassava. *Aonidomytilus albus*. Insecticides. Absorption. Tubers. Analysis. Insect control. India.

In recent years cassava has been heavily infested by scales (*Aonidomytilus albus*), which can cause complete crop loss. Because aldicarb (Temik) in many cases achieves complete control of this pest, a study was carried out to determine the uptake and persistence of aldicarb residues in cassava roots. Temik 10G (0.50, 1.00 and 1.50 kg a.i./ha) was applied to an 8-mo-old crop. Residues were determined 15, 35 and 55 days after application It is concluded that the use of aldicarb should not be encouraged after root formation. If a treatment is necessary at that time, the dosage should not exceed 0.50 kg a.i./ha. Harvesting should not be done until at least 55 days later. (*Summary by Abstracts on Tropical Agriculture*) C03 F01

0039-3728 TERNES, M., MONDARDO, E. and VIZZOTTO, V.J. **Variação do teor de amido na cultura da mandioca em Santa Catarina.** (*Variations in starch content of cassava grown in Santa Catarina*). Florianópolis, SC, Brasil, Empresa Catarinense de Pesquisa Agropecuária. Unidade Ciência. Indicação de Pesquisa no. 23. 1978. 27p. Port., Sum. Port., 8 Refs., Illus.

Cassava. Starch content. Tubers. Timing. Cultivars. Brazil.

At the exptl station in Itajaí (S. Brazil), 3 cassava cv. (Amarela, Guachinha & Rosinha) were grown in an Araranguá soil (dystrophic quartz sand) and 2 cv. (Mico & Casca Roxa) in a Riosul soil (dystrophic cambisol) to evaluate fluctuations in starch content in roots from 6-20 mo after planting. The Lane Eynon method was used for lab analyses. Values of 20-36% starch were obtained, depending on time of harvest, region and cv. Results showed that it was viable to harvest in the 1st as well as the 2nd crop cycle in both regions. There was a decline in the starch curve from Oct.-Dec., after which it ascended. This decline is due to the regrowth of the aerial part affected by the winter. (*Author's summary. Trans. by T.B.*) C03

0040-9934 MAINI, S.B. **Quality aspects of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.49-57. Engl.

Cassava. Tubers. Starch content. Protein content. Fat content. Mineral content. HCN content. Vitamin content. Analysis. Amino acids. Leaves. Cassava chips. Cassava flour. Toxicity.

The composition of cassava roots is discussed from the point of view of quality of starch, protein, fat, Ca, P, HCN and vitamin contents. Tables give data on proximate analyses of cassava and some of its products, the essential amino acid profiles in the roots and leaves (used for animal feed), microbial specifications for starch, chips and flour, quality requirements for starch and tapioca, and specifications for chips and flour. (*Summary by T.B.*) C03

0041-4248 FIGUEIREDO, I.B., VITTI, P. and PEREIRA, A.S. **Comportamento de substâncias nitrogenadas e caroteno em duas variedades de mandioca.** (*Behavior of nitrogenated substances and carotene in two cassava varieties*). Boletim do Instituto de Tecnologia de Alimentos no. 51:145-164. 1977. Port., Sum. Port., Engl., 19 Refs., Illus.

Cassava. Cultivars. Analysis. Starch content. HCN content. Protein content. Timing. N. Amino acids. Enzymes. Tubers.

Bitter cassava var. Branca-de-Santa-Catarina and sweet IAC 135 from the Instituto Agronômico at Campinas (Brazil) were analyzed for starch, HCN, β-carotene, total and free amino acids, and crude protein content at different stages of growth and using different parts of the plant. It was found that nitrogenated substances and β-carotene varied with var., plant age and harvesting time. (*Author's summary*) C03

0042-10411 LORENZI, J.O. *et al.* **Variação de carboidratos e ácido cianídrico em raízes de mandioca, após a poda da parte aérea.** (*Variation in carbohydrate and HCN content in cassava roots after pruning the aerial part*). Bragantia 37(16):139-144. 1978. Port, Sum. Port., Engl, 15 Refs.

Cassava. Pruning. HCN content. Carbohydrate content. Dry matter. Timing. Tubers. Field experiments. Brazil.

Data are presented on the variation of DM, HCN, starch, total soluble carbohydrates and reducing sugars content in 13-mo-old cassava roots at successive stages after total removal of the aerial part of the plant. During the 14 days following pruning, starch % decreased from 79.06 to 62.52%; total soluble carbohydrates and reducing sugars went from 7.65 and 1.55% up to 17.56 and 5.03%, respectively. Total carbohydrate content presented small losses as a result of pruning, probably due to the new sprouting process. Root HCN content fell from 67 to 35 ppm. It was also observed that on the 17th day after pruning, different levels of similar carbohydrates were recorded in the different root types (from the base and the middle of the planted cutting, and from the stem base of the plant). These variations may be due to a more intensive mobilization of stored carbohydrates or to greater differences in age and composition of each root type since its origin. This suggests that more detailed research work needs to be done on the root sampling method for lab analysis. (*Author's summary*) C03 D02

0043-10937 BILESKI, L.M. *et al.* **Purificação e caracterização bioquímica da β-glicosídase "linamárase" da mandioca.** (*Purification and biochemical characterization of the β-glycosidase linamarase of cassava*) Coletânea do Instituto de Tecnologia de Alimentos 8:329-344. 1977. Port, Sum Port., Engl., 19 Refs, Illus

Cassava. Linamarase. Linamarin. HCN content. Toxicity. Biochemistry. Analysis. Laboratory experiments. pH. Temperature. Brazil.

The following biochemical parameters of the enzyme linamarase, a β-glycosidase found in cassava roots and leaves, were determined optimum pH (5.5), optimum temp (37°C) and the effect of substrate concn. The substrate linamarin, a cyanoglycoside found in cassava, was extracted, purified and crystallized. The HCN liberated from the enzymic breakdown of linamarin was determined qualitatively and quantitatively. (*Author's summary*) C03

0044-10488 YEOH, H.H. and CHEW, M.Y. **Protein content and acid composition of cassava seed and tuber.** Malaysian Agricultural Journal 51(1):1-6. 1977. Engl., Sum. Engl., 17 Refs.

Cassava. Seed. Tubers. Protein content. Composition. N. Amino acids. Analysis. Water content. Malaysia.

The protein content of the seed kernel of cassava var. Trinidad was 31.6 g/100 g dry wt, whereas that of the root cortex of var. Black Twig was 1.5 g Moisture content of the seed kernel was only 6.6 g/100 g fresh wt as compared to 54.6 g for the root Total amino acid content of the seed was 23 53 g/100 g fresh wt and of the root, 0.671 g. There was no correlation between the amino acid profiles of the seed and the root. As compared with the FAO/WHO (1965) essential amino acid recommendation for ideal protein, the seed is nutritionally richer and the root, slightly inferior. (*Author's summary*) C03

0045-11203 WHOLEY, D.W. and BOOTH, R H. **A comparison of simple methods for estimating starch content of cassava roots.** Journal of the Science of Food and Agriculture 30(2) 158-164. 1979. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Tubers. Starch content. Dry matter. Analysis.

A comparison of simple methods for estimating starch content of cassava roots showed a strong relationship between root specific gravity and root DM content. In the absence of drying facilities, a specific gravity balance appears adequate to separate root samples according to DM content. A strong relationship between root specific gravity and starch content was observed using a maceration/sieving technique. This relationship was close to one reported in literature based on chemical analysis Root DM content may be used as an indication of starch content, but care should be exercised in using linear conversions until more information is available. Existing conversion tables from root specific gravity to starch content and the starch content calibrations on the Reimann balance used, grossly underestimated starch content of the samples analyzed. (*Author's summary*) C03

0046-10455 LORENZI, J.O. **Absorção de macronutrientes e acumulação de matéria seca para duas cultivares de mandioca (*Manihot esculenta* Crantz).** (*Macronutrient uptake and dry matter production in two cassava cultivars*). Tese Mag. Sc. Piracicaba, Brasil, Universidade de São Paulo. Escola Superior de Agricultura "Luiz de Queiroz", 1978. 92p. Port., Sum Port., Engl., 44 Refs.

Cassava. Cultivars. Field experiments. Fertilizers. Nutrient uptake. Nutritional requirements. Dry matter. N. P. K. S. Ca. Magnesium. Translocation. Growth. Tubers. Leaves. Stems. Analysis. Timing. Brazil.

In field expt conducted on a dark red Latosol at the exptl station in Campinas (São Paulo), cassava cv. Branca de Santa Catarina and IAC Mantiqueira received a uniform dressing of 40 kg N, 80 kg P_2O_5 and 60 kg K_2O/ha in the form of ammonium sulfate, simple superphosphate and potassium chloride, respectively; N was top dressed 60 days after emergence. Plants had to be irrigated at 15 and 45 days because of a drought period At 6 different times in the growth cycle, plants were sampled (at 60-day intervals) and analyzed for growth parameters and macronutrient composition. There were statistical differences in root production of the 2 cv.; max DM accumulation occurred 120-180 days after emergence. Peaks of macronutrient uptake coincided with max rates of DM production. Extraction of macronutrients was the same in both cv. except for P; export was different only in the case of K and S. (*Author's summary*) C03 D03

0047-11720 TUPYNAMBA, M.L V.C. and VIEIRA, E.C. **Isolation of cassava leaf protein and determination of its nutritive value.** Nutrition Reports International 19(2) 249-259 1979. Engl., Sum. Engl., 28 Refs

Cassava. Leaves. Proteins. Analysis. Nutritive value. Laboratory animals. Amino acids. Animal physiology. Biochemistry. Brazil.

Leaf protein concentrate (LPC) of cassava was obtained and its nutritive value determined at the U. Federal de Minas Gerais Extraction of the leaves was carried out at pH 7 and precipitation of the protein at pH 4. LPC contained 38.41% protein. Amino acid analysis revealed that cassava LPC was comparable to FAO reference protein with regard to essential amino acids, except for a deficiency in methionine and an excess of leucine. PER values for diets whose protein sources were casein and LPC + 0.5% methionine were 2.97 and 0.28, respectively Rats fed on a diet containing LPC as the protein source lost wt during the 28-day period. Food efficiency, apparent NPU and apparent digestibility were also determined. (*Author's summary*) C03 H01

0048-11863 THAILAND. DEPARTMENT OF AGRICULTURE. DIVISION OF RESEARCH AND EXPERIMENT. **[Comparative studies on yield, starch content, HCN content and percentage fiber of cassava roots at different harvesting times].** *In* ____. Annual Report for 1969. Bangkok, 1970?. pp.76-77. Thai., Sum. Engl.

Cassava. Harvesting. Timing. Tuber productivity. HCN content. Starch content. Fibre content. Plant development. Thailand.

A randomized complete block design with 13 treatments and 4 replications was used. Plants were grown at a spacing of 1 x 1 m and fertilizer (8-8-4) was applied at a rate of 100 kg/rai (6.25 rai = 1 ha). Plants were harvested at monthly intervals from 6-18 mo. Root yield increased significantly with increasing plant age. Harvesting time had no effect on starch or HCN content; but % fiber increased with increasing plant age. (*Summary by Kasetsart University*) C03 D03

See also 0014 0021 0026 0033 0063 0075 0170 0233 0247 0258 0295 0339 0340 0341

D00 CULTIVATION

0049-4020 MATTOS, J.C. DE A. **Aspectos gerais da cultura da mandioca.** (*General aspects of cassava cultivation*). Cerrado 7(28).18-19. 1975. Port., Illus.

Cassava. History. Nutritional requirements. N. P. K. Fertilizers. Irrigation. Cultivars. Diseases and pathogens. Injurious insects. Cultivation. Brazil.

A history is given of cassava cultivation in Brazil, with emphasis on research being done at the U. Federal da Bahia (under the BRASCAN NORDESTE agreement) and at the Centro Nacional de Pesquisas da Mandioca e Fruticultura (part of EMBRAPA) in Cruz das Almas. General cultural practices, fertilizer and irrigation requirements,and recommended var. are discussed briefly. In general disease and pest problems are regional; of importance are CBB, anthracnose, the hornworm, shootflies and mites. (*Summary by T.B.*) D00

0050-11210 MERRICK, J.E. **Status of root crops in American Samoa.** *In* Regional Meeting on the Production of Root Crops Nouméa, New Caledonia. South Pacific Commission no. 174. 1977. pp.122-124. Engl.

Cassava. Cultivation. Uses. Starch crops. Tonga.

Amer. Samoa is made up of 3 island groups. Root crops, mainly taro (*Colocasia esculenta*), form the basis of the people's diet. Production of all root crops is severely hampered by the recent trend to move from a subsistence to a capitalistic, job-oriented type of society. There was a decrease in farmers and in production, but taro plantings are now expected to continue to increase. The cultivation of taro, giant taro (*Alocasia macrorrhiza*), yams (*Dioscorea alata*), cassava and sweet potatoes is reviewed. Cassava is grown mainly as an emergency crop, 2-5 stem pieces being planted in small circular areas where the soil has been loosened. An early-maturing (6 mo) var. is preferred for human consumption. To reduce wind damage, farmers prune plant tops to a height of ca. 5 ft. (*Summary by T.B.*) D00

0051-11235 TORO M., J.C. and GARCIA P., S. **Cassava in Caicedonia, present status.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1979. 14p. Engl., Sum. Engl., 6 Refs.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979.

Cassava. Cultivation. Pest control. Productivity. Cassava programs. Colombia.

The present situation of cassava cultivation in Caicedonia (Colombia) is studied after 8 yr cooperation between the Nat. Federation of Coffee Growers and CIAT. From an initial 60 ha and 8 farmers in 1971, the project had developed more than 1300 ha (90 farmers) by the end of 1978.

Yields have declined considerably as a result of pests, diseases and continuous cropping without fertilizer. The role of the extension agent in recommending effective cultural practices is emphasized. (*Summary by T.B.*) D00

0052-11229 CASTRO M., A. **The new technology for cassava production.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1979. 36p. Engl., Sum. Engl., 12 Refs., Illus.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979.

Cassava. Cuttings. Planting. Pest control. Tubers. Storage. Productivity. Costs. Plant development.

Cassava is a low-priority crop in agricultural development policies in most L.A. countries, limiting active research and extension activities. A description is given of CIAT-generated low-cost technology that can increase yields. This package consists of the visual selection of planting material; chemical treatment (fungicides + insecticides + micronutrients) of the selected cuttings; proper preparation of the cuttings (cut rectangularly at 20 cm, with 5-7 nodes) and planting vertically at a depth of 10 cm; and the use of high-yielding, adapted var. Cassava should be planted on ridges when soils are heavy textured with >1200 mm rainfall/yr. On Oxisols and Vertisols, cassava should be fertilized with ½ t dolomitic lime and 1 t/ha 10-20-20 NPK + 20S + 10 Zn. In other soils, sufficient fertilizer to replace the nutrients extracted in the final product should be applied. Timely control of weeds is important. Pest-tolerant var. should be used; rotation or fallowing can also be practiced to break pest cycles. If disease-resistant material is not available, planting should be timed to avoid disease attack. Mechanical harvesting aids and storage of fresh roots are also discussed. (*Author's summary*) D00

0053-1171 CILKOVA, M. **Maniok-prastará tropická uzitková rostlina.** (*Cassava, an ancient tropical beneficial plant*). Ziva 24(6):213-214. 1976. Czech.

Also in Spanish

Cassava. Cultivation. Cassava products. Uses. Tanzania.

A brief history is given of cassava, synonymy, distribution, sweet and bitter var., edaphic and climatic requirements, botanical description of the plant, root composition, HCN content, uses and traditional processing methods. A description is given of cultural practices as observed by the author in Tanzania. (*Summary by T.B.*) D00

0054-9738 CORREA, H. **A cultura da mandioca como matéria prima na produção de álcool.** (*Growing cassava as a raw material for making alcohol*). *In* Simpósio Estadual do álcool, 1o., Divinópolis, Brasil, 1977. Divinópolis. Brasil, Empresa de Assistência Técnica e Extensão Rural do Estado de Minas Gerais, 1977. pp.82-99. Port.

Cassava. Climatic requirements. Soil requirements. Planting. Timing. Spacing. Fertilizers. Weeding. Insect control. Disease control. Production. Productivity. Brazil.

A description is given of cultural practices for growing cassava under different edaphic and climatic conditions in the state of Minas Gerais, Brazil. Aspects dealt with include soil preparation, liming (2-3 t/ha), soil conservation, planting dates, recommended var. (Branca de

Santa Catarina, Riqueza, Congonha, Híbrida), HCN content, preparation of cuttings, planting distances (1 x 0.5-0.6 m) and densities (16,600-20,000 plants/ha), fertilization, planting methods, weed control, pest control (*Atta* spp., *Erinnyis ello, Mononychellus* sp., *Silba pendula, Coelosternus* spp., *Pseudococcus* sp.), disease symptomatology and control [*Xanthomonas manihotis,* witches'-broom, *Cercosporidium* (*Cercospora*) *henningsii, Phaeoramularia manihotis* (*Cercospora caribaea*)], pruning, harvesting and crop rotation with legumes (soybeans). Also included are 11 questions on this topic that were discussed during the symposium. (*Summary by J.S. Trans. by T.B*) D00 F01

0055-10424 CHEW, E.Y. **The current status of cassava production and research in Malaysia.** Kelang, Selangor, Malaysian Agriculture Research and Development Institute, 1978. 12p. Engl., 15 Refs

Cassava. Production. Productivity. Rotational crops. Cultivars. Spacing. Planting. Fertilizers. Weeding. Processing. Storage. Uses. Marketing. Malaysia.

Data are given on area planted to cassava and production in the 3 major regions of Malaysia, of which Malay Peninsula is the most important (11,558 ha in 1974; av yield 20.7 t/ha); the state of Perak accounts for 50% of the production. Continuous monocropping for up to 10-20 yr is common. Rotation with vegetables, sweet potatoes, maize and peanuts is increasing, but intercropping is rare. Black and Green Twig (34.8 and 30.2 t/ha, respectively) are the preferred bitter var; sweet var. Medan and Puteh are early maturing (6-9 mo vs. 12-14 for the bitter var.) but yield less (av. 24 and 22.1 t/ha). Promising new clones are C5, Trinidad 14652/A, Brazil 14656/A and Bangkok, which all outyield Black Twig. Cultural practices are outlined. Common diseases are brown leaf spot, white thread disease and CBB; pests (scale insects and mites) are of minor importance. Brief comments are made on processing, storage, utilization, marketing and ongoing research activities. (*Summary by T.B*) D00

0056-2727 DELGADO B., T.E. and ROSAS S., C. **Yuca, resultados de la investigación y recomendaciones para su cultivo en el país.** (*Results of research on cassava and recommendations for its cultivation in Peru*). Lima, Perú. Ministerio de Alimentación. Dirección General de Investigación. Informe Especial no. 65. 1977. 30p. Span., 20 Refs.

Cassava. Cultivars. Spacing. Planting. Cuttings. N. P. K. Fertilizers. Soil requirements. Research. Dry matter. Protein content. Starch content. Cassava programs. Peru.

Information is given on cultural practices and exptl results obtained at different sites in the coastal and jungle regions of Peru from 1960 on. Cultural practices described are planting density, time, depth, spacing and method; cutting size, portion of the stem used, storage and planting position. Where soil analyses have not been made, the following NPK fertilizer applications are recommended: 120-60-40 kg/ha for the coastal areas and 100-80-100 kg for the jungle. Yields varied greatly from one site to another; those cv. with the highest surface unit yields (kg/ha) in the 7 coastal regions studied were Blanca de Congoyape (45,000), Negra Mochera (41,000 and 20,800), Cogollo Morado (39,000), Lucero LM (36,500) and Blanca Mochera (27,000 and 19,000). The following cv. were outstanding in the jungle: Auquina Amarilla and Tarapoto II (25,000 kg each), Conga de Tumbes and Negra (17,000 kg each, the latter with 28% starch content); Alabarmo and Bora Rumo (> 28% starch content) are recommended for industrial purposes. The % of DM, protein and starch, toxicity with peel, and yield of flour (%) of these cv. are given in table form. Only Negra Mochera, Tolonera, Colorada, Iqueña and Maleña have shown tolerance to the root knot nematode (*Meloidogyne* sp.) under coastal conditions. (*Summary by S.S. de S. Trans. by T.B.*) D00 J00

0057-10463 INSTITUTO NICARAGUENSE DE TECNOLOGIA AGROPECUARIA. **Cultivemos yuca.** (*Cassava cultivation*) Managua, 1977 5p. Span.

Cassava. Climatic requirements. Soil requirements. Land preparation. Cultivars. Planting. Cuttings. Injurious insects. Diseases and pathogens. Harvesting. Nicaragua.

A brief description is given of cultural practices and methods of chemical control for the different pests and diseases of cassava at the exptl centers in La Calera and Posoltega, Nicaragua (*Summary by S G V Trans. by T.B.*) D00

0058-10422 CONTRERAS G., J. **El cultivo de la yuca en zona central de Veracruz.** (*Cassava cultivation in the central part of Veracruz*). Ciudad de México Instituto Nacional de Investigaciones Agrícolas. Centro de Investigaciones Agrícolas del Golfo Centro. Circular CIAGOC no. 65. 1978. 8p. Span , Illus

Cassava. Climatic requirements. Cuttings. Planting. Land preparation. Thrips. Cassava common mosaic virus. Cultivars. Fertilizers. Uses. Mexico.

Cassava is planted at the beginning of the rainy season (last 1/2 of June) in the warmer climates (22-35°C) in the state of Veracruz. Cuttings 20-30 cm long with approx 10 buds are used. Cassava is mainly grown on small plots for family consumption. Insects of possible economic importance are thrips and shoot flies; the only disease of importance is witches'-broom. Recommended edible var. are Criolla, Cubana, Guaxupe, Smalling Sta. Cruz and Itú; C-59-6 and C-59-9 are good industrial cv. All yield > 20 t/ha. (*Summary by S G.V. Trans. by T.B.*) D00

0059-4383 MURILLO, J.L.U. and AVILES, C.L. **Cultivo de la yuca.** (*Cassava cultivation*). Alajuela, Costa Rica. Centro Agrícola Regional de la Zona Norte. Boletín no. 51. 1975. 7p. Span.

Cassava. Cultivars. Cuttings. Planting. Land preparation. Herbicides. Fertilizers. *Sphaceloma manihoticola Cercospora caribaea. Cercospora henningsii. Uromyces manihotis. Anastrepha pickeli. Erinnyis ello Bemisia.* **Injurious mites. Costa Rica.**

Because cassava has become one of the most important economic crops in N. Costa Rica, the area planted to this crop is increasing The need to improve cultural practices, selection of cuttings, use of fertilizers and weed control is discussed. A brief description of type of damage and chemical control of the following diseases and pests are given: superelongation, brown and white leaf spots, rust and ash; the fruitfly, hornworm, mites and the whitefly. The 2 most common commercial sweet var. are Valencia and Mangi. (*Summary by T.B.*) D00

0060-4342 GARAY, F **Mandioca dulce** (*Manihot palmata,* Muell). (*Sweet cassava*). Boletín del Ministerio de Agricultura (Argentina) 9.28-30. 1908. Span.

Cassava. Sweet cassava. Cultivation. Argentina.

Cassava is a basic staple in the diets of the lower income strata of the province of Corrientes (Argentina) and is grown mainly as a subsistence crop for family consumption. Local cultural practices are given Although the total area planted to cassava was greater than for potatoes and sweet potatoes, much less cassava was available on the market. (*Summary by M.R.T. Trans by T B.*) D00

0061-9812 TORRE, J. DE LA *et al.* **Prácticas agronómicas.** (*Cultural practices*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1978. 5p Span.

Cassava. Cuttings. Planting. Fertilizers. Cultivars. Cultivation systems. Spacing. Weeding. Insect control. Disease control. Harvesting. Peru. Dominican Republic. Colombia.

A description is given of the agronomic practices used by small cassava growers in Peru, the Dominican Republic and the Colombian N. Coast, as well as by small and large producers in Cuba. The following aspects are dealt with briefly: soil preparation; var. used; cutting selection, size and angle of cut; planting system; fertilization; weed, pest and disease control. At present these farmers obtain yields similar to or better than the world averages; it is thus concluded that with improved cultural practices, yields can be increased significantly without substantially affecting production costs. Some short- and long-term recommendations are made. (*Summary by S.S. de S. Trans. by T.B.*) D00

0062-7922 INSTITUTO NACIONAL DE REFORMA AGRARIA. CUBA. **Normas técnicas para el cultivo de la yuca.** (*Techniques for cultivating cassava*). La Habana, Cuba, Centro de Información y Documentación Agropecuaria. 197?. 25p. Span.

Cassava. Cultivars. Identification. Cultivation. Planting. Timing. Cuttings. Fertilizers. Diseases and pathogens. Injurious insects. Nutritive value. Cuba.

The following aspects of cultivating cassava are discussed: botanical description, bitter and sweet var., description of recommended sweet var. (Señora Ponga la Mesa, Masa de Puerca, Señora Blanca, Palenque, Siboney and Señorita), climatic and soil requirements, preparation of the land, planting position of cuttings, planting dates and distances, irrigation, harvesting and nutritive value of the aerial part and roots. Pests include *Erinnyis ello, Lonchaea chalybea, Lagochirus obsoletus* and *Tetranychus tumidus*. Diseases are not of importance, but care should be taken with Cercospora leaf spot, CBB and *Gloeosporium* or *Colletotrichum*. (*Summary by T.B.*) D00

0063-8726 NORMANHA, E.S. *et al.* **Mandioca supera crescimento demografico.** (*Cassava production increases more rapidly than population growth*). Coopercotia 19(156) 16-22. 1962. Port., Illus

Cassava. Climatic requirements. Soil requirements. Cultivars. Planting. Weeding. Harvesting. Pruning. *Erinnyis ello. Coelosternus.* Industrial starches. HCN content. Toxicity. Brazil.

This is a condensation of 3 papers dealing with work on cultural practices and starch processing done at the Instituto Agrônomico in Campinas, as well as the use of leaves and branches for forage, done at the Escola Superior de Agricultura Luiz de Queiroz. Aspects of cultivation include climate and soil requirements, var., planting dates, preparation of the land, weed control, pruning and harvesting. Symptomatology and control of CBB and witches'-broom are described. Important pests include the hornworm *Erinnyis ello,* the grubs of *Coelosternus* sp. and a shoot fly. The processing of starch from cassava is outlined. Based on literature, the use of the aerial part of the plant for forage and HCN toxicity are also discussed briefly. (*Summary by J.S. Trans. by T.B.*) D00 F01 C03

0064-4022 **O CULTIVO da mandioca e o seu aproveitamento industrial.** (*The cultivation of cassava and its industrial uses*). Agricultura-a Força Verde 1(5):24-26. 1977. Port., Illus.

Cassava. Cultivation. Industrialization. Brazil.

A report is given of the 1st state meeting of 150 cassava growers from the northern part of the state of Rio de Janeiro. There was general discontent among the growers due to the extremely low prices offered for cassava destined for alcohol production. It was suggested that the possibility of producing alcohol from the wastes of flour production be looked into. The creation of a state farmers cooperative was proposed. (*Summary by T.B*) D00 102

0065-10481 ONWUEME, I.C. Cassava. *In*_____. The tropical tuber crops. Chichester, England, John Wiley & Sons, 1978. pp.109-163. Engl., 70 Refs., Illus

Cassava. Plant anatomy. Plant development. Cultivation. Harvesting. Viroses. Bacterioses. Mycoses. Injurious insects. Uses. Economics.

This text for university students provides general background information on cassava. Aspects dealt with include botany (classification, environmental requirements, growth cycle, the root, tuber, stem, leaves, flower, fruit and seed), planting (seed-bed preparation, planting material, planting angle, other methods of propagation, spacing, planting time, mechanization), field operations (weed control, fertilizing, harvesting, yields, rotation), diseases and pests (viruses, bacteria, fungi, insects, mites), utilization (root composition and utilization, gari, farinha, meal of retted cassava, chips, pellets, flour, starch, leaves), improvement (aims and methods) and economic importance. Data are given on world production, problems and the future perspectives of the crop. (*Summary by F.G. Trans. by T.B.*) D00

See also 0390

D01 Soil, Water, Climate and Fertilization

0066-11207 AGBOOLA, A.A. and OBIGBESAN, G O. **The response of some improved food crop varieties to fertilizers in the forest zone of western Nigeria.** *In* Seminar on Fertilizer Use Development in Nigeria, Rome, Italy, 1974. Report on FAO/NORAD and Federal Department of Agriculture. Rome, FAO-AGL/MISC/76/3. 1976. pp.63-77. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Fertilizers. N. Timing. Tuber productivity. Starch productivity. K. Field experiments. Nigeria.

Expt with improved var. of maize, rice and cassava in the forest zone of W. Nigeria showed that N was the most important nutrient limiting the yield of the 1st 2 crops. Improved cassava cv. 60506 responded better (64.1 t at 90 kg N at 15 mo) to N fertilizer than the standard local 53101, which had a lower yield ceiling (55.7 t at 60 kg N at 15 mo). K raised the DM and starch content and total root yield of the improved cv. Ammonium sulfate seemed to be superior to sulfur-coated urea or urea (*Summary by T.B.*) D01 D03

0067-4546 KOCH, L. and MEER, M. VAN DER **Uitkomsten van eenige bemestingsproeven met cassave.** (*Results of some fertilizer experiments with cassava*). Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw no. 50. 1926. 15p. Dutch.

Cassava. Field experiments. Fertilizers. Manures. Dung. *Crotalaria*. Ammonium sulphate. Calcium. Cultivars. Tuber productivity. Java.

Application of 174 kg ammonium sulfate/ha did not increase root yields significantly in 2 expt. The application of lime (0.87 t/ha), with or without a crop of *Crotalaria anagyroides* prior to cassava, was tested. The green manure had a positive effect on cassava root yield, but lime gave positive results in only one of the 2 expt. The effect of different planting densities on yield was studied in plots where half had been planted with green manure prior to cassava; significant differences with regard to density were not found, but yield on the green-manured plots was significantly higher. (*Summary by J.V.*) D01 D03

0068-4299 DESHMUKH, P.P. *et al.* **Performance of some tapioca varieties under hot and dry climate of Central India.** Journal of Root Crops 3(1) 25-28. 1977. Engl., Sum. Engl., 3 Refs

Cassava. Cultivars. Growth. Agronomic characters. Tubers. Climatic requirements. India.

An evaluation was made of cassava cv. H-97, H-165 and M-4, in comparison to a local Kerala var., on a sandy loam soil with adequate protection from the wind. H-97 and the local var. performed best in the hot, dry climate of central India. Cassava should be irrigated and protected from the hot winds (*Summary by T.B.*) D01 C01

0069-4489 L'EMPLOI DES engrais chimiques dans la culture du manioc. (*The use offertilizers in cassava cultivation*) Entreprises et Produits de Madagascar 1950:63-65. 1950. Fr., Illus.

Cassava. Fertilizers. N. P. K. Calcium. Tuber productivity.

Based on exptl data from Java, Portugal and S.A , recommendations are made for the use of NPK, Ca and Mg fertilizers for growing cassava in Madagascar. (*Summary by I.B.Z. Trans. by T.B*) D01 D03

0070-4771 OBIGBESAN, G.O. Nutritional problems in root crops production. *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.25-35. Engl., Sum. Engl., 13 Refs.

Cassava. Nutritional requirements. Climatic requirements. Soil analysis. Deficiencies. N. P. K. Nutrient uptake. Tuber productivity. Timing. Fertilizers. Resistance. Nigeria.

Emphasis is placed on the need to apply balanced nutrient elements for optimum yield and good quality. Aspects discussed include agroclimatology and soils, plant tissue analysis, deficiency symptoms in plants, nutrient uptake (data on yield and nutrient uptake of cassava cv 53101 at different stages of growth and equivalent amounts of fertilizer removed by cassava and yams through harvest), time and type of fertilizer applications. Interrelations between crop nutrition and disease resistance are stressed. (*Summary by T.B*) D01

0071-9811 SOLORZANO V., N. Efectos del cultivo de yuca (*Manihot esculenta*) sobre los nutrimentos del suelo. (*Effects of cassava cultivation on soil nutrients*). Tesis Ing. Agr. San José, Universidad de Costa Rica, 1975. 101p Span., Sum Span., 38 Refs., Illus.

Cassava. Cultivars. P. K. Ca. Mg. Soil analysis. Nutritional requirements. Soil requirements. Dry matter. pH. Analysis. Cultivation. Nutrient uptake. Costa Rica.

To determine the effects of cassava on soil nutrients, 3 var. (Valencia, Mangi, Bayuna) were grown at the exptl station Fabio Baudrit M. of the U. of Costa Rica. A split plot design with 5 replications was used. Soil samples were taken at 4 times during the vegetative cycle in the furrows (20 cm from the cuttings) and between the furrows (20-40 cm from the cuttings), at 2 depths (0-10 cm and 10-30 cm). The no. of thickened roots in lateral and longitudinal positions was also determined. Data on P-K-Ca-Mg are given for the different samplings. The quantity of nutrients removed from the soil varied greatly, being almost double in Bayuna Dulce, a very leafy var. Nevertheless, Mangi yielded the best (28.1 t roots), also producing 28.8 t stems and 11.0 t leaves/ha. Valencia gave similar results. Bayuna Dulce had the greatest no. of roots, but they were not fully developed at 12 mo. All the var. produced 75% of their roots in a lateral direction. (*Extracted from author's summary. Trans. by T.B.*) D01

0072-10059 MOHAN KUMAR, C.R., MANDAL, R.C. and HRISHI, N. Effect of plant density, fertility levels and stages of harvest on cassava production. Journal of Root Crops 1:59-62. 1975. Engl., Sum. Engl., 3 Refs.

Cassava. Spacing. Harvesting. Timing. N. P. K. Dung. Fertilizers. Tuber productivity. Field experiments. India.

The response of cassava hybrid H-165 to varying levels of spacing, fertilization and harvest dates was studied at the Central Tuber Crops Research Institute, Trivandrum (India) for 2 yr. Root no /plant and root wt were significantly higher at wider spacing (90 x 90 cm). There was a significant increase in yield with increased fertility. Max root yield was obtained at 9 and 10 mo. Per-day root production was max at 6 and 7 mo and also at the high level of fertilization. Cooking quality of the roots was best at 7 and 8 mo. (*Author's summary*) D01 D02 D03

0073-9964 MOHAN KUMAR, C.R. and MANDAL, R.C. **Studies on production economics of high yielding varieties of tapioca to the application of nitrogen.** Journal of Root Crops 3(2):63-65. 1977 Engl., 3 Refs.

Cassava. Fertilizers. N. Tuber productivity. Cultivars. Costs. Economics. Income. Field experiments. India.

In an expt at Central Tuber Crops Research Institute, conducted on a soil low in the major plant nutrients, an evaluation was made of the effect of 5 levels of N (0-40-80-120-160 kg) on yield of 2 hybrids (H 165 and 97) and the standard local var. M4 A basal dressing of 100 kg P and K were aplied at planting. Increasing N increased yield and the no of thickened roots/plant, but economic yield was obtained at 80 kg N for the 2 hybrids (22.5 and 16.5 t/ha) and at 40 kg for the local var. (10.1 t) (*Summary by T.B.*) D01 J00

0074-9958 COTEJO JUNIOR, F.R. and TALATALA, R L. **The effect of rate and time of fertilizer application on the yield of cassava.** Visca Vista 1(1) 22-23. 1978. Engl.

Cassava. Fertilizers. N. P. K. Tuber productivity. Timing. Agronomic characters. Field experiments. Philippines.

In an expt with 4 NPK treatments, a good response was obtained to all rates in the rainy season, but optimum results were obtained at the 90-60-60 level. There were, however, no significant differences as to time of application During the dry season, results were very different, there being no significant differences in yield at any level (*Summary by T.B.*) D01 D03

0075-11009 ASHOKAN, P.K. and SREEDHARAN, C. **Influence of levels and time of application of potash on growth, yield and quality of tapioca (*Manihot esculenta* Crantz).** Journal of Root Crops 3(2).1-4. 1977. Engl., Sum. Engl., 16 Refs.

Cassava. K. Growth. Tuber productivity. Timing. Field experiments. HCN content. Protein content. Starch content. Dry matter. India.

In field expt at the College of Agriculture, Vellayani, the effect of different levels and time of application of K in conjunction with FYM on production of cassava var. H-97 was studied. Max yield was obtained at 112 5 kg K. Three split applications gave a better response at lower levels of K. FYM gave a better response at higher levels of K. The utilization index showed a decrease after 75 kg K. Quality parameters such as DM, starch content and cooking quality were increased by K fertilization, whereas crude protein and HCN content decreased. (*Author's summary*) D01 D03 C03

0076-9965 WAHAB, A.H., HASSAN, I. and LUGO-LOPEZ, M.A. **Performance of twenty cassava cultivars on marginal peats and peaty clays of Guyana.** Journal of Agriculture of University of Puerto Rico 40(4):343-354. 1978 Engl., Sum. Engl., Span., 7 Refs., Illus.

Cassava. Cultivars. Soil analysis. Tuber productivity. Field experiments. Laboratory experiments. Tubers. Plant height. Soil requirements. Composition. Deterioration. Storage. Timing. Guyana.

A 1-yr expt was conducted with 20 cv. to assess the suitability of Guyana's marginal Anira peat no. 20 and Inki clay no. 100 for growing cassava. Tacana and Iracema (Brazil) ranked above all others on both soils, producing 28 t/ha on the Anira peat and 24 t on the Inki clay. All introduced cv outyielded their local counterparts. The highest yielding native cv. Badwoman produced 12 and 10 t/ha on the Anira peat and Inki clay, respectively. M Col 673 had the highest root DM content, ca. 40% for both soils. Edible fresh matter content (ratio of peeled to unpeeled root) averaged 0.85 and was essentially the same for all cv. There was a highly significant relationship between total plant wt and root yield on both soils ($r = 0.92$ and 0.94), and between HI and root yield ($r = 0.64$ and 0.81). The no. of stems/cutting and stem diameter at harvest were not related to yield; however, the no. of edible roots/plant was highly correlated with yield ($r = 0.69$ and 0.54). Root thickness was also related to yield ($r = 0.92$ and 0.95) on both soils. Under field conditions, all cv. stored well for 5 days before primary deterioration began. (*Author's summary*) D01 D03

0077-10480 NUNES, W. DE O *et al.* **Resposta da mandioca à adubação mineral e à métodos de aplicação do potássio em solos de baixa fertilidade.** (*Response of cassava to mineral fertilization and methods of potassium application in low-fertility soils*). Pesquisa Agropecuária Brasileira (Série Agronômica) 9:1-9 1974. Port., Sum Port., Engl, 15 Refs

Cassava. Soil fertility. Fertilizers. N. P. K. Soil analysis. Productivity. Statistical analysis. Field experiments. Brazil.

The effects of NPK and the method of K application on yield of cassava cv. Manjaría, Suruí and Branquinha were evaluated in 7 expt on 2 soils low in P (a tertiary material of the tablelands and a planosol) in the state of Rio de Janeiro Yield responses at 2 sites were not statistically significant; at the remaining 5, P was the major limiting factor. Application of 40 kg P_2O_5/ha increased yield an av of 86%, but with an additional 40 kg, av yield increase was only 8% Quadratic production functions computed for 3 sites indicated that 67 kg P_2O_5/ha was the most economical level of application, resulting in an av yield of 29,746 kg/ha, as compared to av state levels of approx 12,000 kg Yield responses of up to 30 kg N and 40 kg K_2O/ha were not statistically significant; likewise, splitting the K application had no influence on yield. (*Author's summary*) D01

0078-10061 ALMEIDA, F.C.G., NUNES, R. DE P and NUNES, F.E C. **Produção de raízes de mandioca (*Manihot utilissima* Pohl.) em regime de suplementação hídrica e suas relações com a produção de ramas.** (*The relationship of cassava root yield to green matter production under irrigated conditions*). Ciência Agronômica 6(1/2):31-34. 1976. Port., Sum. Engl., 7 Refs, Illus.

Cassava. Tuber productivity. Cultivars. Leaves. Statistical analysis. Field experiments. Experiment design. Branching. Brazil.

A randomized complete block design with 4 replications was used to determine root yield and its relation to green matter formation in 10 cassava cv. grown under irrigated conditions at the Depto. Nacional de Obras Contra Secas expt station in Paracuru, Ceará (Brazil). It was possible to place the cv. into 3 statistically different groups of productivity with respect to both root and green matter production. There was a positive and significant correlation ($r = 0.65$) between

these 2 factors. The coefficient of determination indicated that 42% of the variability observed for root yield could be attributed to variability in the amount of green matter produced. (*Author's summary*) D01

0079-9974 PUSHPADAS, M.V. and AIYER, R.S. **Nutritional studies on cassava (*Manihot esculenta* Crantz.). II. Effect of potassium and calcium on yield and quality of tubers.** Journal of Root Crops 2:42-71. 1976. Engl., Sum. Engl., 23 Refs.

Cassava. K. Ca. Tuber productivity. Tubers. Cultivars. Field experiments. Analysis. Dry matter. HCN content. Starch content. Nutritional requirements.

Response of 2 cassava var. (M-4 and H-105) to factorial combinations of 3 levels of K (0-125-250 kg K_2O/ha) and Ca (0-600-1200 kg CaO/ha) was evaluated in a field expt at Kerala Agricultural U. at Vellayani (India). Levels of N and P_2O_5 were kept constant at 150 and 100 kg/ha, respectively, using ammonium sulfate and superphosphate. K and Ca had no effect on no. of leaves or plant height. The individual effect of K and the combined effect of K and Ca were significant in increasing root yield. For M-4 the max yield of 25.05 t/ha was obtained with treatment K_2Ca_1, for H-105, the max of 25.27 t was obtained with K_1Ca_0 and K_2Ca_1 (the difference in yield between these treatments was not significant). In terms of starch yield/ha, K_2Ca_1 again gave the highest value for both var., while in terms of % starch content of the fresh roots, K_2Ca_0 gave the highest value for both var. K increased the edible portion, DM and starch content of roots but decreased crude protein and HCN contents. Ca depressed starch content at 0 level of K and decreased HCN only in the case of H-105. Under conditions of adequate nutrient supply, M-4 was superior to H-105 with regard to per hectare fresh root and starch yield, as well as the various quality factors studied. (*Author's summary*) D01 D03

0080-9967 GODFREY-SAM-AGGREY, W. and GARBER, M.J. **Effects of phosphorus and lime on cassava (*Manihot esculenta* Crantz).** Zeitschrift für Acker-und Pflanzenbau 164(1).40-53. 1978. Engl., Sum. Engl., Germ., 30 Refs., Illus

Cassava. P. Agricultural lime. Ca. Cultivars. Productivity. pH. Tuber productivity. Field experiments. Cultivation. Nutritional requirements.

The effects of P (0-578-1156-1734 kg/ha) in the form of basic slag (18% P_2O_5 and 45% "active" lime) on 4 cassava cv. and lime (0-1255-1883-2511-3766 kg Ca/ha) on cv. Cocoa were evaluated on intensively and newly cropped (after 7 yr bush fallow) acid Njala upland soils, respectively. The cv. responded differently to the different P rates and incident lime on the intensively cropped site. Cocoa and Nigeria yields showed a significant positive linear relationship with P rates, but only Cocoa yield was significantly and linearly correlated with total active lime. There appears to be a genotype/fertilizer interaction in Cocoa and Nigeria, probably due to increasing Ca in the former and to P in the latter. Root no. showed significant linear response to P rates, all other mean cv root no. differences being significant except between Llanera and Nigeria. Soil pH at harvest and Cocoa yield showed significant positive linear correlation. P rates, residual soil P and total active lime correlated significantly with soil pH at harvest. As applied basic slag increased, residual soil P increased exponentially, thus leaving a large residual P. As applied total active lime increased, soil Ca increased exponentially. Increasing lime rates above 260 kg/ha on land after 7 yr bush fallow significantly reduced individual root wt but had no significant effect on either root yield or no. This amount can be supplied by the application of 578 kg basic slag/ha. Optimum liming level for these soils appears to lie between pH 5.5-6.5 for Cocoa. (*Author's summary*) D01 D03

0081-9960 ASHOKAN, P.K. and SREEDHARAN, C. **Influence of levels and time of application of potash on growth, yield and quality of tapioca (*Manihot esculenta* Crantz).** Journal of Root Crops 3(2)·1-4. 1977 Engl., Sum Engl., 16 Refs.

Cassava. Potash. Growth. Tuber productivity. Dung. Fertilizers. Protein content. HCN content. Dry matter. Field experiments. Timing. India.

A field expt was conducted to study the effect of different levels and times of application of K in conjunction with FYM. Max yield of H-97 was obtained at 112.5 kg K. Three split applications gave a better response at lower K levels; FYM gave a better response at higher K levels. The utilization index showed a decrease after 75 kg K. Quality parameters such as DM and starch content were increased by K fertilization; cooking quality was also improved. Crude protein and HCN content showed a decrease with K. (*Author's summary*) D01 D03

0082-9940 MOHAN KUMAR, B. **Soil and fertilizer requirements of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.17-20. Engl.

Cassava. P. N. K. Zn. Molybdenum. Fertilizers. Soil requirements. Soil fertility. Agricultural lime. HCN content. India.

The majority of the cassava-growing area in Kerala has laterite soils, high rainfall and temp. The main fertility problems are leaching, soil acidity and consequent immobilization of P, and rapid decomposition and loss of OM. In several expt at the Central Tuber Crops Research Institute, 100 kg each N and K_2O/ha was sufficient for optimum yield. Application of 2000 kg CaO in alternate years in conjunction with 100 kg P_2O_5 increased yield ca. 20% The best source of N was calcium ammonium nitrate followed by urea; for P, it was basic slag and citrate-soluble P. There was a significant response to Zn, Mo and B at 12 5, 1.0 and 10.0 kg zinc sulfate, ammonium molybdate and borax in the presence of 100 kg each NPK. However, further expt showed that optimum levels of Zn and Mo were 2.5 and 0 5 kg, respectively. Foliar applications of Zn significantly reduced HCN content. (*Summary by T.B.*) D01

0083-4128 CURVA B., A. **Respuesta de la yuca (*Manihot esculenta* Crantz) a la fertilización con NPK en Tarapoto.** (*Response of cassava to NPK fertilization in Tarapoto*). Tarapoto, Perú. Centro Regional de Investigación Agropecuaria del Oriente. Avances en Investigación 1(1).20-25. 1977. Span., Sum. Span., 5 Refs

Cassava *Manihot esculenta*. Fertilizers. N. P. K. Experiment design. Statistical analysis. Cultivars. Soil fertility. Peru.

The low-yielding cassava var. Rumo Maqui (av 7.5 t/ha/9 mo) was submitted to 15 NPK treatments (60-180 kg N, 0-120 kg P_2O_5, 60-180 kg de K_2O/ha) on a sandy clay loam soil in Tarapoto, Peru. A central composite design (response surface design of the 2nd order) was used, in which the central level was 120-60-120 NPK. Plants were harvested at 11 mo. Response to fertilization was not significant, but P levels tended to be so (120 kg P gave the highest yield - 21,430 kg/ha). In the analyses of regression the stationary point was estimated to be 17,135 kg (max response) at a fertilization rate of 90-55-135, which was close to the central level. A cost analysis showed that this yield is economically significant in comparison to the control (12,630 kg/ha). (*Summary by T.B.*) D01

0084-10423 CHEW, W. Y. **Micronutrient fertilization of cassava on Malaysian peat soil.** Jalan Kebun, Kelang, Selangor Malaysian Agricultural Research & Development Institute. Peat Research Station. 1978. 12p. Engl., Sum. Engl., 23 Refs

Cassava. Soils. Soil requirements. Soil analysis. Copper. Manganese. Zn. Iron. Molybdenum. Boron. Growth. Tuber productivity. Starch productivity. Nutrient uptake. Field experiments. Malaysia.

To prevent possible deficiencies on virgin peat, Malaysian farms usually apply basal dressings of Cu, Mn, Zn, Fe, Mo and B to each cassava crop. A series of field expt were conducted to determine the response of cassava to these micronutrients and optimum rates of application. It was found that only Cu was essential; application of 0.5 kg Cu was sufficient to give good yields. Each crop absorbed 70-120 g/ha Cu; leaf content increased from 7-14 ppm with the addition of Cu and yields were approx tripled. In all plots without Cu fertilizer, Cu deficiency symptoms were observed and yields were extremely poor. *(Summary by T.B.)* D01 D03

0085-10412 ARRUDA, F. B. *et al.* **Comportamento de duas variedades de mandioca sob dois níveis de umidade e de adubação do solo.** *(Evaluation of two cassava varieties at two levels of irrigation and fertilization).* Bragantia 37(13).109-116 1978. Port., Sum. Port., Engl , 7 Refs., Illus.

Cassava. Field experiments. Irrigation. Soil moisture. Rainfull data. Tuber productivity. Starch productivity. N. P. K. Fertilizers. Brazil.

Results are given of a field trial at the Centro Experimental de Campinas in São Paulo to determine the effects of sprinkler irrigation and NPK fertilization on cassava. Statistical analysis showed there was no significant increase in production due to irrigation or to fertilization IAC 105-66 was more resistant to drought than Branca de Santa Catarina; and when fertilized, it had ca. 2% more starch content Fertilization had a slightly negative effect on root production of both var., irrigated or not. (*Author's summary. Trans. by T.B.*) D01 D03

0086-10406 CHEW, W.Y. **The performance of tapioca, sweet potato and ginger on peat at the Federal Experiment Station, Jalan Kebun, Selangor.** Planter 45(521).445-451. 1969. Engl., Sum. Engl , 12 Refs.

Cassava. Soils. Soil requirements. Soil analysis. Land preparation. Planting. Cultivars. Fertilizers. Ca. N. P. Potash. Tuber productivity. Field experiments. Malaysia.

Malaysia has a large area of acid peat with a low mineral content, high water table, coarse woody texture and high timber content. Drainage, liming and fertilizing with major and trace elements are necessary for short-term crops Cassava, sweet potatoes and ginger yield well on peat. Information is given on how to prepare the land and plant these crops, recommended var. fertilizer rates, cultural practices and harvesting. (*Summary by T.B.*) D01 D03

0087-10408 CHEW, W.Y. **Assessment of cassava as an industrial crop on Malaysian peat.** Serdan, Selangor. Malaysian Agricultural Research & Development Institute. Report no. 57. 1977. 12p. Engl., Sum. Ind., Engl., 13 Refs.

Cassava. Soils. Soil requirements. Soil analysis. Field experiments. Cultivars. Tuber

productivity. Starch productivity. Fertilizers. Ca. Timing. N. P. K. Copper. Cultivation systems. Mechanization. Costs. Land preparation. Planting. Weeding. Harvesting. Income. Cassava programs. Malaysia.

Land pressure necessitates the development of Malaysia's 2½ million ha of peat for agricultural production. Cassava appears to be one of the most suitable because it adapts well to high soil acidity and low fertility, on peat it also forms thickened roots easily and is less expensive to harvest. Yields are as good on peat soil as on upland sedentary soils, cv. Black Twig yields ca. 30-50 t/ha on peat; however, continuous cropping decreases yields Three t/ha hydrated lime is necessary since peat pH is 3.5 or below, but lime has a long residual effect (≥ 5 yr) On newly cleared peat, NPK requirements for max yield are 180-200, 25-30 and 200 kg/ha, respectively. Since peat soils are deficient in Cu, from 2-10 kg $CuSO_4$/ha are required (residual effect, ≥ 2 yr); foliar sprays are also effective. A wide spacing of 1½ x 1 m does not affect yields. Several manual weedings are required. Harvesting is usually done from 10-14 mo. Given the high fertilizer costs, cassava is a profitable crop on peat only when the necessary marketing infrastructures are available. (*Summary by T.B.*) D01 D02 D03 J00 K01

0088-9736 ARISMENDI, L.G. **Resultados experimentales de algunas prácticas y características agronómicas del cultivo de la yuca (*Manihot esculenta* Crantz) en la sabana de Jusepín.** (*Experimental results of agronomic practices and characteristics of cassava in the savanna of Jusepín*). Jusepín, Venezuela. Universidad de Oriente. Escuela de Ingeniería Agronómica, 1976. 56p. Span., Sum. Span , 72 Refs , Illus.

Cassava. Agronomic characters. Cultivars. Identification. Plant anatomy. Planting. Harvesting. Timing. P. K. N. Fertilizers. Herbicides. Weeding. Tuber productivity. Bitter cassava. Sweet cassava. Tubers. Leaves. HCN content. Starch content. Protein content. Mineral content. Field experiments. Venezuela.

To facilitate the selection of cassava clones with characteristics appropriate for commercial exploitation, 6 main aspects were studied. Field expt were conducted at the Sabana Exptl Station and the chemical-bromatological analyses at the U de Oriente in Jusepín, Venezuela. (1) Morphological aspects of 28 clones. There was a wide range of variation in yield; the best clones were José María (bitter, 3.14 kg/plant) and Mantequilla (sweet, 2 22 kg/plant). A positive correlation was found between root production and diameter and between production and length and no. of roots. The bitter clones were better than the sweet ones with regard to root yield/plant, height and no of shoots/plant, branching height, root diameter and no. of roots/plant. Drawings of a leaf of each of the clones are included. (2) Analysis of 3 expt with sweet and bitter clones. Under savanna conditions, the bitter clones Querepa, José María and Juliana (av yield 33 t/ha) and the sweet Canaria, Caureña, Ceiba Llanera and Mantequilla (21.5 t/ha) were best. (3) Planting and harvesting dates. Planting should be done at the beginning of the rainy season (May-June); harvesting time ranges from 11-12 mo of age. (4) Fertilization. Optimal application rates are 100-200 kg N, 114 kg P and 80 kg K_2O/ha. (5) Weed control. The best herbicides were Cotoran (3 kg/ha) and Gesapax (2-3 kg/ha); highest foliage and root yields were obtained with the former. (6) Chemical-bromatological analysis of 27 clones. There was a positive correlation between (a) HCN content in the peeled root (parenchyma) vs. HCN content in the leaves, (b) HCN content in the parenchyma vs. starch content, and (c) HCN content in the parenchyma vs. HCN content in the peel. These relationships confirm the reason why bitter clones are preferred for processing industrial starch, animal feed and casave. Except for crude fat content in the roots, the analysis of variance showed significant differences for all components studied (total DM, crude protein and fiber, ash, N-free extracts, P, Ca, K and Mg). Once detoxified, the leaves are of great nutritive value for animals because of their high protein, ash, fat and mineral contents. (*Summary by S.S. de S. Trans. by T.B.*) D01 D02 D03 B00

0089-11818 THAILAND. DEPARTMENT OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. [Fertilizer experiments on cassava from 1964-1968]. *In* ——. Annual Report for 1968. Bangkok, 1969?. pp.140-141. Thai, Sum. Engl.

Cassava. Fertilizers. Tuber productivity. Climatic requirements. Manures. N. P. K. Field experiments. Growth. Thailand.

The effects of fertilizer on growth and yield of cassava were studied at 2 sites in Rayong and Pechaburi provinces. Treatments were as follows: 50-50-25, 50-50-50 N, P_2O_5, K_2O/ha, 3.8 t compost/ha, control. Fertilizer was applied to the 13 x 32 m plots at planting. Results of the 4-yr expt in Rayong and the 2-yr expt in Pechaburi were not consistent and could not be concluded. Nevertheless, the fertilizer treatments tended to produce more root yield, especially under favorable moisture conditions. The control plots, on the other hand, have lower yields in the successive crops. If the climatic conditions had been favorable, the control plot might have maintained the good root yields in the 2nd planting; but yields were still markedly lower than the fertilized plots. (*Summary by Kasetsart University*) D01

0090-3853 LORENZI, J.O. **Adubação e calagem da mandioca.** (*Fertilization and liming of cassava*). São Paulo, Brasil, Coordenadoria de Assistência Técnica Integral, 1977. 9p. Port.

Cassava. Minerals. N. P. K. Fertilizers. Production. Tuber productivity. Cultivars. Ca. Nutritional requirements. Brazil.

The requirements of cassava and its adaptation to different soil types are considered; tables give data on nutrient extraction by cassava as compared to other crops. The main results obtained by the Instituto Agronômico de Campinas are as follows: P and K should be placed alongside the cuttings at planting; N should be top dressed 30-60 days after sprouting. P increased root yield the most, K rarely affects it and N gives variable results. Based on chemical analysis of the soil, the root & tubers section of IAC make fertilizer recommendations. Liming in soils poor in Ca and Mg can increase yield due to the effect of pH as well as the strengthening of Ca and Mg. An alternative is crop rotation with well-fertilized grasses and unfertilized cassava. (*Summary by F.G. Trans. by T.B.*) D01

0091-11838 THAILAND. MINISTRY OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. [A study on nitrogen requirements of cassava]. *In* ——. Progress report for 1968. Bangkok, 1969?. pp.133-136. Thai., Sum. Engl.

Cassava. Nutritional requirements. N. Fertilizers. Tuber productivity. Field experiments. Thailand.

Four expt were conducted in 3 provinces (2 in Rayong, 1 in Cholburi and 1 in Pechaburi) to determine the optimum N rate for cassava, using a randomized complete block design with 4 replications. There were 5 fertilizer treatments: 0-0-0, 0-100-50, 50-100-50, 100-100-50 and 150-100-50 kg N, P_2O_5, K_2O/ha, each of which was applied in an 8 x 12 m planting area. At Cholburi, fertilizer treatments gave significantly higher yields than the control: 26.9, 27.5, 28.7 and 24.4 t/ha, respectively, for 50, 100, 150 and 0 kg N/ha. It is interesting to note that a significant response to N fertilization was observed only when soil OM content was $<1\%$. Different responses to N were noted at the remaining locations, where OM content was $>1\%$, with only slight increases in root yield with high N rates. (*Summary by Kasetsart University*) D01

0092-11809 SITHIBOOSAYA, C. *et al.* **[Determination of the best plant spacing and fertilizer rates for cassava].** *In* Thailand. Department of Agriculture. Field Crop Division. Report on soil-field crop fertilizer. Bangkok, 1975. pp.387-400. Thai., Sum. Engl.

Cassava. Field experiments. Planting. Spacing. Fertilizers. N. P. K. Productivity. Thailand.

Low-fertility soils at 5 locations in the E and NE were selected to evaluate 3 NPK fertilizer levels (0-0-0, 50-50-25 and 100-100-50 kg/ha) and 4 spacings (100 x 100, 100 x 75, 100 x 50 and 75 x 50 cm) in a 3 x 4 factorial expt using a randomized complete block design Plants were harvested at 12 mo. The greatest response of cassava to fertilizers was at the 100 x 100 and 100 x 75 cm spacings The interaction between fertilizer rates and spacing had no effect on yield. (*Summary by Kasetsart University*) D01 D02

0093-11804 RATANANUKUL, S. *et al.* **[The response of cassava to nitrogen and phosphorus fertilizers].** *In* Thailand Department of Agriculture. Field Crop Division. Report on soil-field crop fertilizer. Bangkok, 1976. Thai., Sum. Engl.

Cassava. Field experiments. N. P. Soil analysis. Tuber productivity. Thailand.

In a 5 x 4 factorial expt at 4 sites, a randomized complete block design with 3 replications was used to evaluate the effect of 5 N rates (0-50-100-150-200 kg/ha) and 4 P rates (0-50-100-150 kg P_2O_5) on cassava yield. Soils were analyzed for OM content, soil pH, P and K All plots received 50 kg K/ha before planting. At 50 kg N, there was a response, and yields increased as the N fertilizer applications increased. Highest yield was obtained at 150 kg N/ha. At > 150 kg N, yield decreased. The crop responded to P at 50 kg P_2O_5/ha; highest yields were obtained at 150 kg. Higher rates of P decreased yield. Applications of N and P at > 50 kg increased fresh wt of stems but not of roots. (*Summary by Kasetsart University*) D01

0094-11831 THAILAND. MINISTRY OF AGRICULTURE AGRICULTURAL RESEARCH DIVISION. **[Comparison of fertilizer application times for cassava].** *In* ——. Progress report for 1969. Bangkok, 1970?. Thai., Sum. Engl.

Cassava. Fertilizers. Nutritional requirements. Timing. Tuber productivity. Field experiments. Thailand.

An expt was conducted to determine suitable fertilizer application times for obtaining optimum root yield. The following 9 treatments were arranged in a randomized complete block design with 4 replications: broadcast at planting time; side-dressed at 1, 2, 3 or 4 mo; side-dressed at 1 and 3 mo in 2 equal applications; side-dressed at 1, 2 and 4 mo in 3 equal applications, side-dressed at 1, 3 and 6 mo in 3 equal applications; control. There were no marked differences among treatments Under exptl conditions single and split applications of fertilizer resulted in similar root yields (*Summary by Kasetsart University*) D01

0095-11780 SITHIBOOSAYA, C., CHOO-LAKSANA, P. and UTHAYOPAS, P. **[The response of cassava to NPK fertilizer].** *In* Thailand Department of Agriculture. Field Crop Division. Report on Soil-Field Crop Fertilizer. Bangkok, 1974. pp.185-191. Thai., Sum. Engl.

Cassava. Nutritional requirements. Fertilizers. N. P. K. Productivity. Soil analysis. Field experiments. Thailand.

The effect of 3 levels of NPK fertilizer on cassava yield was studied, using a central composite rotatable design in a factorial expt. Two sites in the E and NE were selected and the soils analyzed for OM content and chemical composition. No significant differences were found. There was no response to NPK at either site, probably because the soils were already very fertile. The yields in the control (no fertilizer) were 52.5 t/ha in the NE and 36.25 t in the E. (*Summary by Kasetsart University*) D01

0096-11795 CHEW, W.Y., RAMLI, K. and JOSEPH, K.T. **Copper deficiency of cassava (*Manihot esculenta* Crantz.) on Malaysian peat soil.** MARDI Research Bulletin 6(2) 208-213. 1978. Engl , Sum. Engl., Ind., 14 Refs., Illus

Cassava. Copper. Deficiencies. Leaves. Mineral content. Soil analysis. Tuber productivity. Malaysia.

Cassava grown on virgin peat soil in Malaysia often suffers from Cu deficiency, the symptoms of which are described. The deficiency is most likely the result of low Cu content in peat (6 ppm) and is corrected by the soil application of copper sulfate (2-10 kg/ha), increasing leaf Cu content from ca. 7 ppm (deficient) to ca. 14 ppm (normal). (*Author's summary*) D01

0097-11745 EDWARDS, D.G. and KANG, B.T. **Tolerance of cassava (*Manihot esculenta* Crantz) to high soil acidity.** Field Crops Research 1:337-346. 1978. Engl., Sum. Engl., 11 Refs , Illus.

Cassava. Soil requirements. pH. Ca. Fertilizers. Tuber productivity. Mineral content. Cassava African mosaic virus. Nigeria.

A pot expt was conducted in Nigeria to study tolerance of 2 cassava cv (Ojukaniye and Apuwuru) to a soil pH of $\geqslant$4.25 for 13 wk At moderate rates of lime (soil pH 4 25), max fresh root yields varied from 1.0 to 1.6 t/ha. In the absence of liming, yields were only 16 and 21% lower. (*Summary by Abstracts on Tropical Agriculture*) D01 E04

0098-11703 MOTA, F.S DA, ACOSTA, M.J.C. and BEIRSDORF, M.I.C. **Zoneamento agroclimático da cultura da mandioca no Brasil.** (*Agroclimatic zonation for cassava in Brazil*). Brasilia, Brasil, Instituto Nacional de Meteorologia. Série: Pesquisa Meteorológica no. 3 1978. 16p. Port., Sum. Port., Engl , 27 Refs , Illus.

Cassava. Climatic requirements. Temperature. Water requirements (plant). Planting. Timing. Rainfall data. Maps. Soil moisture. Brazil.

Based on a literature survey of climatic relationships of cassava in several regions of the world, the following agroclimatic indices for the zonation of this crop in Brazil were established: av annual temp (> 20°C), occurrence of a dry season (a monthly rainfall < 50 mm and soil water storage < 15 mm), av monthly water deficiency in the active growth period (< 100 mm), total water surplus in the active growth period (< 300 mm). All Brazilian states have regions apt for cassava; a map shows the inapt, marginal, tolerable and preferential regions. (*Extracted from author's summary*) D01

0099-11819 THAILAND. DEPARTMENT OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. **[Fertilizer experiments on cassava from 1963-67]**. *In* ____. Annual Report for 1967. Bangkok, 1968?. pp.137-139. Thai., Sum. Engl.

Cassava. Nutritional requirements. Fertilizers. N. P. K. Field experiments. Thailand.

The effects of the following fertilizer treatments on root yield in successive crops were studied: control, 50-50-25, 50-50-50, 75-75-119, 25-25-12.5 kg N, P_2O_5, K_2O/ha + 1.3 t compost/ha All fertilizers were applied to the 10 x 32 m plots at planting. Results of the 5-yr trials indicated good responses, as measured by root yields. Mean yield declined in the control plots as a result of continuous cropping, whereas yield was maintained at a fairly high level by the application of fertilizers. A rate of 50-50-25 NPK is considered suitable for cassava production The results of these expt.need to be confirmed. (*Summary by Kasetsart University*) D01

0100-11817 THAILAND. DEPARTMENT OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. **[Fertilizer experiments on cassava from 1963-1967]**. *In* ____. Annual Report for 1967 Bangkok 1968?. pp 271-273 Thai. Sum. Engl.

Cassava. Fertilizers. Field experiments. Soil fertility. Productivity. Manures. Thailand.

A field expt was conducted at Houypong Exptl Station, Rayong Province, to observe the effect of different fertilizer rates on root yield of successive cassava crops Treatments were as follows: control, 50-50-25, 50-50-50, 3.7 t compost/ha + 25-25-12.5 kg N, P_2O_5, K_2O/ha. All fertilizers were applied in the 10 x 32 m plots at planting. Weeding was done throughout the season and the crop harvested at 12 mo. There was no significant difference between the control and the fertilized plots the 1st yr, due to the high fertility of the soil. In the successive crops, however, the yield of the control plot decreased steadily, but the fertilized plots maintained their high production the following season. Av root yields during the 4 yr were 22 5 and 23.1-26.9 t/ha for the control and fertilized plots, respectively. An av of 25 t/ha for the 50-50-25 NPK treatment indicates that this rate is suitable for maintaining good soil fertility for long-term cassava planting. (*Summary by Kasetsart University*) D01

0101-11810 NILNONT, C. *et al.* **[Regional study of the response of cassava to various kinds of green manures]**. *In* Thailand, Department of Agriculture. Progress report on Scientific. Bangkok, 1970. pp.1108-1113. Thai., Sum. Engl.

Cassava. Green manures. Tuber productivity. Field experiments. Thailand.

A randomized complete block design with 4 replications was used to determine the effect of different green manures on cassava yield Plot size was 6 x 10 m Of the 7 treatments, 5 evaluated different legume manures and 2 chemical fertilizers The green manures were planted in the rows which were 50 cm apart. Each green manure treatment was fertilized with 50 and 25 kg/ha of P_2O_5 and K_2O, respectively; the plants were chopped down when there was 80% flowering and left for 3-4 wk The cassava was then planted at a 1 x 1 m spacing. Since it was the 1st yr of the expt, it was not possible to reach definite conclusions; nevertheless, the green manures were highly significant in increasing cassava yields. As compared to the control, cassava responded to green manure in all treatments, especially to cowpeas. Legumes were grown easily, with high fresh wt, and were easy to chop. It was also found that the green manure improved the physical properties of the soils, such as structure and drainage. (*Summary by Kasetsart University*) D01

0102-11815 SITHIBUS, C. *et al.* [Long-term fertilizer experiments for cassava]. *In* Thailand. Department of Agriculture. Field Crop Section Progress report in fertilizer experiment for cassava. Bangkok, 1976. Thai., Sum. Engl.

Cassava. Fertilizers. Soil impoverishment. N. Climatic requirements. Productivity. Fields experiments. P. K. Thailand.

Expt were conducted at 3 field crop exptl stations (Houypong in Rayong Province, Banmaisamrong in Nakornrachasima Province and in Korn Kean Province) to assess the exhausting of soil fertility under long-term cassava cropping and fertility improvement by fertilization Each trial had 8 treatments and 4 replications, as follows: control; 50-0-0; 50-50-0; 50-0-50; 50-50-50; 50-50-50 N, P_2O_5, K_2O + 1.35 t compost/ha; 50-50-50 kg N, P_2O_5, K_2O/ha + cassava stems and leaves; and cassava stems and leaves only. Preliminary observations (1975) showed no marked response to fertilizer treatments at Houypong, where the control plot produced 21.4 t/ha on these fertile soils. A similar trend was observed at Banmaisamrong, where the control plot yielded 20.2 t/ha, with no significant difference between it and the highest fertilizer treatment. Expt will continue for several seasons to observe changes in root production. Data from Korn Kean were unreliable because of unsuitable environmental conditions so other locations will be considered to replace it. (*Summary by Kasetsart University*) D01

0103-11837 THAILAND. MINISTERY OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. [A study on nitrogen requirements and nitrogen uptake of cassava]. *In*_____. Progress report for 1967. Bangkok, 1968?. pp.267-270. Thai., Sum. Engl.

Cassava. Nutritional requirements. Field experiments. N. P. K. Soil requirements. Tuber productivity. Soil fertility. Fertilizers. Harvesting. Timing. Thailand.

Expt were conducted in Rayong, Cholburi and Pechaburi to assess the N requirements of cassava in different soil types. The N content of the leaf, stem and root was also determined. There were 5 fertilizer treatments: control, 0-100-50, 50-100-50, 100-100-50 and 150-100-50 kg N, P_2O_5 and K_2O/ha. Each fertilizer treatment was applied to a planting area of 8 x 12 m There were no significant differences among N levels at any of the sites. At Rayong, where soil OM is considerably high (1.66%), the control plot produced 24.4 t fresh roots/ha. The available P and exchangeable K of this plot were also high. The fertilizer-treated plots of this location produced only 73-79% of max expected yield (where all fertilizer supplies were adequate). At Cholburi, where soil texture is very sandy, there was no marked difference among treatments. Av yield was low (6.25-12 5 t/ha) because of low soil moisture during the growing season. A similar trend was observed at Pechaburi, where the fertility level of the soil is high, the control plot producing as much as 39.4 t/ha At 150 kg N/ha, a yield of 53.13 t was obtained It was noted that higher fertility levels prolonged the harvesting period from 12 to 16 mo. (*Summary by Kasetsart University*) D01

0104-11800 SITHIBOOSAYA, C. *et al.* [Economic and agronomic evaluation of NPK fertilizers for cassava]. *In* Thailand. Department of Agriculture. Field Crop Division. Report of soil-field crop fertilizer. Bangkok, 1974. pp.192-196. Thai., Sum. Engl.

Cassava. N. P. K. Soil fertility. Productivity. Field experiments. Thailand.

A central composite rotatable design with 20 treatments was used at 2 sites. The NPK rates studied were 0-40.56-100-159.44-200 kg ammonium sulfate and double superphosphate/ha and 0-81.13-200-318.88-400 kg KCl/ha (16-16-32 fertilizer). Plot size for each treatment was 8 x 10 m,

and the spacing between plants was 1 x 1 m. The harvesting area of each plot was 48 m². Cassava yield did not increase after the fertilizers were applied, nor was there a significant response due to soil fertility variation at either site. This may be due to the fact that the soils had been previously fertilized (residual effect) or because there was only one replication, resulting in nonsignificant yield differences (*Summary by Kasetsart University*) D01

0105-11728 OBIGBESAN, G.O. **Nutritional problems in root crop production in a tropical country—Nigeria.** Beitrage zur Tropischen Landwirtschaft und Veterinarmedizin 16(3):289-297. 1978. Engl., Sum Engl., Germ., Rus., Fr., Span., 17 Refs., Illus.

Cassava. Nutritional requirements. Soil analysis. N. P. K. Leaves. Mineral content. Nutrient uptake. Tuber productivity. Dry matter. Fertilizers. Nigeria.

Nutritional problems in the production of root and tuber crops in a tropical environment (Nigeria) are identified and suggestions for research, presented. The need for soil tests as prerequisites for fertilizer recommendations is emphasized. Problems of timing the fertilizer application, the type of nutrient carrier and nutrient removal at different growth stages are discussed. Research data demonstrate that not only crop species but also cv. within the same species differ in nutrient requirements. Interrelations between crop nutrition and resistance to diseases are discussed and suggestions made for the establishment of a soil test calibration program to identify the nutrient status in each agro-ecological system. (*Author's summary*) D01

0106-11808 SITHIBOOSAYA, C., UTHAYOPAS, P. and NAKVIROJANA, C. **[Determination of the best plant spacing and fertilizer rates for cassava].** In Thailand. Department of Agriculture. Field Crop Division. Report on soil-field crop fertilizer. Bangkok, 1974. pp.167-171. Thai., Sum. Engl.

Cassava. Fertilizers. N. P. K. Planting. Spacing. Soil analysis. Field experiments. Thailand.

Two NPK fertilizer rates (50-50-25 and 100-100-50 kg/ha) and 4 spacings (100 x 100, 80 x 100, 50 x 100 and 50 x 80 cm) were compared in a factorial expt using a randomized complete block design. Plot size was 8 x 12 m Plants were harvested at 12 mo, and the harvesting area was 60 m². Soils were analyzed for pH, OM content, P, K and texture It was concluded that the different spacings had no effect on yield A fertilizer formula of 16-16-8 at 625 kg/ha is recommended for soils low in P and 8-8-4 at 625 kg/ha for soils high in P (> 14 ppm). (*Summary by Kasetsart University*) D01 D02

0107-11812 SITHIBOOSAYA, C., UTHAYOPAS, P., and NAKVIROJANA, C. **[A preliminary study of the effect of liming on the yields of cassava].** *In* Thailand. Department of Agriculture. Field Crop Division. Report on soil-field crop fertilizer. Bangkok, 1974. pp.181-184. Thai., Sum Engl.

Cassava. Tuber productivity. Nutritional requirements. Field experiments. Agricultural lime. Thailand.

Three locations with acid soils were selected in these factorial expt in which 2 lime levels (0 and 1875 kg/ha) and 4 NPK levels (0-0-0, 50-0-0, 50-50-0, 50-50-50 kg/ha) were evaluated using a randomized complete block design. Subplot size was 8 x 12 m. The cassava was harvested for fresh wt at 12 mo; the harvesting area in each subplot was 80 m². Liming did not increase yield greatly. Yields were 24,069 and 22,950 kg/ha for the liming and nonliming treatments,

respectively, which indicated that yield increase by liming did not cover the expenses incurred. (*Summary by Kasetsart University*) D01

0108-10941 ALEMAN, J.M. **Evaluación de la respuesta del cultivo de la yuca (*Manihot esculenta* Crantz) a la aplicación de tres niveles de fertilizantes.** (*Evaluation of the response of cassava to three levels of fertilizer*). *In* Instituto Nicaraguense de Tecnología Agropecuaria. Estación Experimental Regional El Recreo. Informe de las actividades realizadas en el proyecto de raíces y tubérculos tropicales 1977/78. Managua, Nicaragua, 1978. pp.8-19. Span., Sum Span., 11 Refs.

Cassava. Field experiments. Cultivation. N. P. K. Urea. Tuber productivity. Fertilizers. Statistical analysis. Nicaragua.

Three levels of NPK (40-60-40, 80-120-80, 120-180-120 kg/ha) were studied in a randomized block design with 4 replications at the exptl station El Recreo in the state of Zelaya (Nicaragua). No significant difference was found. An increase of 969 kg/ha was obtained in the 80-120-80 kg NPK treatment. Heavy floods from June-Sept limited the efficiency of the trial due to leaching of fertilizers. The C.V. was 30.5%, indicating the low level of reliability of the results. (*Author's summary. Trans. by T.B.*) D01

0109-11839 THAILAND. MINISTERY OF AGRICULTURE. AGRICULTURAL CHEMISTRY SECTION. [A study on nitrogen requirements and nitrogen uptake of cassava]. *In*_____. Progress report for 1967. Bangkok, 1968?. pp.187-191. Thai, Sum Engl.

Cassava. Nutritional requirements. N. Nutrient uptake. Field experiments. Productivity. Fertilizers. Thailand.

Five expt were conducted in 3 provinces (1 in Rayong, 2 in Cholburi and 2 in Korat) to determine the N requirements of cassava planted in different soil types. There were 4 N levels (0-50-100-150 kg/ha) in combination with 100 kg P_2O_5 and 50 kg K_2O/ha. The 5 fertilizer treatments (0-0-0, 0-100-50, 50-100-50, 100-100-50 and 150-100-50 kg N, P_2O_5 and K_2O/ha) were arranged in a randomized complete block design with 4 replications. The fertilizers were split into 3 equal parts and applied in bands around the plant 7 days after sprouting and at 2 and 3 mo after planting The fertilizer treatments yielded better than the control; 100 kg N/ha in combination with P and K resulted in the highest root production. In the absence of P and K, N application gave very poor yields. (*Summary by Kasetsart University*) D01

0110-10452 COCK, J.H and HOWELER, R H. **The ability of cassava to grow on poor soils.** *In* Jung, G.A., ed. Crop tolerance to suboptimal land conditions. Madison, Wisconsin, American Society of Agronomy. ASA Special Publication no. 32. 1978. pp.145-154. Engl., 18 Refs, Illus

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

On the basis of a literature review and exptl work at CIAT (Carimagua), the ability of cassava to grow at low nutritional levels, tolerance of low pH and associated toxicity problems, nutrient requirements for max yield and water requirements are studied. It is concluded that cassava (1) is tolerant of low soil pH and high levels of Al and Mn; (2) tolerates low levels of soil Ca, N and K

better than many other species; (3) has high P requirements for max growth but can use P sources that are relatively unavailable; (4) is highly tolerant of uncertain rainfall patterns; and (5) is an extremely efficient carbohydrate source on low fertility, acid soils with relatively low levels of fertilizer applications. Yields of 36 t/ha/yr have been obtained under conditions that are suboptimal for many other crops. (*Summary by I.B.-Trans. by T.B.*) D01 D03

0111-11805 CHEO-SAMUT, S. *et al.* [Cumulative effects of fertilizers on cassava, *Manihot esculenta* Crantz production]. *In* Northeast Agriculture Center. Thailand. Annual Report for 1974 Bangkok, 1975?. pp.181-184. Thai., Sum. Engl.

Cassava. Fertilizers. Nutritional requirements. Tuber productivity. Dry matter. Plant height. N.P.K. Field experiments. Thailand.

A fertilizer expt was carried out at the NE Agriculture Center on a Korat soil series (pH 6.0, 0.47% OM content, 37 ppm P, 61 ppm K), using a randomized complete block design with 10 treatments and 3 replications Plot size was 4 x 50 m and plant spacing 1 x 1 m. Fertilizer treatments were as follows. 0-0-0, 37.5-37.5-37.5; 37 5-37.5-75, 37.5-75-37.5; 37.5-75-75; 75-37 5-37.5, 75-37.5-75; 75-75-37 5, 75-75-75 and 75-112 5-75 kg N, P_2O_5, K_2O/ha. It was concluded that fresh yield of the control was rather high for the 1st yr. Fertilizer applications did not increase fresh or dry wt of the roots A high N rate (75 kg) tended to increase the wt of stems and leaves, total dry wt, top/root ratio and plant height At a low N rate (37.5 kg), the top/root ratio and plant height did not increase, but stem and leaf wt and total dry wt tended to be higher than in the nonfertilized plot (*Summary by Kasetsart University*) D01 D03

0112-11816 THAILAND. DEPARTMENT OF AGRICULTURE AGRICULTURAL CHEMISTRY SECTION. [Fertilizer experiments on cassava from 1968-1969]. *In* ——. Annual Report for 1969. Bangkok, 1970?. pp.200-205. Thai., Sum. Engl

Cassava. Fertilizers. N. P. K. Manures. Soil fertility. Field experiments. Productivity. Thailand.

This study was aimed at obtaining more information on the maintenance of soil productivity by long-term fertilization with 50-50-25 kg N, P_2O_5, K_2O/ha. This 5-yr project consisted of 5 treatments with a planting area of 10 x 32 m/treatment. After harvesting of the previous crop, the land was cultivated and fertilized for the successive crop. The overall project was divided into 2 phases: the 1st from 1963-67 and the 2nd, started in 1968, is expected to terminate in 1972. There were 2 sets of expt in the 1st phase. The 1st set in Rayong Province consisted of the following treatments: the control; 50-50-25; 50-50-50; 75-75-119; 2.5 t compost/ha + 25-25-12.5 kg N, P_2O_5, K_2O/ha; the 2nd set in Rayong and Pechaburi provinces were as follows: control; 50-50-25; 50-50-50; 3.8 t compost/ha + 31.3-18.8-6.3; 2.5 t compost/ha + 25-25-12.5 kg N, P_2O_5, K_2O/ha. Crop yield was maintained at a fairly high level by the fertilizer applications. A rate of 50-50-25 kg N, P_2O_5, K_2O/ha was suitable at both sites. Furthermore, the combination of compost and chemical fertilizers also tended to increase the yield of successive crops. (*Summary by Kasetsart University*) D01

See also 0022 0133 0165 0209 0422 0466

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

0113-4162 GODFREY-SAM-AGGREY, W. **Effects of plant population on sole-crop cassava in Sierra Leone.** Experimental Agriculture 14:239-244. 1978. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Cuttings. Spacing. Planting. Tuber development. Field experiments. Dry matter. Tuber productivity. Sierra Leone.

Effects of plant population on mean yield and yield components of 2-yr sole cassava crops were studied in 2 expt on Njala upland soils of Sierra Leone. Incresing plant populations of the var. Cocoa (sympodial-type branching) over 7000/ha decreased all parameters studied except top/root wt ratio, which increased. These effects were attributed to competition for environmental resources since area of land/plant unit decreased as plant population increased. The relations between plant population and yield of fresh root and cortex DM were asymptotic, indicating that the respective yields were products of the vegetative phase of cropping. (*Author's summary*) D02 D03 C01

0114-4159 GODFREY-SAM-AGGREY, W. **Effects of delayed hand weeding on sole-crop cassava in Sierra Leone.** Experimental Agriculture 14:245-252. 1978. Engl , Sum. Engl., 7 Refs., Illus.

Cassava. Weeding. Timing. Tuber productivity. Roots. Canopy. Field experiments. Sierra Leone.

The effects of delayed manual weed control at 30-, 45-, 60- and 90-day intervals and no weeding on sole-crop cassava were studied in 2 expt on the upland soils of Sierra Leone. Timing and frequency of weeding were important in influencing root no. and yield, and delayed weed control depressed both attributes. The critical period of competition was in the 45-day weeding interval, with 6 weedings in a 14-mo growing period. *Rottboelha exaltata* was the predominant species among the permanent grasses on the no-weeding plots. *(Author's summary)* D02 D03

0115-9976 LOZANO, J.C. *et al.* **Problemas relacionados com a "semente" da mandioca (*Manihot esculenta* Crantz).** (*Problems related to cassava "seed"*). Fitopatologia Brasileira 3(1):1-11. 1978. Port., Sum. Port., Span., Engl., 29 Refs.

Cassava. Cuttings. Storage. Plant injuries. Viroses. Mycoses. Injurious insects. Mycoplasmoses. Injurious mites. Colombia.

The factors contributing to making cassava "seed" (stem cuttings) suitable for planting are related to its quality, phytosanitary condition and the storage period. Quality is a function of maturity, the no. of nodes/cutting, stem diameter and the extent of mechanical damage incurred during harvesting, transportation and planting. The phytosanitary condition depends on pathological and entomological aspects such as attack by systemic pathogens or soil-borne organisms, infestation by mites and/or insects on the surface of the cutting, as well as insects inside the stem and/or in the soil. Storage usually reduces germination due to dehydration or

attack by pathogens and pests. To prevent these problems, good-quality, sound stem cuttings should be selected and treated with protectant and eradicant fungicides, insecticides and/or acaricides, which makes it possible to store them for > 30 days. (*Author's summary*) D02 E01

0116-11202 WHOLEY, D.W. and BOOTH, R.H. **Influence of variety and planting density on starch accumulation in cassava roots.** Journal of the Science of Food and Agriculture 30(2):165-170. 1979. Engl., Sum. Engl., 14 Refs., Illus.

Cassava. Spacing. Tuber productivity. Starch productivity. Plant development. Cultivars. Dry matter. Field experiments. Timing. Rainfall data.

Root starch content was consistently higher in var. Black Twig than in C5 and was always higher at 1 x 1 m than at 3 x 3 m plant spacing in both var. throughout the sampling period (36-68 wk of age). C5 produced greater fresh root yields than Black Twig at both densities. Starch yields/ha were greater from C5 in the 9th mo after planting, after which time they were similar for both var. No marked peak or consistent decline in root starch content associated with increasing age was observed. It is suggested that variation in root starch content could be influenced by climatic factors (particularly rainfall) and soil moisture. (*Author's summary*) D02 C00

0117-4482 KOCH, L. and MEER, M. VAN DER **Proeven met selective uitdunning bij cassave.** (*Experiments evaluating selective thinning of cassava plants*). Buitenzorg, Java. Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw no. 49. 1926. 13p. Dutch, Sum. Dutch, Illus

Cassava. Cuttings. Planting. Field experiments. Spacing. Tuber productivity. Java.

The effect of selective thinning on root yield was studied in 11 expt in which twice the normal amount of cuttings were planted and several months afterwards, only the better of the 2 plants maintained. Although in 6 of the 11 expt root yield was higher in plots where selective thinning was done, the av effect was not significant. (*Summary by J.V.*) D02 D03

0118-4561 KOCH, L. **Uitkomsten van een snoeiproef en plantverbandsproef met cassave.** (*Results of a pruning and plant density trial with cassava*) Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte berichten uitgaande van den Landbouw-voorlichtingsdiens. Selectie-en Zaadtuin te Buitenzorg no. 28. 1920. 5p. Dutch.

Cassava. Cuttings. Planting. Spacing. Pruning. Tuber productivity. Field experiments. Java.

The effect on root yield of pruning to one shoot/planted cutting at 2 mo after planting was compared with untreated control plants Pruning led to a nonsignificant reduction in yield. In a trial with 3 planting densities (3 x 3 ft, 3 x 2.5 ft and 3 x 2 ft), root yield was not significantly different. (*Summary by J.V.*) D02 D03

0119-4487 KOCH, L. and MEER, M VAN DER **Uitkomsten van eenige steklengteproeven bij cassave.** (*Results of experiments with cassava cuttings of different lengths*). Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw no. 47. 1926. 11p. Dutch.

Cassava. Cuttings. Selection. Tuber productivity. Propagation. Planting. Field experiments. Java.

The effect of cutting length (15-30 cm) on root yield was studied in 5 expt Results were not conclusive. Until the best length for optimal root yield can be determined, the use of 25-cm cuttings is recommended. (*Summary by J.V.*) D02 D03

0120-4490 KOCH, L. and MEER, M. VAN DER **Uitkomsten van vier Plantverbandsproeven bij Cassave.** (*Results of four plant density experiments with cassava*) Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw no. 54. 1926. 3p. Dutch.

Cassava. Cuttings. Spacing. Tuber productivity. Field experiments. Java.

Varying planting distances from 3 x 3.5 ft to 3 x 2.5 ft did not lead to significant yield differences in 4 expt with cassava (*Summary by J.V.*) D02 D03

0121-4552 MEER, M. VAN DER **Bydrage tot de ontleding van het inlandsch landbouwbedrijf; de cultuur van cassave.** (*Contribution to the analysis of a local farm; the cultivation of cassava*). Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte berichten uitgaande van het Algemeen Proefstation voor den Landbouw no 48. 1926. 6p. Dutch

Cassava. Land preparation. Planting. Harvesting. Labour. Costs. Weeding. Tuber productivity. Cultivars. Java.

Data are given on labor use by activity in cassava production on an exptl farm of the General Exptl Station for Agriculture in Indonesia. Almost 3500 man-h/ha are required, of which ca. 45% is for weeding. (*Summary by J.V.*) D02 J00

0122-11204 ANDERS, M.M. **Root crop research in the Kingdom of Tonga.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. pp.200-202. Engl.

Cassava. Field experiments. Planting. Timing. Tuber productivity. Cultivars. Starch crops. Tonga.

Tonga is a chain of 150 islands with a population of 100,000 inhabitants. The principal use of root crops is for human consumption with expanding interest in the use of cassava as a livestock feed. The effect of planting time on yield of various root crops, including sweet potatoes, yams (*Dioscorea* spp.), taro (*Colocasia esculenta*) and cassava is studied (*Summary by Abstracts on Tropical Agriculture*) D02 D03

0123-3494 EMPRESA BRASILEIRA DE PESQUISA AGROPECUARIA. **Sistemas de produção para mandioca.** (*Cassava production systems*). São João de Barra, Rio de Janeiro, Brasil. Circular no. 100. 1976. 22p. Port.

Cassava. Land preparation. Cuttings. Planting. Fertilizers. Timing. Spacing. Harvesting. Labour. Insect control. Disease control. Brazil.

Two production systems are presented for large and small cassava growers in the municipalities of

São João de Barra and Campos, Rio de Janeiro. Data are given on area planted to cassava, av yield (13 2 t/ha), topography, soils, climate, cultural practices and marketing. Technical recommendations include soil preparation, selection of cuttings, planting, fertilization, planting dates and density according to the var used, cultural and phytosanitary practices, inputs, harvesting and marketing. (*Summary by T.B.*) D02

0124-4799 ONOCHIE, B.E. **Weed control in root and tuber crops.** *In* Ene, L.S O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.12-24. Engl , 17 Refs.

Cassava. Weeds. Weeding. Herbicides. Yams. Cocoyams. Nigeria.

The importance of understanding competition between weeds and yams, cassava and cocoyams lies in the fact that these crops have a slow rate of initial growth and are therefore poor competitors. Common weed species in cassava are listed. In Oyo State, *Imperata cylindrica. Cynodon plectostachyon* and *Portulaca oleracea* are more competitive in cassava than *Amaranthus spinosus* or *Ageratum conyzoides*. The critical period of competition is during early canopy formation and tuberization (3rd mo after planting). The av Nigerian farmer spends 32.2 and 53.8% of his time weeding cassava on farms with unimproved and improved management practices, respectively. Promising results obtained with different herbicides are given in table form; special recommendations are given when cassava is intercropped with maize. (*Summary by T.B.*) D02

0125-4874 EZEILO, W.N.O. **Extension problems in seed multiplication distribution and adoption of new technologies.** *In* Ene, L.S O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st , Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.122-133. Engl., 16 Refs.

Cassava. Cassava programs. Propagation. Propagation materials. Cuttings. Socio-economic aspects. Agricultural extension. Nigeria.

The Nigerian extension program is mainly designed for small farmers (< 4 ha) who represent > 95% of the farmers, cultivating > 80% of the total area dedicated to agriculture. Among the most important problems are the multiplication, distribution and adoption of improved, high-yielding var. With regard to cassava, a rapid multiplication technique using 2-node cuttings is discussed. Under the National Accelerated Food Production Project, new var. are tested in minikit trials on farmers' field, thus allowing them to benefit from new var. 3-4 yr sooner than conventional methods Because of budget restrictions, multiplication of vegetative material should be done by private commercial enterprises operating under a certification system of the National Seed Service. Distribution problems include the bulkiness of the cuttings and their storage Problems in the adoption of economically viable improved technology, as well as in the extension service, are discussed. Production-limiting factors identified in a 1975 benchmark survey are given in a table (*Summary by T.B.*) D02 J00

0126-4875 ODIGBOH, E.U **Problems and progress in field mechanization of Nigerian root and tuber crops.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.113-121. Engl., Sum. Engl., 9 Refs.

Cassava. Cassava programs. Mechanization. Planting. Harvesting. Roots. Plant development.

Cultivars. Yams. Cocoyams. Nigeria.

The major food crops in Nigeria are yams, cassava (gari) and cocoyams There is a growing concern about the future of these staples, which are becoming very expensive and may disappear from the market unless planting and harvesting operations can be mechanized. The probabilities of mechanization in the near future are slight. Development of a single-row harvester and a planter at the Agricultural Engineering Dept of the U of Nigeria is discussed Tables give data on variations in root wt, length, penetration and horizontal extension for individual roots and for the whole plant (*Summary by T.B*)D02

0127-9808 MENEZES, D.M. DE **Rendimento da mandioca e do feijão em função de época do plantio.** (*Cassava and bean yields in relation to planting date*). Rio de Janeiro, Brasil. Centro Nacional de Ensino e Pesquisas Agronômicas. Instituto de Ecologia e Experimentação Agrícolas. Comunicado Técnico no. 5. 1958 18p. Port., Sum. Port, 6 Refs., Illus.

Cassava. Planting. Timing. Tuber productivity. Field experiments. Climatic requirements. Beans. Brazil.

On the basis of 5 yr (1952-56) of trials with cassava var Rosa in the state of Rio de Janeiro, Brazil, the best planting dates were determined for obtaining optimum yields. A latin square design (6 x 6) was used with 7.2 x 6 m plots of 5 rows and 9 plants/row; these plots were subdivided into 3 for harvesting at 9, 11 and 13 mo. Best yield was obtained at 13 mo when planting was done from Sept 15-Nov. 15 The correlation between planting and harvest dates was highly significant. It was determined that cassava requires more moisture 4-6 mo after planting. Av temp can be low (22° C) during the 1st mo but should reach 26-27° when plants are 5-6 mo old. (*Summary by J.S. Trans. by T.B.*) D02 D03

0128-11005 HENAIN, A.E and CENOZ, H.M. **Influencia del tamaño de la estaca y la posición de plantación en el surco sobre el rendimiento de raíces de mandioca** (*Manihot esculenta*, Crantz). (*Influence of cutting size and planting position on cassava root yield*). Corrientes, Argentina. Universidad Nacional del Nordeste. Facultad de Agronomía y Veterinaria. Departamento de Producción Vegetal no. 7. 1969. 13p. Span., 9 Refs.

Cassava. Cuttings. Planting. Tuber productivity. Field experiments. Experiment design. Harvesting, Statistical analysis. Argentina.

From 1964-69 trials were conducted at the U. Nacional del Nordeste in Argentina to determine the effect of cutting size and planting position on yield of cassava clone Catigua Guazu A randomized block design with 4 replications was used to study the following variables: cuttings of 5, 8, 12, 15, 20 and 30 cm planted horizontally at a depth of 10 cm; 8-cm cuttings planted at an angle of 45 and 60°, leaving 3 buds above the soil surface; and 15- and 20-cm cuttings planted at an angle of 45 and 60°, leaving 3/4 of the cutting beneath the soil surface. Best total and commercial root yields were obtained with long cuttings (>15 cm) planted at an angle (45-60°) since there was greater sprouting and plant survival (*Summary by F.G. Trans. by T.B.*) D02 D03

0129-10921 WHOLEY, D W **Changes during storage of cassava planting material and their effects on regeneration.** Tropical Science 19(4) 205-216. 1977. Engl., Sum. Engl, Fr., Span., 8 Refs, Illus.

Cassava. Storage. Cuttings. Planting. Water content. Germination. Stems. Colombia

Storage of cassava planting material is practiced in many parts of the world, especially in areas with periods of drought and/or low temp. Two expt are reported, the results of which indicate that losses in stem fresh wt, including moisture and soluble carbohydrates, result in reduced germination and vigor of cuttings Methods whereby the stems may be preserved are suggested, and special "seed" crops are proposed. (*Author's summary*) D02 C01

0130-10057 MOHAN KUMAR, C R. and MANDAL, R.C. **Effect of topping and defoliation on tapioca (H-226).** Journal of Root Crops 1:86. 1975 Engl.

Cassava. Pruning. Defoliation. Tuber productivity. Timing. Developmental stages. Field experiments. India.

A randomized block design with 4 replications was used to study the effect of topping or defoliation on cassava yield at 3 different stages of growth (2, 4 and 6 mo after planting). Mean yield data for the 2 yr are presented in table form. Both topping and defoliation were harmful to the plant, especially at the initial stage of growth. (*Summary by T.B.*) D02 D03

0131-10050 NINAN, C.A. *et al.* **Effect of planting season on yield in cassava.** Tropical Root and Tuber Crops Newsletter 10:6-7. 1977. Engl.

Cassava. Planting. Timing. Tuber productivity. Cultivars. Cuttings. Climatic requirements. India.

Data are given in table form on root yield of 3 cassava cv. planted in the different months of the yr and harvested at 8 mo. In Kerala cassava can be grown year round, but max yields were obtained with the April planting; the 2nd best season was Sept. (*Summary by T.B.*) D02 D03

0132-4126 VALLES P , C.R. **Período crítico de competencia de malezas en yuca (*Manihot esculenta* Crantz) en Tarapoto.** (*Critical period of weed competition in cassava grown in Tarapoto*). Tarapoto, Perú Centro Regional de Investigación Agropecuaria del Oriente. Avances en Investigación 1(1).10-14. 1977. Span., 3 Refs.

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

An experiment was conducted in Tarapoto (Peru) to determine the best period for weeding and the period of critical competition for cassava. The wide-branching var. Auquina Amarilla was planted at a distance of 1 x 1 m in a randomized block design with 12 treatments (6 with and 6 without weeds for periods of 15 days to 11 mo) and 4 replications. The most common weeds were *Malachra aloetifolia, Leptochloa filiformis, Cassia occidentalis, Momordica charantia, Physales angulata, Portulaca oleracea* and *Sida rhombifolia.* Highest yields were obtained when cassava was kept completely free of weeds; the period of critical competition was 45-60 days after planting Hand weeding should be done twice: once at 30-40 days and then at 50-60 days. If herbicides are used, the effect should last for the 1st 60 days. The experiment should be repeated with the weed *Rottboellia exaltata,* which is spreading rapidly in the area (*Summary by T.B.*) D02

0133-10064 HARRIS, N.V. **The potential of cassava in coastal Queensland: some observations at the Yandaran plantation.** *In* Conference of Alcohol Fuels, Sydney, Australia, 1978. Proceedings. Sydney, New South Wales Group, Institution of Chemical Engineers, 1978. 4p. Engl., Sum. Engl., 9 Refs.

Cassava. Temperature. Photoperiod. Planting. Harvesting. Weeds. Agricultural equipment. Mechanization. Herbicides. *Phytophthora. Cercospora henningsii.* **Growth. Productivity. Spacing. Australia.**

Yields of up to 61.9 t/ha have been obtained after 450 days under exptl conditions at Yandaran, coastal Queensland. Environmental factors may be limiting growth and development, and it is suggested that in more southerly regions growing periods of up to 24 mo may be needed to maximize yields. Weeds, pests and diseases have been noted; and like any other crop, cassava requires the adoption of sound cultural practices and careful cv. selection to attain satisfactory yields Mechanized planting, with modified sugar cane planters and a cassava harvester, is reported. (*Summary by ICE*) D02 D01

0134-9941 KAMALAM, P **Rapid propagation of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.15-16. Engl., Illus.

Cassava. Propagation. Cuttings. Planting. Field experiments.

A description is given of a rapid propagation technique developed at CTCRI, in which 1/2 node cuttings are sprouted in a mist chamber. In 1 yr 647 plants and 3235 20-cm cuttings are produced. Further increase in this rate is being studied using 1/4 of a node with a portion of bud A simple, less-expensive technique for distributing planting material is the planting of 2-node cuttings directly in the field (45 cm apart) at the beginning of the rainy season. (*Summary by T.B.*) D02

0135-9926 COCK, J.H., CASTRO M., A. and TORO, J.C. **Agronomic implications of mechanical harvesting.** *In* Weber, E.J., Cock., J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978. pp.60-65. Engl., Sum. Engl , 15 Refs., Illus.

Cassava. Harvesting. Cuttings. Planting. Cultivars. Starch content. Timing. Plant development. Rooting. Mechanization.

Mechanical harvesting is basic if cassava production is to be increased on a large scale. Problems involved in the 3 steps of the harvesting operation are discussed. (1) Cutting the tops. Var. with single, upright stems or late-branching habits are best; the ideal type would also have a root/shoot ratio of 3:2. To prevent disease and pest problems as well as soil depletion, top debris should be finely chopped and left in the field. (2) Removal of roots from soil. Uniform root size and distribution are desirable. Planting cuttings with a straight cut in an inclined or vertical position gives good results. Increasing distances between rows from 1 to 1.6 m to accomodate the mechanical harvesters also appears feasible. (3) Separating roots from stem for packing. (4) Storing Removal of the green parts of the plant 3 wk before harvest, together with a postharvest fungicidal treatment, can improve shelf life of even severely damaged roots. (*Summary by T.B.*) D02 C01

'0136-9925 LEIHNER, D. **Follow-up evaluation of two harvesting machines.** *In* Weber, E.J., Cock, J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978. pp.58-59. Engl., Sum. Engl., 1 Ref., Illus.

Cassava. Harvesting. Mechanization. Agricultural equipment. Cultivars. Field experiments. Productivity. Colombia.

Following the workshop, CIAT personnel evaluated further the Richter harvester and the CIAT harvesting aid to determine their performances with different cassava var. Flat plots of M Mex 11, CMC 84 and M Col 22 — classified as difficult, intermediate and easy for manual harvesting — were harvested using the machines and by hand for comparison Percentages of broken, cut and skinned roots were calculated from samples of the harvested crops. The roots that were not lifted during the harvest were dug up later and the total amount of leavings calculated on a t/ha basis Results indicated that both mechanical methods were superior to manual harvesting of the difficult-to-harvest var. in reducing leavings; however, crop losses in the intermediate- and easy-to-harvest var. were fewer with manual harvesting. In general differences in performance of the 2 mechanical harvest systems were small; and both, though they damaged roots slightly more than the manual method, cut down the time and effort involved. (*Summary by IDRC*) D02

0137-9924 KEMP, D.C **Harvesting: a field demonstration and evaluation of two machines.** *In* Weber, E J , Cock, J H. and Chouinard, A , eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada International Development Research Centre. IDRC-114e. 1978 pp.53-57. Engl., Sum Engl., 1 Ref., Illus

Cassava. Harvesting. Mechanization. Field experiments. Agricultural equipment. Colombia.

A field evaluation was made of 2 mechanical harvesters — the Richter harvester and the CIAT harvesting aid — on 12 small plots of the difficult-to-harvest cassava var. Chiroza Gallinaza, planted in 3 cultivation systems (ridge, flat, bed) at 4 densities (5-20,000 plants/ha). Sample strips of roots lifted by each machine were trimmed and counts made of total roots broken, cut and skinned; roots remaining in the soil from 5 plants/treatment were dug out by hand and counted. Results are summarized in table form. Both harvesters were capable of working efficiently under test conditions More research should be done to study other variables such as forward speed and crop variety. (*Summary by T.B*) D02

0138-4273 ODIGBOH, E.U. **A two-row automatic cassava cuttings planter: development, design and prototype construction.** Journal of Agricultural Engineering Research 23:109-116. 1978. Engl., Sum. Engl., 6 Refs., Illus

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

The manual planting of cassava cuttings is an arduous operation that constitutes one of the major factors limiting large-scale production in Nigeria A detailed description is given of a fully automatic 2-row planter that plants 25-cm cuttings with diameters between 2-5 cm at a depth of 17 cm on small ridges at a 0-80° adjustable angle. Plant spacings can be adjusted to 90 cm between and 89 cm within rows. The planter is tractor drawn at speeds up to 10 km/h. (*Summary by T.B*) D02

0139-9888 WHOLEY, D.W. **Rapid propagation of cassava (*Manihot esculenta* Crantz).** Ph.D. Thesis. St. Augustine, Trinidad, University of the West Indies, 1974. 441p. Engl., Sum. Engl., 92 Refs , Illus.

Cassava. Cuttings. Shoots. Propagation. Field experiments. Spacing. Planting. Roots. N. P. K. Fertilizers. Germination. Climatic requirements. Rooting. Production. Plant-growth substances. Laboratory experiments. Timing. Composition. Colombia.

Cassava plants grown at 10,000 plants/ha yield approx 45 stem cuttings (15 cm long) after 1 yr; therefore, the propagation of new var. is slow. Expt were conducted to identify new methods for the rapid propagation of cassava under field conditions. Softwood stem cuttings do not establish under field conditions; however, a 6-fold increase in the commercial multiplication rate can be achieved by planting short, 2-node hardwood stem cuttings at low densities to promote the production of more cuttings/plant. A series of expt under mist showed that shoots develop before roots from hardwood stem cuttings and that the time to appearance of shoots and roots is influenced by the temp of the rooting medium Planting position has no effect on shoot dry wt but has a great effect on the position from which the stems develop. When cuttings were inverted, roots were produced from the base of the developing shoots to compensate for reduced nodal and basal roots. Two-node hardwood stem cuttings planted in a propagation frame can be used to produce 8-cm shoots that root after 3 wk in a similar frame. Regrowth of shoots develops from buds in the nodes of scale leaves at the base of the 1st formed shoot Shoots continue to develop until soluble-carbohydrate reserves in the cutting are exhausted. The application of NPK fertilizers to the rooting medium increases the no. of shoots produced. This method makes it possible to multiply cassava 24 times more rapidly than commercial methods. (*Author's summary*) D02

0140-9939 NAIR, G.M. **Improved cultural practices of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds Cassava production technology. Trivandrum, India. Central Tuber Crops Research Institute, 1978. pp.21-24 Engl , Illus.

Cassava. Planting. Land preparation. Spacing. Cuttings. Harvesting. India.

Cultural practices are given for growing cassava in Kerala and parts of Tamil Nadu (India). Aspects dealt with include planting dates, land preparation, spacing and plant populations, selection of planting material and preparation of cuttings, no of shoots/plant, hilling the plants and harvest times. (*Summary by T.B.*) D02

0141-11840 THIRAPORN, C. **[Study on planting time for cassava].** *In* Thailand. Department of Agriculture. Field Crop Division. Annual report for 1972. Bangkok, 1973?. pp.227-230. Thai., Sum. Engl.

Cassava. Field experiments. Planting. Timing. Productivity. Climatic requirements. Thailand.

An expt was conducted at the Neon Soong Field Crop Expt Station, Nakornrachasima Province, and the Khon Kaen Field Crop Expt Station, Khon Kaen Province, to determine the optimum time for planting cassava Planting was done at monthly intervals from May-Oct.; plants were harvested at 12 mo. Although the expt at Neon Soong was damaged, results at Khon Kaen showed that the highest yields were obtained when planting during the rainy season (June-Aug.). (*Summary by Kasetsart University*) D02

0142-11843 THAILAND. DEPARTMENT OF AGRICULTURE. DIVISION OF RESEARCH AND EXPERIMENT. [Study on time of planting of cassava]. *In* ——. Annual Report for 1969. Bangkok, 1970?. pp.77-79. Thai., Sum. Engl.

Cassava. Field experiments. Planting. Timing. Productivity. Thailand.

Expt were carred out over 4 growing seasons to study the effect of planting method (vertical and horizontal position) and time (Jan.-Dec.) on yield of cassava. Results in 1969 showed that yield differed according to planting date, the highest yields being obtained with the Sept. planting, using a vertical position. Results of 3-yr expt showed that planting during the rainy season tended to give the highest yields The best date at Huai Pong Field Crop Expt Station was from July-Oct. (*Summary by Kasetsart University*) D02

0143-10450 SILVA, J.R. DA **Adubação para mandioca.** (*Cassava fertilization*). Campinas, Brasil, Centro de Treinamento de Campinas, 1965?. 28p Port

Cassava. Nutritional requirements. N. P. K. Costs. Nutrient uptake. Mineral content. Fertilizers. Tuber productivity. Ca. Soil requirements. Brazil.

A review is made of lab and field expt on NPK fertilization in the state of São Paulo N fertilizer should not be placed in the planting furrows; and during dry years fertilizer placed in the furrows can harm plants. Recommended NPK rates are given for some of the different soil types (Glacial, Terra Roxa Misturada, Corumbataí, Salmourão); further work is being done to determine economic levels of applications for the different localities. In general cassava responded most to P fertilization. (*Summary by F.G. Trans. by T.B.*) D02

0144-11847 THAILAND. DEPARTMENT OF AGRICULTURE. DIVISION OF RESEARCH AND EXPERIMENT. **[Study on effect of different cutting lengths on growth and yield o cassava]**. *In*——. Annual Report for 1968. Bangkok, 1969?. pp.72-73. Thai., Sum. Engl.

Cassava. Field experiments. Cuttings. Growth. Germination. Climatic requirements. Tubers. Tube productivity. Thailand.

An expt was conducted to determine optimal cutting length for a local var. Cuttings of 4, 6, 8, 10 anc 12 in. in length were arranged in a randomized complete block design with 4 replications. Plants wer grown at a 1 x 1 m spacing, and fertilizer (8-8-8) was applied at a rate of 100 kg/rai (6.25 rai = 1 ha) Results showed that the shorter the cutting length, the lower the % of germination obtained. Ther were no differences in root wt and no. of roots/hill. It is suggested that optimal cutting lengtl depended on climatic conditions: optimal length was generally 4 in., but under dry conditions, 6-8 in was preferable. (*Summary by Kasetsart University*) D02

0145-11859 THAILAND. DEPARTMENT OF AGRICULTURE. DIVISION OF RESEARCH AND EXPERIMENT. [Study on cassava spacing]. *In*——. Annual Report for 1969. Bangkok, 1970?. Thai., Sum. Engl.

Cassava. Field experiments. Planting. Spacing. Productivity. Thailand.

An expt was conducted at Huai Pong Field Crop Expt Station to study the effect of different spacings on cassava yield, using a randomized complete block design with 9 treatments and 6 replications. Spacing treatments were 60 x 60, 60 x 80, 60 x 100, 60 x 120, 80 x 100, 80 x 120, 100 x

100, 100 x 120 and 120 x 120 cm. The harvested area was 4 x 10 m. There were no significant differences in yield among treatments. Combined analyses of the results from 1967-69 showed that best results were obtained with the 100 x 100 cm spacing although there were no statistical differences among treatments (*Summary by Kasetsart University*) D02

0146-11807 SITHIBOOSAYA, C. *et al.* **[Determination of the best plant spacing and fertilizer ra- for cassava].** *In* Thailand. Department of Agriculture. Field Crop Division. Report on cass fertilizer experiment. Bangkok, 1973. p.124. Thai., Sum. Engl.

Cassava. Field experiments. Cultivars. Planting. Spacing. Fertilizers. N. P. K. Costs. Tul productivity. Thailand.

Spacings of 100 x 100, 80 x 100, 50 x 100 and 50 x 80 cm were compared using native cassava var. fr 4 locations. The NPK fertilizers were applied at 50-50-25 and 100-100-50 kg/ha. There were significant differences in fresh wt of roots, stems and leaves. If the 100 x 100 cm spacing is taken standard, an increasing no. of plants/ha tended to give increased yields. Based on planting costs, 100 x 100 or 80 x 100 cm spacings were the most suitable. (*Summary by Kasetsart University*) D

0147-3149 EMPRESA BRASILEIRA DE PESQUISA AGROPECUARIA **Sistemas de produção para mandioca; mandioca + arroz, mandioca + milho. Região: Norte.** (*Production systems for cassava, cassava + rice and cassava + maize in the northern region of Brazil*). Macapá-AP, Brasil. Série Circular no. 62. 1975. 19p. Port.

Cassava. Rice. Maize. Cultivation. Inter-cropping. Rotational crops. Brazil.

This manual is designed for small farmers (2-6 ha) using rudimentary technology and family labor. Cultural practices (land preparation, planting, harvesting and processing, storage and marketing), technical recommendations (planting method and date, recommended var., selection of cuttings, pest control, etc.) and yield are analyzed for 3 production systems: cassava, cassava + rice and cassava + maize. A production system based on rotation of tropical crops is presented for the Federal Territory of Amapá, including characterization of the producer, credit, yields, work schedule and technical recommendations. (*Summary by F.G. Trans. by T.B.*) D02 K01

0148-11218 HAYNES, P.H. and SIVAN, P. **Towards the development of integrated root crop research and production in Fiji.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. pp.51-61. Engl., 15 Refs.

Cassava. Tuber productivity. Cultivars. Cultivation. Planting. Spacing. Fiji.

Achievements in agronomic research are determined by the precision with which problems are identified and by the technologies available for their solution. An attempt is made to show how changing attitudes to agronomic research have influenced present and past root crop research. Research on taro, yams, cassava since 1973, the evaluation of root crop resources, investigations to determine the best agronomic practices and the development and extension of systems for commercial production are discussed. (*Summary by Abstracts on Tropical Agriculture*) D02 D03

0149-11868 SINTHUPRAMA, S., THIRAPORN, C. and TONG-GLAM, A. **[Relationship between cassava spacing and weed competition]**. *In* Thailand. Department of Agriculture. Field Crops Division. Annual Report for 1973. Bangkok, 1974?. pp.100-101. Thai., Sum. Engl.

Cassava. Planting. Spacing. Weeding. Tuber productivity. Field experiments. Thailand.

In an expt studying the effect of spacing on weeds in the cassava field, weeds covered the field during the 1st 3 mo at any spacing. Cassava yields were reduced ca. 36.9%, as compared to weeding, under no-weeding conditions with either wide or narrow spacings. A closer spacing of 50 x 60 cm (5333 plants/rai; 6.25 rai = 1 ha) resulted in fewer weeds and lower costs than wider spacing. At wide spacing and no-weeding conditions, cassava yields were extremely low. It is concluded that weeding gave higher yields than no weeding (*Summary by Kasetsart University*) D02

0150-4305 SASIDHAR, V.K., NAIR, V.R. and SADANANDAN, N. **Effect of different methods of planting on the tuber yield of tapioca variety-Malayan-4.** Journal of Root Crops 3(1).57-58. 1977. Engl., 1 Ref.

Cassava. Planting. Tuber productivity. India.

Four planting methods were evaluated at the College of Agriculture, Vallayani, using a randomized block design with 9 replications. Cuttings of Malayan-4 were (1) planted vertically, (2) at an angle of 60°, (3) horizontally, or (4) split cuttings were planted horizontally. Best yield (32.02 t/ha) and no. of roots/plant (16.86) were obtained in T1, whereas the lowest yield (19.87 t) and no. of roots (10.58) occurred in T4. There was no significant difference in yield between the 1st 3 treatments. (*Summary by F.G. Trans. by T.B.*) D02

0151-11844 SOMBATNUN, P. *et al.* **[Storage of cassava stems]**. *In* Thailand. Department of Agriculture. Division of Field Crops. Cassava research summary for 1976. Bangkok, 1977?. Thai., Sum. Engl.

Cassava. Cuttings. Field experiments. Storage. Timing. Germination. Thailand.

A 3 x 8 factorial expt was conducted to determine the best storage method for cassava stem planting material, using a split plot design with 2 replications. Storage conditions (storage house, tree shade, covered and uncovered in the field) were studied in the main plot, and the factorial expt were arranged in the subplots. Treatment of cuttings (untreated, treated with oil, or with paraffin) was used as the 1st factor and storage period (0-15-30-45-60-75-90-105 days), the 2nd factor. Each treatment consisted of 10 cuttings 15 cm long No changes in % germination were observed when stems were stored for 15 days, but the % decreased slightly after 30 days. Highest % germination was obtained with untreated cuttings kept in the storage house. (*Summary by Kasetsart University*) D02

0152-1399 CENTRE FOR AGRICULTURAL RESEARCH IN SURINAM. **Report for the year 1974.** Wageningen, The Netherlands. Celos Bulletins no. 31. 1976. p.8, 10. Engl., Illus.

Cassava. Harvesting. Agricultural equipment. Cultivars. Field experiments. Tuber productivity. Timing. Surinam.

The following developments were reported with regard to cassava: (a) Intermediate technology. A harvester (lifter) device is described whereby the roots are levered out of the ground with a boom apparatus after the plant has been cut 15 cm from the ground; and (b) Crop production. A comparison was made of 33 cv. introduced from Venezuela, Brazil and Colombia based on yield, starch content and other characteristics. Preliminary results (12.5 mo) showed yields of > 4.5 kg/plant; av starch production ranged from 1-1.9 kg. (*Summary by T.B.*) D02 D03

0153-11713 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Sistema de propagación rápida de la yuca; unidad audiotutorial.** (*Rapid propagation system for cassava; audiotutorial unit*) Cali, Colombia, 1978 61 diap color 5 x 5 cm, cinta magnetofónica 19'08"; acompañada de guión 12p y guía de estudio 17p Span., Illus.

Cassava. Propagation. Cuttings. Colombia.

This audiotutorial unit (cassette, printed script, 61 color slides, study guide, self-evaluation test), prepared by the Communications Support Unit at CIAT, is available for use with a manually or automatically synchronized slide projector/cassette tape recorder. Each unit is available from the Distribution Office at a cost of US$50; photocopies of the study guide alone can be obtained from the Cassava Information Center. There has been an increased demand for planting material in recent yr; however, cassava has a slow rate of propagation, a mature plant producing 10-20 normal-sized cuttings (20 cm long)/yr CIAT has developed a simple, inexpensive rapid propagation method. The facilities and materials required, as well as the methodology used, are described and illustrated. Another advantage of this system is that it can be used to obtain CBB-free material. (*Summary by T.B*) D02

0154-10465 ECHEVERRIA R., H. **Introducción a los estudios de factibilidad sobre labores mecanizadas de plantación y cosecha de yuca procesable** (*Manihot esculenta* Crantz). (*Feasibility study for the mechanized planting and harvesting of cassava*). Maracay, Universidad Central de Venezuela. Instituto de Ingeniería Agrícola, 1971. 152p Span., Sum. Span, 42 Refs., Illus

Cassava. Mechanization. Planting. Harvesting. Agricultural equipment. Venezuela.

Results are given of an exploratory study on the mechanization of cassava cultivation in Venezuela, using different machines adapted for planting and harvesting (drawings and photographs included). The machines are compared with the manual operation on the basis of several biological parameters to determine the relative capacities and efficiency at the exptl level. The capacity of the mechanized operations far surpassed that of the manual operations. Because of problems in design, however, the use of the implements was less efficient than the manual operations It was also found that soil texture affected the final no. of roots harvested in the different operations. The planter should be redesigned to plant cuttings at an angle and to improve the feeding of the cuttings through the rotary hopper. Statistical analysis showed that the root distribution pattern in the soil profile is in the shape of an elipse (major axis, 72.16 cm; minor axis, 31.70 cm); this shape was used as a parameter in the design of the harvesting mechanism. This profile may be affected by plant growth habit and the pattern of water run-off. Therefore, further designs should be studied to determine which is the most adequate since roots whose tips are not within the circumscribed area will be broken by the harvester. The potato harvester was unsuitable, but the subsoiler could be adapted for this purpose. (*Summary by T.B.*) D02

[1]0155-11869 TONG-GLAM, A. *et al.* **[Effect of harvesting time after stem cutting on yield and quality of cassava].** *In* Thailand. Department of Agriculture. Division of Field Crops.

Cassava research summary. Bangkok, 197?. Thai., Sum. Engl.

Cassava. Harvesting. Timing. Tuber productivity. Thailand.

A randomized complete block design with 4 replications was used to determine the effect of harvesting time (0, 5, 10, 15, 20, 25 and 30 days after stem cutting) on yield and quality of cassava. Plants were spaced at 1 x 1 m and fertilizer applied at a rate of 8-8-8 kg N, P_2O_5, K_2O/rai (6.25 rai = 1 ha). The results of this 3-yr expt (1975-78) showed that time of harvest had no effect on root yield. This may be a useful guide to farmers when calculating time between uprooting and transportation. (*Summary by Kasetsart University*) D02

0156-4091 EMPRESA BRASILEIRA DE ASSISTÊNCIA TECNICA E EXTENSÃO RURAL. **Sistemas de produção para mandioca; Natal, Agreste Potiguar, Sertão de Angicos, Seridó, Serrana Norteriograndense.** (*Cassava production systems for the state of Rio Grande do Norte in Brazil*). Natal-RN, Brasil. Boletim no. 11. 1976. 29p. Port.

Cassava. Production. Cultivation. Brazil.

Researchers, extensionists and producers met in Natal, Rio Grande do Norte in 1976 to develop cassava production systems suitable for the region. The characteristics of the microregions, cultural practices, credit availability and commercialization are given. Two systems are presented: one for farmers receiving technical assistance, with access to credit, landowners, mechanized operations, av expected production 20 t/ha; and one for small farmers with little knowledge of cultural practices, family labor, no technical assistance, av expected production 12-15 t/ha. (*Summary by F.G. Trans. by T.B.*) D02

0157-11294 WHOLEY, D.W. and COCK, J.H. **Rapid field-multiplication of cassava.** Tropical Agriculture 56(3):263-269. 1979. Engl., Sum. Engl., 16 Refs., Illus.

Cassava. Field experiments. Propagation. Cuttings. Planting. Spacing. Plant development. Timing. Branching. Growth. Shoots.

In a series of expt, 5-cm 2-node hardwood cuttings were established in the field with acceptable losses By modifying planting density and growing period, accelerated multiplication rates can be achieved without the need for specialized propagation structures. Owing to limited reserves of nutrients, these short cuttings emerge slowly and require a higher standard of crop management than commercial-type cuttings. (*Author's summary*) D02 C01

0158-4553 VINE, P.N. **Propagación rápida de la yuca en Trinidad.** (*Rapid propagation of cassava in Trinidad*). Yuca Boletín Informativo no. 3:5-6. 1978. Span, Illus

Also in English

Cassava. Cuttings. Propagation. Field experiments. Trinidad and Tobago.

Rapid multiplication of cassava, using CIAT-designed propagation frames and procedure, does not work in Trinidad unless modified. These modifications are described, as they may be of interest to other workers who may be experiencing difficulties with this method. (*Summary by Abstracts on Tropical Agriculture*) D02

0159-9966 DIAZ-DURAN, A. **Un implemento diseñado para ayudar en la cosecha de la yuca.** (*A cassava harvesting aid*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1978?. 6p. Span., Illus.

Cassava. Agricultural equipment. Mechanization. Tubers. Harvesting. Colombia.

A cassava root harvesting aid was designed that can be attached to a tractor with a hydraulic system. This implement breaks up the soil and loosens the roots, making their manual extraction easy. The aid, as well as the method of operating it, is described and illustrated. (*Summary by R.A F. Trans. by T.B*) D02

0160-11848 THAILAND. DEPARTMENT OF AGRICULTURE. DIVISION OF RESEARCH AND EXPERIMENT. **[Study on cassava spacing]**. *In* ——. Annual report for 1968. Bangkok, 1969?. Thai., Sum. Engl.

Cassava. Field experiments. Tuber productivity. Spacing. Thailand.

An expt was conducted at Huai Pong Field Crop Expt Station to study the effect of spacing on cassava yield. A randomized complete block design with 9 treatments and 6 replications was used. Treatments were 60 x 60, 60 x 80, 60 x 100, 60 x 120, 80 x 100, 80 x 120, 100 x 100, 100 x 120 and 120 x 120 cm. Results from the 1967 expt showed that there was no statistical difference in yield among treatments; in 1968, however, yields were significantly different. Highest yields were obtained at 100 x 100 cm (5842 kg/rai; 6.25 rai ≐ 1 ha), 100 x 120 cm (5474 kg/rai) and 80 x 100 cm (5471 kg/rai), respectively. Combined analysis of the 1967-68 results showed that yield was significantly different, highest yields being obtained at 100 x 100 cm. This spacing is thus considered optimal for cassava. (*Summary by Kasetsart University*) D02

0161-11866 SINTHUPRAMA, S., THIRAPORN, C. and SONHLAKSAP, N. **[Study on plot size and plot shape for cassava experiments]**. *In* —— Thailand. Department of Agriculture. Division of Research and Experiment. Progress report for 1973. Bangkok, 1974?. pp 262-268. Thai, Sum. Engl.

Cassava. Field experiments. Experiment design. Thailand.

An expt was conducted with a local var. to determine optimum plot size (50-80 m^2) and shape for cassava expt. Planting time and fertilizer rates were based on recommendations of the Dept. of Agriculture. Plants were harvested in an area of 1 x 5 m and yield recorded Optimum plot size was 50 m^2; all the plot shapes used in this expt gave nearly the same coefficient of variation value. (*Summary by Kasetsart University*) D02

0162-11841 VICHUKIT, V. **[Effect of topping on yield and some growth parameters of cassava (*Manihot esculenta* Crantz)]**. Mg. Sc. Thesis Bangkok, Thailand, Kasetsart University, 1979. Thai., Sum. Engl.

Cassava. Leaves. Pruning. Growth. Harvesting. Timing. Leaf area. Tuber productivity. Stems. Field experiments. Thailand.

A field expt was conducted with a local var. to study the effect of topping on yield and some growth parameters of cassava at Kasetsart U. Student Training Center, Siracha, Chonburi, from 1976-77. The 10 treatments were as follows: control (no topping) and topping 6, 12 and 18 leaves/plant when the plants were 5, 6 and 7 mo old. Plants were harvested at 8, 10 and 12 mo.

LAI and leaf fresh wt were significantly different among treatments. Topping gave > LAIs and leaf fresh wt than no topping. The highest LAI was obtained when harvesting at 10 mo, followed by 8 and 12 mo, respectively. Harvesting at 12 mo gave the lowest LAI because most of the leaves had been shed. Stem fresh wt, leaf and stem fresh wt, root fresh wt, no. of thickened roots/plant, av fresh wt/thickened root, HI and root starch content were not significantly different among treatments, except at different harvest periods. The values obtained from the 12-mo harvest were superior to 10 and 8 mo, respectively. The treatment where 12 leaves were topped at 5 mo tended to give the highest root fresh wt. (*Summary by Kasetsart University*) D02 D03

0163-10924 ALVIM, R., NACIF, A. DE P. and CORREA, H. **A cultura da mandioca para produção de etanol.** (*Growing cassava for ethanol production*). Informe Agropecuário 3(33).3-13. 1977. Port., Illus.

Cassava. Energy productivity. Ethanol. Cultivation. Cultivars. Production. Soil fertility. Minerals. *Erinnyis ello. Xanthomonas manihotis.* **Inter-cropping. Rotational crops. Brazil.**

This analysis of cassava as an energy source points out the problems that must be faced by the producers, industrialists and researchers in order to make its use for the production of ethanol feasible. It is necessary to improve present subsistence practices so that Brazil can become self-sufficient in gasoline (with only 5% of its territory planted to cassava) Among the main activities being carried out towards this goal are the introduction and evaluation of cv., soil fertility and mineral nutrition studies, crop rotation and associations, obtention of propagation material, physiological and plant health studies, and the profitability of different production systems. (*Summary by I.B. Trans. by T.B*) D02 D03

See also 0042 0072 0088 0092

D03 Energy Productivity and Yields

0164-10043 PEREIRA, A.S., LORENZI, J.O. and ABRAMIDES, E. **Competição de variedades de mandioca.** (*Evaluation of cassava varieties*). São Paulo, Brasil. Instituto Agronômico. Circular no. 68. 1977. 7p. Port., Sum. Port., Engl., 2 Refs.

Cassava. Cultivars. Sweet cassava. Bitter cassava. Field experiments. Tuber productivity. Brazil.

An evaluation was made of 7 cassava clones at 7 sites in the state of São Paulo. The bitter var. Branca de Santa Catarina, the standard industrial type in this state, was used as the control. There was an interaction between var. x locality. Av. yields of IAC x-352-6 and IAC-Mantiqueira were comparable to the control; the former produced more branches and leaves than all the other var (*Author's summary*) D03

0165-4202 HENAIN, A E and CENOZ, H.M. **Ensayo comparativo de clones de mandioca cultivados en la Provincia de Corrientes.** (*Evaluation of cassava clones grown in the province of Corrientes*). Corrientes, Argentina, Universidad Nacional del Nordeste. Facultad de Agronomía y Veterinaria, 1968. 10p. Span.

Cassava. Cultivars. Field experiments. Tuber productivity. Timing. Starch productivity. Climatic requirements. Argentina.

An evaluation was made of 6 cassava var (Cambi, Carapé, Pombero Negro, Pombero Blanco, Catigua Guazu, Blanca) grown in Corrientes, Argentina from 1964-68, using a randomized block design with 4 replications. Data on the statistical analyses of total and commercial root yield are given in tables Cambi and Pombero Blanco had best edible root yield and the highest % of starch content in the roots. Carapé was outstanding for the low annual variation in yield, which indicates its better adaptability to the different climatic conditions which affected yield from one year to another. (*Summary by S.G.V. Trans. by T.B*) D03 D01

0166-4475 KOCH, L. A. **Een globale bepaling van het zetmeelgehalte in geschilde cassave wortels voor proefdoeleinden. B. Uitkomsten van een vergelijkende proef met 15 cassavevarieteiten .** (*A. A global method for determining the starch content of peeled cassava roots for experimental purposes. B. Results of a comparative trial with 15 cassava varieties*). Buitenzorg, Java. Departement van Landbouw, Nijuerheid en Handel. Korte Berichten uitgaande van de selectie-en zaadtuinen voor rijst en andere eenjarige inlandsche Landbouwgewassen no. 11. 1918. 11p. Dutch.

Cassava. Cultivars. Starch productivity. Tuber productivity. Starch content. Dry matter. Field experiments. Java.

A study was made of the relationship between DM and starch content of cassava roots. It is stated that when only global data on starch content are required, a great deal of time can be saved, merely by subtracting 7.5 from the DM content. A simple sun-drying method for determining

DM content is described. Results are given of a trial evaluating the yield of 15 cv.; data are also given on their starch content, determined by the aforementioned method. (*Summary by J.V.*) D03

0167-4584 STOK, J.E. VAN DER **Onderzoekingen omtrent de ver betering van het cassave-gewas door selectie der zaailingen.** (*Experiments on the improvement of cassava through seedling selection*). Teysmannia 21(3):1-8. 1910. Dutch.

Cassava. Selection. Tuber productivity. Starch productivity. Java.

A detailed report is given of the selection procedure in cassava, starting with 700 seedlings of cv. Manis and 100 of cv. Begog. Plants were harvested 8 mo after planting and a 1st selection took place. Cuttings of promising plants were planted in single rows of 12 plants and a 2nd selection done 12 mo after planting, eliminating the low yielders ($<$ 4.9 kg/plant for Begog and 4.1 kg/plant for Manis). The remaining 12 lines of Begog and 15 of Manis were compared with the parent cv.; 7 gave higher root yield than the respective parent cv. Starch content varied from 13.0-25.5%. (*Summary by J.V.*) D03 G01

0168-4026 MANDIOCA . (*Cassava*). Acompanhamento da Situação Agropecuária do Paraná 3(2).37-38. 1977. Port.

Cassava. Production. Productivity. Brazil.

A report is given of the situation of cassava production in 2 regions of the state of Paraná (Brazil) in 1977-78. Some areas were attacked by the hornworm. Av yields are 17 t/ha/yr and 36 t/ha/2 yr. (*Summary by T.B.*) D03

0169-10042 PEREIRA, A.S. **Descrição sumária de cultivares de mandioca-de-mesa.** (*Brief description of sweet cassava cultivars*). São Paulo, Brasil. Instituto Agronômico. Circular no. 91. 1978. 25p. Port., Sum. Engl., Illus.

Cassava. Cultivars. Identification. Agronomic characters. Tubers. Stems. Leaves. HCN content. Starch content. Tuber productivity. Sweet cassava. Brazil.

A brief description is given of 14 cassava cv. grown on latosol soils (terra roxa misturada) at the Campinas expt station in the state of São Paulo Based on taste and cooking quality, only 9 were considered really good sweet cv.. Vassourinha-antiga, Palma, Santa, Tatu, Guaxupé, Carapé, Piraçununga, Ouro-do-vale and Jaçanã. Regarding yield and pest and disease resistance, Santa, Vassourão, Piraçununga, Ouro-do-vale and Jaçanã performed best. (*Author's summary*) D03

0170-9972 RAJENDRAN, P.G., KAMALAM, P. and MANI, S.B. **Quality aspects of Mukibat tubers.** Journal of Root Crops 2:64-66. 1976. Engl., 5 Refs.

Cassava. Mukibat system. Tuber productivity. HCN content. Starch content. India.

The quality of roots from Mukibat plants at different stages of maturity (6-13 mo) was compared to the normal cassava plants. It was clear that DM and starch production in the Mukibat plant

were superior to the controls. HCN content was always higher in the Mukibat roots. With regard to organoleptic tests and cooking quality, the Mukibat roots were slightly inferior to the control. (*Summary by T.B.*) D03 C03

0171-3551 **LES PLANTES à racines ou a tubercules.** (*Root and tuber crops*). Agronomie Tropicale 29(4):506-508. 1974. Fr.

Cassava. Cultivars. Tuber productivity. Harvesting. Timing. Hybridizing. Germplasm. Dahomey. Malagasy Republic.

Results are given of expt with several root and tuber crops in different parts of Africa in 1972 With regard to cassava, local var. CB outyielded by far the introduced var. Llanera (Colombia) and Vira Barco (Brazil) in adaptability trials in Ivory Coast The best yielding var. in Dahomey were Cabunga (11 mo), H 38 (15 mo) and Danzane Feto (18 mo). Only 3 of the 251 var. evaluated had a starch content of > 20% but their yields were < 40 t/ha. Var. improvement trials at the Lake Alaotra station in Madagascar showed that hybrid 56,648 and H 60 were the best of 335 clones studied. (*Summary by S.S de S Trans. by T.B.*) D03 G01

0172-10060 NUNES, R. DE P. and ALMEIDA, F.C.G. **Aumento da precisão em experimento de mandioca, *Manihot utilissima* Pohl (*Manihot esculenta*, Grants), através do emprego de variável concomitante.** (*Increasing the efficiency of cassava experiments by using the analysis of covariance*). Ciencia Agronomica 7(1/2):93-98. 1977. Port., Sum Engl., 5 Refs.

Cassava. Tuber productivity. Cultivars. Field experiments. Statistical analysis. Experiment design. Brazil.

The analysis of covariance was applied to data obtained in a field expt in which 10 cassava cv. were evaluated for root and green matter production under irrigated conditions in Ceará, Brazil. For this purpose, green matter was defined as the covariate and root production as the dependent variable. The study was concerned mainly with control of error variance to increase exptl precision and adjust treatment means. The relative efficiency of the analysis of covariance was 112% that of simple analysis of variance. It thus appears that green matter data can be used successfully as a covariate to reduce error variance and thereby increase the precision of field expt. (*Author's summary*) D03

0173-9980 VRIES, C.A. DE **Increasing crop yields - relative potential of specific crops by region and/or country.** *In* Rechcigl Junior, M., ed. Man, food and nutrition; strategies and technological measures for alleviating the world food problem. Cleveland, Ohio, CRC Press, 1975. pp.109-125. Engl., 41 Refs., Illus.

Cassava. Legume crops. Productivity. Cereals.

The main calorie-providing crops are cereals and root crops. Crop yield increases from 1950-70 are compared to farm area increases in the world, major regions and by country. Factors determining yield are discussed; and the potential of cereal, root and legume crops is estimated. With regard to cassava, potential yield is 100 t/ha/yr, with a target of 65 t (82.5 kcal x 10^6); realized record yield, 77 t/ha Expectations are discussed in light of the FAO Indicative World Plan, according to which internal demand for starchy roots in developing countries will rise between 2 7-4.1%/yr. Because of their nutritional value, it is hoped that the increase in root crop production for human consumption will be for sweet potatoes and yams rather than cassava. (*Summary by T.B.*) D03

0174-11299 ROSENTHAL, T.R.F. *et al.* **Amidos de mandioca, variedades precoces do estado do Pará.** (*Cassava starch from early-maturing varieties in the state of Pará*). Informativo do INT 10(15/16) 25-34. 1977. Port., Sum. Port., Engl., 5 Refs., Illus.

Cassava. Cultivars. Cassava starch. Analysis. Composition. Gelatinization. Viscosity. Starch productivity. Tuber productivity. Brazil.

An evaluation was made of 15 early-maturing (10 mo) cassava var. (Mameluca, Mico, Amazonas, Iracema, Jurará, Cachimbo, Bubão, Tataruaia, Pretinha, Engana-Ladrão, Jaboti Bravo; M Col 808, Jaraqui, Simeão, Mameluca Brava) in the state of Pará (Brazil) to determine which presented the highest starch and root yields and which had starch of the export type. The most productive were Tataruaia and Jaraqui; highest starch viscosity (Brabender) was showed by Simeão and the lowest by Jurará. M Col 808 met all the General Foods Co.'s starch viscosity requirements. Based on Concex export specifications, almost all the starches studied could be classified as A type. The highest starch yield/ha was presented by Tataruaia, which is the most indicated for starch extraction, alcohol or glucose production. (*Author's summary*) D03 I01

0175-10943. ALEMAN, J.M. **Evaluación agronómica de tres niveles de tecnología en el cultivo de la yuca.** (*Agronomic evaluation of three levels of technology in cassava cultivation*). *In* Instituto Nicaraguense de Tecnología Agropecuaria. Estación Experimental Regional El Recreo. Informe de las actividades realizadas en el proyecto de raíces y tubérculos tropicales. Managua, Nicaragua, 1978. pp.28-36. Span., Sum. Span.

Cassava. Field experiments. Planting. Fertilizers. Tuber productivity. Cultivation. Statistical analysis. Nicaragua.

Three levels of technology (high, intermediate, traditional) were evaluated in a latin square (3 x 3) design at the exptl station El Recreo in the state of Zelaya (Nicaragua). There was no significant difference among treatments. The high level of technology gave an increase in yield of 5016 kg/ha over the traditional farming system, whereas intermediate technology gave an increase of only 23 kg. This may be due to the fact that heavy rainfall from July-Sept. favored leaching of fertilizers (high and intermediate technology), and the var. used (Sutra Blanca) seems to have a low yield capacity. The C.V. for the trial was 18.34%. (*Author's summary. Trans. by T.B.*) D03

0176-3727 SILVA, J.G. DA *et al.* **Balanço energético cultural da produção de álcool etílico de cana-de-açúcar, mandioca e sorgo sacarino, fase agrícola e industrial.** (*Energetic/cultural balance of sugar cane, cassava and sweet sorghum in the production of ethyl alcohol: agricultural and industrial phases*). Brasil Açucareiro 88(6):8-12. 1976. Port., 16 Refs.

Cassava. Sorghum. Sugar cane. Cultivation. Production. Alcohol. Energy productivity. Industrialization. Brazil.

The possibilities of 3 crops with good potential in Brazil for the production of motor alcohol are analyzed: sugar cane, cassava and sweet sorghum. An energetic/cultural balance is presented, in which the difference between the energy produced and consumed is analyzed at all stages of the productive process — both agricultural and industrial. As for cassava, an av yield of 14.5 t roots/yr was adopted. Branch production was quantified at 22 t/ha and possible use as a fuel estimated. At 50% moisture content, total heat generated is 1300 kcal/kg on the av (= to sugar cane). The energy consumed in the industrial phase is 6.5 kg steam/l alcohol produced (174 l/t of roots). Tables give data on manual and mecanical operations and energy consumed. In the agricultural phase, the mechanized operations consume the most energy (50%) for fuel, followed

by N fertilization (approx 20%), and machinery maintenance (10%). The best yearly energetic balance (return of useful units/unit of energy spent) was for sugar cane (4.44), followed by sorghum (4.25); the respective values for cassava were 3.28, 2.63 and 1.59, for total utilization of the branches, 50% utilization and no utilization. The results obtained with cassava could be improved by the use of improved technology. (*Summary by I.B. Trans. by T.B.*) D03 102

0177-10942 ALEMAN, J.M. **Evaluación comparativa de cuatro variedades de yuca (*Manihot esculenta* Crantz).** (*Comparative evaluation of four cassava varieties*). *In* Instituto Nicaraguense de Tecnología Agropecuaria. Estación Experimental Regional El Recreo. Informe de las actividades realizadas en el proyecto de raíces y tubérculos tropicales 1977/78. Managua, Nicaragua, 1978. pp.20-27. Span., Sum. Span.

Cassava. Cultivars. Tuber productivity. Statistical analysis. Field experiments. Nicaragua.

Yield of 3 local cassava var. (Sutrita, Sutra Blanca, Sutra Amarilla) and one introduced from the state of Carazo (Cubana) was compared in a trial at the exptl station El Recreo in the state of Zelaya (Nicaragua), using a randomized complete block design with 4 replications. There was no significant difference in yield, but Cubana and Sutrita (27,736 and 24,854 kg/ha, respectively) yielded 6231 and 3349 kg/ha more than Sutra Blanca. Some replanting of Cubana had to be done because of damage to planting material during its shipment and storage; this affected yield in some plots (C.V. 19.57%). (*Author's summary. Trans. by T.B.*) D03

See also *0015* *0018* *0019* *0026* *0027* *0046* *0048* *0066* *0067* *0069* *0072* *0074* *0076* *0079* *0080* *0081* *0084* *0085* *0086* *0087* *0088* *0110* *0113* *0114* *0117* *0118* *0119* *0120* *0122* *0127* *0128* *0130* *0148* *0152* *0162* *0163* *0255* *0298* *0461* *0464*

D04 Postharvest Studies

0178-9933 BALAGOPAL, C. **Post harvest problems of cassava roots.** *In* Hrishi, N. and Gopinathan Nair, R , eds Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978 pp 58-61. Engl , Illus.

Cassava. Harvesting. Post-harvest losses. Tubers. Storage. Enzymes. Deterioration. Moulds. *Aspergillus*. **India.**

A brief review is made of the problem of rapid deterioration of harvested cassava roots, possible causes and different storage techniques. (*Summary by T.B*) D04 I02

0179-4215 COURSEY, D.G. and BOOTH, R.H. **Post-harvest problems of non-grain staples.** Acta Horticulturae 53:23-33. 1977. Engl., Sum. Engl , 38 Refs.

Cassava. Post-harvest losses. Storage.

Tropical staple foods other than grains (e.g., cassava, yams, cocoyam, plantains, breadfruit, sago) are important in humid tropical ecosystems. Postharvest losses in these crops have been estimated at ca. 25%. Some considerations common to all, as well as major crop-specific problems are discussed. Cassava is different from the other root crops, in which the edible product is an organ of dormancy. The thickened cassava root appears to have a function only as an organ of perennation and cannot be stored for much time. A brief description is given of inexpensive storage techniques. (*Summary by T.B.*) D04

0180-7325 SHUYLER, H.R. *et al.* **Pre and post-harvest losses of tropical roots and tubers and their reduction.** Rome, Italy, Food and Agriculture Organization of the United Nations, 1976. 62p. Engl., Sum Engl., 113 Refs.

Paper presented at International Symposium on Tropical Root Crops, 4th., Cali, Colombia, 1976.

Cassava. Harvesting. Post-harvest losses. Tubers. Cassava African mosaic virus. *Bemisia. Xanthomonas manihotis.* **Mycoses. Cassava products. Storage. Injurious insects. Processing. Marketing. Starch crops.**

Pre- and postharvest loss of tropical roots and tubers is reviewed. Causes of preharvest losses include diseases and insect pests; loss due to weeds is not well known. Current control emphasizes cultural practices and breeding for resistance. In addition to diseases and insects, postharvest losses are related to processing and marketing, where physiological deterioration frequently occurs. Reduction of postharvest loss currently centers around cultural practices including rotation, improved mass selection of propagating material and integrated pest control. It is concluded that within the next 5-10 yr, improved cultural practices should be disseminated to the subsistence grower; this would require extensive training to strengthen extension activities. (*Author's summary*) D04

E01 General Descriptive Studies

0181-3045 CENTRE FOR OVERSEAS PEST RESEARCH (ENGLAND). **Cassava.** *In*_____. Pest control in tropical root crops. London, PANS Manual no. 4. 1978. pp.97-221. Engl., 78 Refs., Illus.

Cassava. *Cercospora henningsii Phyllosticta. Phoma. Uromyces manihotis. Glomerella cingulata. Rosellinia. Sclerotium rolfsii. Xanthomonas manihotis.* **Cassava African mosaic virus. Cassava common mosaic virus. Cassava brown streak virus. Nematodes.** *Aonidomytilus albus. Erinnyis ello. Anastrepha manihoti. Silba pendula.* **Entomology. Insect control. Disease control.**

In the 1st chapter data are given on the synonymy, distribution, symptoms, development and spread, and control of the following diseases of cassava: (1) Fungal diseases Brown leaf spot (*Cercosporidium henningsii*), white leaf spot (*Phaeoramularia manihotis*), Cercospora leaf blight (*Cercospora vicosae*), concentric-ring leaf spot (*Phoma* sp., *Phyllosticta manihobae, Phyllosticta manihoticola*), cassava ash (*Oidium manihotis*), anthracnose (*Glomerella manihotis*), superelongation (*Sphaceloma manihoticola*), rust (*Uromyces* spp.), Glomerella and Botryodiplodia stem rots, root rots (*Phytophthora drechsleri, Rigidoporus lignosus, Rosellinia necatrix, Corticium rolfsii*) and several minor leaf, stem and root diseases. (2) Bacterial diseases. CBB (*Xanthomonas manihotis*), bacterial leaf spot (*X. cassavae*), bacterial stem rot (*Erwinia cassavae*) and bacterial stem gall (*Agrobacterium* sp.). (3) Virus and mycoplasma-like diseases. AMD, common mosaic, brown streak virus, leaf vein mosaic and witches'-broom. In the 2nd chapter, root-knot nematodes (*Meloidogyne incognita, Meloidogyne* spp.), root-lesion nematodes (*Pratylenchus brachyurus, Pratylenchus* spp.), and *Helicotylenchus erythrinae* and *Rotylenchulus reniformis* are discussed briefly. In the chapter on insect and mite pests, data are given on distribution, synonymy, symptoms, life cycle, cultural and chemical control of the following: variegated grasshopper (*Zonocerus variegatus*), whiteflies (*Aleurotrachelus* sp., *Aleurothrixus aepim, Bemisia* spp., *Trialeurodes* spp.), scales (*Aonidomytilus albus, Pseudaulacaspis pentagona, Parasaissetia nigra*), mealybugs (*Phenacoccus gossypii, P. manihoti, Ferrisia virgata*), lacebugs (*Vatiga manihotae*), thrips (*Corynothrips stenopterus, Retithrips syriacus, Scirtothrips manihoti*), the hornworm (*Erinnyis ello*), fruitflies (*Anastrepha manihoti, A. pickeli*), shootflies (*Silba pendula, Carpolonchaea chalybea*), leaf-cutting ants (*Atta* sp., *Acromyrmex* sp.), and mites (*Mononychellus tanajoa, Tetranychus cinnabarinus, Oligonychus peruvianus*) and gallmidges. (*Summary by T.B.*) E01 F01

0182-1397 NIEMANN, E. *et al.* **Breitag zur kenntnis der pflanzenkrankheiten und -schädlinge Togos.** (*Diseases and pests of cultivated plants in Togo*). Zeitschrift für Planzenkrankheiten und Pflanzenschutz 79(10):595-619. 1972. Germ., Sum. Engl., Fr., 28 Refs.

Cassava. Virosis. Mycosis. Nematodes. Injurious insects. Togo.

A geographical-climatic description of Togo is given, together with information on the major staple and export crops. Maize and cassava are the predominant staple crops in the S., whereas millet and sorghum are planted in the N. and central part, where yams are cultivated as well. Statistics (1967) are given on crop areas and production. Cassava is grown on 146,000 ha, with a

production of 1.075 million t/yr. Dry tapioca is exported at a rate of 3130 t/yr. The diseases identified on cassava are AMD, a root rot caused by *Botryodiplodia theobromae* and brown leaf spot [*Cercosporidium* (*Cercospora*) *henningsii*]. Nematodes found in association with the roots and in the soil of cassava fields are *Meloidogyne* sp., *Rotylenchus reniformis, Helicotylenchus erythrinae, Pratylenchus brachyurus, Scutellonema aberrans, Tylenchus* sp., *Criconemoides citri* and *Xiphinema elongatum*. The only insect pest of importance is the whitefly *Bemisia* sp. In evaluating the economic importance of these pests, it is reported that cassava grown in S. and central Togo is 100% infected with AMD and that considerable yield reduction is likely. Attempts to establish AMD-free plantations have failed so far due to massive incidence of the whitefly vector. The other pests and diseases are of only minor importance. The development of AMD-resistant or tolerant varieties is recommended as a solution (*Summary by D.E.L.*) E01 F01

0183-4861 TERRY, E.R Disease problems in root crops production. *In* Ene, L.S O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.81-95. Engl., Sum. Engl, 26 Refs.

Cassava. *Xanthomonas manihotis*. Cassava African mosaic virus. *Cercospora henningsii*. Disease control. Resistance. Plant breeding. Nigeria.

Major areas for critical research on vegetatively and air-borne diseases of root crops in Nigeria are identified, and the present state of knowledge on these diseases is summarized. Virus and viruslike, bacterial and fungal diseases of cassava are listed in table form Emphasis is placed on CBB, AMD and brown leaf spot [*Cercosporidium* (*Cercospora*) *henningsii*]. (*Summary by T B*) E01

0184-10421 PERSLEY, G. and LEUSCHNER, K. Report on a visit to the Mid-West and East Central States, Nigeria, 4-9 December, 1975. Ibadan, Nigeria, International Institute of Tropical Agriculture, 1975. 13p. Engl., 11 Refs.

Cassava. *Xanthomonas manihotis*. *Tetranychus urticae*. *Zonocerus variegatus*. *Bemisia*. Resistance. Selection. Cultivars. Nigeria.

A survey was made of CBB incidence and insect pests on root crops in Mid-West and East Central States. *Tetranychus telarius* and *Zonocerus variegatus* were common pests. There was very high incidence of CBB in E.C.S. (75% of the cassava crop was destroyed in 1973). In general more CBB was found on the agricultural exptl stations than in farmers' fields; therefore, great care should be taken in the dissemination of clean seed stock. Materials supposedly resistant at Umudike or IITA have proved to be susceptible when grown in this region, probably due to different environmental pressures or different pathogenic strains; this should be looked into. (*Summary by T.B.*) E01 F01

0185-9930 THANKAPPAN, M. Diseases of tapioca and their control. *In* Hrishi, N and Gopinathan Nair, R, eds Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.69-75. Engl, Illus.

Cassava. *Cercospora henningsii*. *Pseudomonas*. Cassava African mosaic virus. Leaves. Diseases control. Resistance. Cultivars. Cultivation. Defoliation. India.

The 3 main diseases of cassava in India are African mosaic, brown leaf spot caused by

Cercosporidium henningsii, and bacterial wilt, possibly caused by *Pseudomonas solanacearum*. A brief description is given of their symptoms, how they are spread and recommended control measures. (*Summary by T.B.*) E01

0186-10045 LOGAN, J. **Plant pathology in Zambia.** PANS 20(2):169-176. 1974. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Cassava African mosaic virus. *Xanthomonas manihotis*. **Zambia.**

The climate of Zambia is described, together with the types of farming practiced and the organization of the plant pathology diagnostic and advisory services. The most important diseases of maize, rice, cassava, beans and other crops are reviewed, and currently recommended control practices are given. With regard to cassava, African mosaic disease is widespread; resistant var. are being imported for testing. Precautions have been taken to prevent the introduction of CBB from Zaire and elsewhere. (*Summary by T.B.*) E01

0187-10403 CARVALHO, M.B. DE **As principais pragas da mandioca em Pernambuco.** (*The principal pests of cassava in Pernambuco*). Recife, Pernambuco, Brasil, Secretaria da Agricultura, Indústria e Comércio. Boletim 1940.174-179. 1940?. Port.

Cassava. *Erinnyis ello*. **Insect control. Insecticides. Pest damage.** *Eudiplosis brasiliensis*. **Brazil.**

The most important pest of cassava in Pernambuco (Brazil) is *Erinnyis ello*. In addition to chemical control, biological control is mentioned as a good possibility since several different cases of parasitism were observed in the field. Parasitic flies reported are *Belvosia williamsi*, *Oxysarcodexia* sp., *Zygosturmia* sp. and *Cubaemyia* sp. *Apanteles* sp. (Braconidae) is also reported parasitizing the hornworm. Pests of minor importance include the gall midge *Jatrophobia* (*Eudiplosis*) sp., the stemborers *Coelosternus manihoti*, *Araecerus fasciculatus* and *Ozyneus prolixus*. (*Summary by T.B.*) E01

0188-11222 LOZANO, J.C. **An overview of cassava pathology.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.13-26 Engl., Sum Engl., 58 Refs.

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

Cassava is affected by more than 30 pathogens (viruses, mycoplasma, bacteria and fungi), some of which are able to reduce yields by > 50%. Because of the nature of this crop, its traditional system of cultivation and the strong influence of ecosystems on both host and pathogens, it appears that cassava pathogens do not interact with their host and that the mechanism of resistance to pests is wide (resistance to diseases and pests + adaptation to climate and edaphic factors in each ecosystem = negative production factors) and of a field nature. The integration of cultural, regulatory, biological, physical and chemical control measures appears to be necessary for cassava pest control (*Author's summary*) E01

0189-10905 NYIIRA, Z.M. and OTIM-NAPE, G.W. **Cassava bacterial blight and minor diseases of cassava in Uganda.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds.

Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978 Report. London, England, Centre for Overseas Pest Research, 1979. pp.65-69. Engl., 9 Refs.

Also in French

Cassava. *Xanthomonas manihotis. Cercospora henningsii. Erwinia cassavae. Fusarium. Phoma.* Cassava brown streak virus. Cassava African mosaic virus. Symptomatology. Epidemiology. Disease control. Uganda.

Among the diseases of cassava in Uganda are brown leaf spot (*Cercosporidium henningsii*), stem wilt (*Fusarium oxysporum, Verticillium dahliae*), root rot (*Armillariella mellea*), concentric-ring leaf spot (*Phoma micidosa*), leaf and stem blight (*Bacterium cassavae = Erwinia lathyri*?), CBB, AMD and cassava brown streak virus Data are given in table form on symptoms, transmission, distribution, importance and control measures. Emphasis is placed on CBB since it is the most widespread and poses the greatest threat. (*Summary by F.G. Trans. by T.B.*) E01

0190-11714 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Descripción de las enfermedades de la yuca; unidad audiotutorial.** (*Description of cassava diseases; audiotutorial unit*). Cali, Colombia, 1977. 93 diap. color 5 x 5 cm.; cinta magnetofónica 28'33", acompañada de guión 21p. y guía de estudio 32p. Span., 20 Refs., Illus

Cassava. Symptomatology. Etiology. *Xanthomonas manihotis. Xanthomonas cassavae Erwinia carotovora. Cercospora henningsii Cercospora caribaea. Phoma. Fomes lignosus. Uromyces manihotis. Oidium. Sphaceloma manihoticola. Gloeosporium manihotis. Glomerella cingulata.* Cassava common mosaic virus. Cassava African mosaic virus. Cassava vein mosaic virus. *Phytophthora drechsleri. Rosellinia.* Colombia.

This audiotutorial unit (cassette, printed script, 93 color slides, study guide, self-evaluation test), prepared by the Communications Support Unit at CIAT, is available for use with a manually or automatically synchronized slide projector/cassette tape recorder. Each unit is available from the Distribution Office at a cost of US$50; photocopies of the study guide alone can be obtained from the Cassava Information Center. One of the main factors limiting to cassava production is disease. More than 30 bacterial, fungal, viral and mycoplasma diseases attack cassava, causing losses in stand and vigor, reduced photosynthetic capacity and root rot. The following diseases are described and illustrated: (a) bacterial - CBB (*Xanthomonas manihotis*), bacterial stem rot (*Erwinia carotovora* var. *carotovora*), bacterial necrosis (*Xanthomonas cassavae*), stem gall (*Agrobacterium tumefaciens*); (b) Viral and mycoplasma - AMD, common mosaic, leaf vein mosaic, frog skin, witches'-broom; (c) fungal leaf diseases - brown leaf spot (*Cercosporidium henningsii = Cercospora henningsii*), leaf blight (*Cercospora vicosae*), white leaf spot (*Phaeoramularia manihotis = Cercospora caribaea*), concentric-ring leaf spot (*Phoma* spp. = *Phyllosticta*), cassava ash (*Oidium manihotis*), superelongation (*Sphaceloma manihoticola*), anthracnose (*Glomerella manihotis = Colletotrichum manihotis*), rust (*Uromyces* spp.), Periconia leaf spot (*Periconia shyamala*); fungal stem diseases - necrosis caused by *Glomerella* sp. and *Botryodiplodia* sp. and rot caused by basidiomycetes or ascomycetes; root rots - preharvest rots caused by *Phytophthora drechsleri, Pythium* spp., *Rosellinia necatrix, Rigidoporus lignosus (= Fomes lignosus), Armillariella mellea (=Armillaria mellea)*, and postharvest rots (microbial and physiological). (*Summary by T.B.*) E01

0191-10926 BERNARDO, E.N. and PALOMAR, M.K. **Pest problems, control practices and their economics for sweet potato, cassava and gabi.** Baybay, Leyte, Philippines, Visayas

State College of Agriculture, 1978. 12p. Engl., 20 Refs.

Paper presented at the National Workshop-Symposium on Root Crops, Baybay, Leyte, Philippines, 1978.

Cassava. Sweet potatoes. Taro. *Xanthomonas manihotis. Cercospora henningsii.* **Biological control. Pest control. Disease control. Costs. Symptomatology. Philippines.**

The principal pests and diseases of cassava, sweet potatoes, and taro in the Philippines are studied briefly. On cassava, *Tetranychus* mites (*T. kanzawai*) are important; mealybugs and scale insects are minor pests. CBB is the most important bacterial disease, and brown leaf spot (*Cercosporidium henningsii* = *Cercospora henningsii*) is found everywhere. Root rot diseases caused by fungi and bacteria have also been reported. Chemical control and the economics of the same are discussed on the basis of a literature review. (*Summary by F.G. Trans. by T.B.*) E01 F01

0192-10914 TERRY, E.R. **The development of a pathology program within a National Root Crops Improvement Program.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1978. 16p. Engl., 19 Refs.

Paper presented at the Regional Root and Tuber Crop Improvement Workshop, Freetown, Sierra Leone, 1978.

Cassava. Cassava programs. Productivity. Plant breeding. Disease control. Diseases and pathogens. Resistance. Nigeria.

The main factors to be considered in developing a pathology program for root crop production are the quantification of crop losses (disease surveys using a standard rating scale and appraisal of yield losses), categorization of diseases (vegetatively or aerially disseminated, pre- and postharvest rots), and control (cultural measures, host-plant resistance). Tables list virus and viruslike, bacterial and fungal diseases of cassava, causal agents and distribution in Africa. (*Summary by F.G. Trans. by T.B.*) E01

0193-10418 INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE. **Description and evaluation of major cassava diseases in Africa.** Ibadan, Nigeria, Root and Tuber Improvement Program, 1976?. 14p. Engl , Illus

Cassava. Cassava African mosaic virus. *Xanthomonas manihotis. Cercospora henningsii. Cercospora caribaea. Glomerella manihotis.* **Africa.**

Brief descriptions and suggested guidelines (scales) are given for evaluating the severity of 5 diseases of economic importance in cassava-growing areas of Africa: AMD, CBB, brown and white leaf spot, and anthracnose. (*Summary by T.B.*) E01

0194-10415 PERSLEY, G.J. **Report on cassava disease survey in Cameroon.** Ibadan, International Institute of Tropical Agriculture, 1976. 30p. Engl., 3 Refs., Illus.

Cassava. Cassava African mosaic virus. *Glomerella manihotis. Xanthomonas manihotis. Cercospora henningsii. Cercospora caribaea. Cercospora vicosae.* **Cameroon.**

In a survey of the distribution and severity of cassava diseases in Cameroon, data were collected

from 155 farms over 2200 km during 2 wk in June/76. Notes were taken on vegetation, soil type, topography, cropping system, companion crops, age and vigor of the plant. The main diseases were AMD, anthracnose (*Glomerella manihotis*) and CBB (*Xanthomonas manihotis*). Cercospora leaf spots are also frequent. (*Summary by I.B. Trans. by T.B.*) E01

See also *0115*

E02 Bacterioses

0195-11003 MEYER, J.A. and MARAITE, H. **La bactériose, une grave maladie du manioc en Afrique.** (*CBB, a serious disease of cassava in Africa*). Bulletin des Séances de la Académie Royale des Sciences d'Outre-Mer 2:193-201. 1975. Fr., Sum. Fr., Flem , 15 Refs.

Cassava. *Xanthomonas manihotis.* **Disease control. Etiology. Zaire.**

CBB, caused by *Xanthomonas manihotis,* presents 3 clearly distinguishable types of symptoms: small angular leaf spots, leaf wilt and stem necrosis The 1st 2 symptoms are not serious and have been known for a long time; although stem necrosis was insignificant, it has been causing considerable damage in Zaire since 1971. Necrosis has been attributed to many causes (insects, fungi, bacteria), but in this case is caused by *X. manihotis. (Extracted from author's summary. Trans by T.B)* E02

0196-11243 BRADBURY, J.F. **Perspectives in the taxonomy of bacteria pathogenic to root and tuber and grain legume crops.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.87-93. Engl., Sum. Engl., 5 Refs.

Cassava. *Erwinia carotovora. Xanthomonas manihotis. Xanthomonas cassavae.*

About 50 supposedly different species of bacteria have been reported to produce disease on tropical grain legume and root and tuber crops. Of these only 15 are relatively important and another 10 are of minor importance. The remainder cannot be accepted as valid species because their descriptions are inadequate for recognition and there are no known reference cultures. The 15 important pathogens include species in 5 clearly separable genera: *Agrobacterium, Corynebacterium, Erwinia, Pseudomonas* and *Xanthomonas.* Within these genera separation into species is often difficult. Application of logical taxonomic rules leads to the conclusion that many nomenspecies are in reality strains of a single species differing mainly or solely in pathogenicity and host range. With the advent of the new Bacteriological Code of Nomenclature, a satisfactory nomenclature for these nomenspecies, useful to the plant pathologist and acceptable internationally under the Code, must be worked out. Such a nomenclature, using the category of "pathovar" (pv.), has recently been proposed and is outlined and discussed here. (*Author's summary*) E02

0197-11244 MOSTADE, J.M. and BUTARE, I. **Symptomatologie et epidemiologie de la necrose bacterienne du manioc causée par** *Xanthomonas cassavae* **au Rwanda.** (*Symptomatology and epidemiology of cassava bacterial necrosis caused by Xanthomonas cassavae in Rwanda*). *In* Maraite, H. and Meyer, J.A , eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.95-101. Fr., Sum. Engl., 2 Refs., Illus.

Cassava. *Xanthomonas cassavae*. Epidemiology. Stems. Leaves. Maps. Rwanda.

Xanthomonas cassavae has been detected on cassava in Rwanda since 1977. It induces water-soaked angular leaf spots that often spread along the veins. The spots become necrotic and cause premature leaf fall. When coalescing or when a principal vein is infected, there may be drying of large areas of the lamina. On the stem dark green, water-soaked spots are visible; they become cankerous and on enlarging may girdle the stem, causing loss of turgor and dieback of the shoot. Vascular browning is restricted. Inoculation of plants in the field reproduced these symptoms. A survey showed that the disease is of limited importance, found only on gravelly and sandy soils. Natural infection during the rainy season seems to depend on heavy storms, which injure the plant and propagate the inoculum (*Author's summary*) E02

0198-11246 LEU, L.S. **Cassava bacterial blight in Taiwan.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978 Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.119-129. Engl., Sum. Engl., 9 Refs., Illus.

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

CBB, the most important disease of cassava in Taiwan, was probably present before 1945. The disease is systemic and transmitted primarily by cuttings contaminated with bacteria and secondarily by wind-borne water. Angular leaf spots, wilting, defoliation, gum exudates on the leaf lobe, stipule and stems (especially on the last 2), and plant death are caused by the vascular-invading *Xanthomonas manihotis*, which is confined to the genus *Manihot* and shows poor survival ability in the soil. The disease was induced by using bacterial suspension, dipping of healthy cuttings, injecting into young stems, spraying of whole plants, clipping the leaves of young plants with contaminated scissors, and pouring into injured roots of young plants. For screening var. for resistance to CBB, clipping leaves of young plants with known concn of bacterial suspension is recommended. The use of resistant var. is the most effective control measure (*Author's summary*) E02

0199-11248 TAKATSU, A., FUKUDA, S. and PERIN, S. **Epidemiological aspects of bacterial blight of cassava in Brazil.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.141-150. Engl., Sum. Engl., 14 Refs.

Cassava. *Xanthomonas manihotis*. Epidemiology. Cultivars. Resistance. Brazil.

In studies on the effects of temp, water deficiency and variation of *Xanthomonas manihotis* on CBB severity, it was found that temp was the most important factor. Infected plants including susceptible cv., kept under higher temp conditions (> 20/30°C, night/day) recovered. These temp conditions also stimulated germination of infected cuttings and fast growth of shoots, many of which were without symptoms until fully developed. High temp conditions allowed vigorous plant growth and fast maturing of tissue, limiting the bacteria at the point of infection. Water deficiency for > 5 days also promoted the same phenomenon. Pathogenicity tests with differential var. showed that there are many strains of *X. manihotis*, varying in virulence; however, the strains could not be separated into races. CBB is an important limiting factor in the highlands and the S. region of Brazil, where temp is lower (min < 20°; max < 30°) and rainfall is > 1200mm. Despite the high rainfall in the Amazon region, CBB is not important because of the high temp. In the NE where the climate is generally hot and dry, CBB is found only in limited ecological areas. (*Author's summary*) E02

0200-11245 MARAITE, H. and WEYNS, J. **Distinctive physiological, biochemical and pathogenic characteristics of *Xanthomonas manihotis* and *X. cassavae*.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.103-117. Engl., Sum. Engl., 21 Refs., Illus.

Cassava. *Xanthomonas manihotis. Xanthomonas cassavae.* Biochemistry. Etiology.

Xanthomonas cassavae was isolated from angular leaf spots and necrotic stem lesions of cassava collected in Rwanda and Tanzania. In physiological and biochemical tests 20 isolates from Rwanda and a subculture of NCPPB 101 from Malawi were compared to 9 *X. manihotis* isolates from Zaire, Cameroon, Nigeria and Brazil. Besides their yellow color, a slower growth on Difco NA and formation of long chains of cells in yeast-sucrose broth, all isolates from *X. cassavae* could also be differentiated from *X. manihotis* by a strong requirement of thiamine, a longer delayed Kowacs oxidase reaction, a more rapid formation of acid from maltose and a lower optimum and max temp and decimal reduction time at 55°C. Both produced Cx endoglucanase, pectine transeliminase and polygalacturonic acid transeliminase on cassava stem medium. When inoculated in young cassava plants under controlled environmental conditions, *X. cassavae* induced angular leaf spots less rapidly than *X. manihotis*, with only exceptional evolution to leaflet blight. In the stem its spread was mainly restricted to the cortex leading to the formation of necrotic areas on the bark and sometimes to dieback by girdling; whereas *X. manihotis* shows a rapid spreading through the xylem vessels, leading to shoot wilt. Optimum temp for disease development is ca. 25° for *X. cassavae* and 30° for *X. manihotis*. Symptoms induced by the latter were always severer than those due to the former. It is recommended to use the following names for these 2 organisms: *X. campestris* pv. *cassavae* and *X. campestris* pv. *manihotis;* and for the diseases they induce, cassava bacterial necrosis and cassava bacterial blight. (*Author's summary*) E02

0201-11249 LAMBOTTE, M. and PERREAUX, D. **Histopathology of cassava bacterial blight in susceptible and tolerant cultivars.** *In* Maraite, H. and Meyer, J.A , eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp 153-160. Engl , Sum. Engl., 11 Refs., Illus.

Cassava. *Xanthomonas manihotis.* Cultivars. Resistance. Plant tissues. Analysis.

Fluorescence microscopy, associated with histochemical tests, was used to study differences in reaction to infection by *Xanthomonas manihotis* in cassava cv. 60444, Isunikakiyan, 5733, 58308, with increasing tolerance to CBB. Samples were taken around the inoculation point 18 days after inoculation by stem puncture when differences in disease expression among the cv. were evident. No histological differences were noted between the control plants of the different cv. punctured with a sterile needle. In the inoculated plants of all cv. a pathological primary fluorescence of the walls of the cortical parenchyma cells, of the laticifers and the phloem cells was detected. The extent of fluorescence was related to the importance of bacterial colonization. Lytic bacterial pockets were observed close to the inoculation point in the cortical parenchyma and phloem of both susceptible and tolerant cv. In susceptible 60444, circular bacterial pockets extended around the extremity of the xylem bundles; these pockets were found only exceptionally in resistant 58308, where, however, an increased fluorescence of the vessel walls and an induced fluorescence of those of the parenchyma cells surrounding the protoxylem were detected. Cicatrization tissue bordering the fluorescent area was often noted as well. The fluorescent zones were only partially stained with phloroglucinol. (*Author's summary*) E02

0202-11247 DANIEL, J.F., BOHER, B. and KOHLER, F. **Les maladies bactériennes du manioc en République Populaire du Congo et en Empire Centrafricain: étiologie et épidémiologie.** (*Bacterial diseases of cassava in the People's Republic of the Congo and the Central African Republic: etiology, epidemiology*). *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.131-140. Fr., Sum. Engl., 26 Refs.

Cassava. *Xanthomonas manihotis Erwinia carotovora.* **Etiology. Epidemiology. Congo. Central African Republic.**

In surveys from 1976-78, *Xanthomonas manihotis* and *Erwinia carotovora* var. *carotovora*, causal agents of CBB and soft root rot, respectively, were recorded on cassava in Congo and Central Africa. Despite the lack of accurate statistical data due to the fact that cassava cultivation is mainly of a family type, it appears that CBB is one of the most important factors limiting this crop in the Congo Isolates obtained from samples showing symptoms of this disease were characterized by studying their morphological and biochemical characters in comparison with reference strains. In artificial inoculations field symptoms were reproduced. CBB develops mainly in savanna areas. Symptoms are present throughout the crop cycle (10-18 mo), but become severest in the rainy season. (*Extracted from author's summary*) E02

0203-11220 FREIRE, J.R J. **Considerações acerca da provável identidade entre** *Bacterium robice* **Bour. e** *Xanthomonas manihotis* **(Arthaud Berthet) Burk.** (*Considerations regarding the probable identity of Bacterium robice and Xanthomonas manihotis*) Agros 6(3):111-117. 1955. Port , Sum Port , Engl., 14 Refs , Illus.

Cassava. *Xanthomonas manihotis.* **Etiology. Brazil.**

Bacterium robici produces foliar lesions on cassava in Madagascar; *Xanthomonas manihotis* causes similar symptoms and attacks vascular stem bundles as well on cassava in Brazil. The characteristics of the 2 species are similar, and they are probably synonymous. Comparative tests with the 2 cultures are recommended. (*Author's summary*) E02

0204-11250 PERREAUX, D. **Study on toxin production by** *Xanthomonas manihotis. In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.161-167. Engl., Sum. Engl., 16 Refs., Illus.

Cassava. Laboratory experiments. *Xanthomonas manihotis.* **Toxins.**

A toxic substance that simulates the blight symptom on cassava leaves and also causes rapid collapse of tomato cuttings and parenchyma of tobacco leaves is produced by *Xanthomonas manihotis* on a modified Watanabe medium and can be extracted at pH 4 by ethyl acetate. Separated on Sephadex G 10, the toxic fractions show a max absorbance at 200 nm. (*Author's summary*) E02

0205-1408 TERRY, E.R **Diagnosis of cassava bacterial blight disease.** *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 5-8. Engl , 7 Refs., Illus.

Cassava. *Xanthomonas manihotis*. Leaves. Stems. Nigeria.

The following aspects of CBB are discussed: characteristic symptoms, isolation of the causal agent from diseased leaves and stem pieces. The 5 methods used to establish pathogenicity and possible reactions are briefly outlined. (*Summary by T.B*) E02

0206-1482 BRADBURY, J.F. *Xanthomonas manihotis*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria no. 559. 1977. 2p. Engl.,2 Refs.

Cassava. *Xanthomonas manihotis*. Culture media. Disease transmission.

A description is given of *Xanthomonas manihotis* based on the original observation of 9 isolates from various geographic areas and supplemented by Dye (1962) and Lozano & Sequeira (1974). Synonymy (including *X cassavae*), symptoms, geographical distribution, race variation and transmission are discussed. (*Summary by T.B.*) E02

0207-10416 TOMINAGA, T. *et al.* *Xanthomonas manihotis* (Arthaud-Berthet and Bondar) Starr, the cause of cassava bacterial blight in Indonesia. Bogor, Indonesia, Central Research Institute for Agriculture. Contribution no. 38. 1978. 16p. Engl , Sum. Engl., Ind., 28 Refs , Illus.

Cassava. *Xanthomonas manihotis* Isolation. Laboratory experiments. Biochemistry. Indonesia.

A report is given of CBB on cassava in South Sulawesi, West Java, and Sumatra in 1974. Symptoms and identification of the causal agent, *Xanthomonas manihotis*, are described. (*Summary by T.B*) E02

0208-10491 PERSLEY, G.J. Studies on the epidemiology and ecology of cassava bacterial blight. *In* Terry, E.R., Persley, G.J. and Cook, S.C.A , eds Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.5-7. Engl., 2 Refs., Illus.

Also in French

Cassava. *Xanthomonas manihotis*. Epidemiology. Ecology. Nigeria.

In order to determine why CBB (a rain-splash disseminated disease) is more widespread and damaging in the savanna and forest/savanna transition zones than in rainy forested areas, a study was made of (1) epidemic development from inoculated cuttings in 3 climatic zones of Nigeria and (2) survival of the pathogen during the dry season in the absence of an epidemic. Results confirmed field observations and also indicated that cultural control should be possible by a short (2-3 mo) fallow period during the early rains, prior to replanting with healthy material. (*Summary by T.B.*) E02

0209-10430 ARENE, O.B. and ODURUKWE, S.O. **The role of NPK-fertilization in inducing resistance in cassava to cassava bacterial blight.** Umudike, Nigeria, National Root Crops Research Institute, 1978. 8p. Engl., Sum. Engl., 12 Refs.

Cassava. N. P. K. *Xanthomonas manihotis.* Field experiments. Analysis. Mineral content. Plant tissues. Fertilizers. Resistance. Nigeria.

The effect of NPK fertilization on early growth vigor of cassava in relation to CBB severity was studied in 4 cv. of predetermined susceptibility, using a randomized complete block design with 10 replications. Parameters of vigor studied were height, fresh wt and DM content. Tissue analysis showed the less susceptible cv. had significantly less N, Ca, Mg, P and K than the most susceptible one The opposite trend was observed among the parameters for vigor, which were significantly low in the very susceptible cv. In a 3^3 factorial expt the relationship of NPK nutrition to vigor and CBB was studied. Vigor increased with an increase in NPK levels up to a point and then decreased at higher levels of fertilization. It seems, therefore, that tolerance to CBB due to fertilization is related to plant vigor. (*Author's summary*) E02 D01

0210-10925 PERSLEY, G.J **Epiphytic survival of *Xanthomonas manihotis* in relation to the disease cycle of cassava bacterial blight.** Brisbane, Australia, University of Queensland. Department of Microbiology, 1978. 4p Engl., Sum Engl., 1 Ref., Illus

Paper presented at International Conference on Plant Pathogenic Bacteria, 4th., 1978.

Cassava. *Xanthomonas manihotis.* Leaves. Cultivars. Resistance. Laboratory experiments. Nigeria.

An epiphytic phase was shown to be part of the disease cycle of CBB at Ibadan (Nigeria), an area that has a 5-mo dry season. *Xanthomonas manihotis* occurred on leaf surfaces of plants with no symptoms of CBB, of both resistant and susceptible var.; on symptomless leaves of infected plants; and on leaves with angular leaf spots. The pathogen was consistently found on leaf surfaces during the rainy season; it was detected less frequently and at lower levels at the beginning and end of the rainy season and during the dry season after unseasonal rain. This suggests that it survives the dry season as an epiphyte and increases in no. when moisture becomes available; the no. again decrease when moisture is limited. The widespread and rapid development of new angular leaf spots as rains become frequent at the beginning of the wet season probably results from the epiphytic population that has survived the dry season. The sensitivity of a leaf-infiltration method for detecting epiphytic populations is discussed. (*Author's summary*) E02

0211-10487 HAHN, S.K. **Breeding cassava for resistance to bacterial blight.** PANS 24(4):480-485. 1978. Engl., Sum. Engl., Fr., Span., 10 Refs., Illus.

Cassava. *Xanthomonas manihotis* Resistance. Selection. Cultivars. Plant breeding. Germplasm. Genetics. Nigeria.

Cassava bacterial blight has been reported in several African countries Heavy infection with CBB can lead to total crop failure as most local var. are very susceptible. The best control method is through varietal resistance. IITA has made progress in breeding for resistance to both CBB and African cassava mosaic disease (AMD), incorporating simultaneously other desirable agronomic qualities. Since 1972, 583 cassava families from CIAT, East Africa and IITA have been tested for

sources of high resistance to CBB and 748 IITA clones for CBB resistance in an ecological setting of high rainfall, sandy and acid soil. Cv. 58308 emerged highly resistant Other aspects of the breeding-work discussed are conditions affecting varietal selection· genetic mechanism resistance, stability of resistance to CBB over time and in different areas in Africa; high heritability; genetic correlation between resistance to CBB and AMD: correlation of CBB resistance to CBB and AMD; correlation of CBB resistance with other characteristics such as root yield and leaf defoliation; and finally some factors affecting CBB field scores. The sources of high resistance to CBB identified have been quickly and successfully incorporated into promising cassava clones. (*Author's summary*) E02 G01

0212-10486 LOZANO, J.C. and BELLOTTI, A. *Erwinia carotovora* var. *carotovora*; causal agent of bacterial stem rot of cassava: etiology, epidemiology and control. PANS 24(4):467-479. 1978. Engl., Sum. Engl., Fr., Span., 25 Refs., Illus.

Cassava. *Erwinia carotovora Anastrepha pickeli*. Stems. Disease control. Isolation. Vectors. Epidemiology. Etiology. Insect control. Pest damage. Productivity. Colombia.

In Colombia a bacterial disease of cassava associated with cassava fruit fly (*Anastrepha* spp.) damage has been observed during the past 4 yr Following stem damage by *Anastrepha* larvae, the pathogen enters the plant. The symptoms are internal rotting of the stem, wilting of young shoots or branches, followed by tip collapse and dieback or canker formation of lignified stem parts. The cassava stem rot bacterium (CSRB) is a slender gram-negative rod with an av size of 2 4 x 1.2 μm. The cells are motile and possess 4 - 8 peritrichous flagella. In 48-h-old cultures, the cells are single or in chains of 2 - 3 cells, unencapsulated and nonspore forming. Biochemical, physiological and cultural characteristics of CSRB are presented. It is concluded that CSRB is a close relative of the *E. carotovora* group and is indistinguishable from *E carotovora* var. *carotovora*; it is distinct from *E cassavae*. As a result, cassava is now reported as a host of *E. carotovora* var. *carotovora*. The use of clean, CSRB-uninfected cuttings of var. resistant to the insect vector seems to be the most promising control measure. Other methods are the use of insecticides and/or attractants. (*Author's summary*) E02 F01

0213-10053 ENE, L.S.O. Control of cassava bacterial blight (CBB). Tropical Root and Tuber Crops Newsletter no. 10:30-31. 1977. Engl.

Cassava. *Xanthomonas manihotis*. Disease control. Intercropping. N. P. K. Fertilizers. Nigeria.

CBB was significantly reduced by providing shade (intercropping cassava with maize or melon) or by any other means of reducing the impact of rain drops, such as mulching. Biweekly foliar application of Agrimycin 500 at 800 g/1000 *l* of water/ha significantly reduced CBB incidence. (*Summary by Abstracts on Tropical Agriculture*) E02

0214-10058 DANIEL, R.S., NAIR, N.G. and HRISHI, N. A new wilt disease of cassava. Journal of Root Crops 1:81-83. 1975. Engl., Sum. Engl., 5 Refs., Illus.

Cassava. Bacterioses. Etiology. *Pseudomonas*. India.

A new disease causing the sudden wilting of cassava plants was found on the Central Tuber Crops Research Institute farm and in isolated parts of the state of Kerala. The disease is characterized by drooping of leaves and a black linear discoloration of the stems and roots It appears to be different in its symptomatology from CBB, described by Lozano & Sequeira from Colombia in

1974. The causal organism is a bacterium; studies are under way to identify the pathogen and to develop control measures. (*Author's summary*) E02

0215-9931 NAIR, N.G **Bacterial diseases of cassava.** *In* Hrishi, N and Gopinathan Nair, R., eds Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.66-68. Engl., Illus.

Cassava. *Erwinia cassavae Xanthomonas manihotis* **Leaves. Petioles. Stems.**

Four bacterial diseases of cassava have been reported thur far. The causal organisms are *Bacterium cassavae* (Uganda), *Xanthomonas cassavae* (Nyasaland) and *X. manihotis* (Africa and S A.). Symptoms are described briefly, with emphasis on CBB, the most important disease. Another bacterial disease has been reported from Kerala, the causal organism of which has not yet been identified positively; it may be a strain of *Pseudomonas solanacearum* Species of *Bacillus, Erwinia* and *Corynebacterium* have been reported inducing soft rots but are more important in the postharvest damage of roots (*Summary by R.A.F*) E02

0216-10432 ARENE, O. B. **Advances in control of bacterial blight disease of cassava** *(Manihot utilissima* **Pohl.).** Umudike, Umuahia, Federal Agricultural Research and Training Station, 1975. 17p. Engl., Sum Engl., 16.Refs

Paper presented at Annual Conference of the Nigerian Society for Plant Protection, 5th., Samaru, Nigeria, 1975

Cassava. *Xanthomonas manihotis.* **Disease control. Plant breeding. Resistance. Nigeria.**

Advances made in the control of CBB are reviewed with regard to the pathogen (reduction of the inoculum by pruning, use of clean planting material, crop rotation and chemical control), environmental conditions (planting dates) and the host (selection of resistant var. and agronomic management of the crop). *(Summary by T.B)* E02

0217-10498 AKLE, J and CNOUHOUE, H **Cassava bacterial blight development in Benin.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report London, England, Centre for Overseas Pest Research, 1979. p 43. Engl.

Also in French

Cassava. *Xanthomonas manihotis.* **Disease control. Cassava programs. Benin.**

CBB is believed to have been present in Benin since 1968 but did not become serious until 1975-76. Mention is made of the campaign being carried out by the Service de la Protection des Végétaux et de la Recherche Agronomique to inform farmers and extension workers about how to recognize symptoms and adopt preventive measures. A var. testing program was initiated at the Research Station on Food Crops, Niaouli in 1977 with 32 var. from IITA, Ibadan and 2 from IRAT, Bouaké. Promising material will be used for breeding to develop well-adapted, tolerant var. (*Summary by T B.*) E02

0218-10497 TERRY, E.R. **Integrated control of cassava bacterial blight in Africa.** *In* ——. Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.35-39. Engl., 33 Refs

Also in French

Cassava. *Xanthomonas manihotis.* **Disease control.-Resistance.-Africa.**

In 1975 world cassava production was 105 million t, of which some 44 million t (43%) were from Africa. The factors affecting integrated control are discussed. Chemical control is not possible since cassava is mainly a subsistence crop, intercropped in small holdings Integrated control should be based on cultural control measures, exclusion of the pathogen, sanitation, management practices and host plant resistance (IITA is releasing clones selected for resistance to CBB). (*Summary by F.G. Trans. by T.B.*) E02

0219-10500 DANIEL, J.F. *et al.* **Cassava bacterial blight in the Congo: Etiology, epidemiology and control.** *In* Terry, E.R , Persley, G J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979 pp.49-54. Engl., 8 Refs., Illus.

Also in French

Cassava. *Xanthomonas manihotis.* **Etiology. Epidemiology. Symptomatology. Isolation. Disease control. Germplasm. Resistance. Congo.**

Surveys were conducted in the Congo from 1976-77 to determine the distribution of CBB The disease has spread along the border with Zaire, with important outbreaks in Loutete, Mouyoundzi and Mindouli; in the Central African Empire there have been important outbreaks adjacent to Cameroon Etiology, symptomatology, epidemiology and control measures (collection of resistant germplasm and introduction of genotypes from IITA) are described. (*Summary by F.G Trans. by T.B*) E02

0220-10931 ATHAYDE, J.T., FURTADO, M.J. and NETO, A.M. **Levantamento de bacteriose (*Xanthomonas manihotis* (Arthaud Berthet) Starr) da mandioca (*Manihot esculenta* Crantz) na região norte do estado do Espíritu Santo.** (*Survey of cassava bacterial blight in the northern part of the state of Espíritu Santo*). Cariacica-ES, Brasil Empresa Capixaba de Pesquisa Agropecuária Comunicado EMCAPA no. 01. 1978. 10p. Port., 4 Refs.

Cassava. Field experiments. Laboratory experiments. *Xanthomonas manihotis.* **Epidemiology. Isolation. Cultivars. Brazil.**

A survey was conducted in 1978 to determine the extent of CBB dissemination in the state. Material presenting disease symptoms (58 samples) was collected, and farmers were interviewed to obtain information on the municipality, origin of the cuttings planted, area planted, area infected and age of the crop. It was found that *Xanthomonas manihotis* is disseminated in the municipalities of Aracruz, Conceição da Barra, Ibiraçu, Linhares, Mucurici, Nova Venécia, Pinheiros and São, Mateus. (*Summary by F.G. Trans by T.B.*) E02

0221-11729 DANIEL, J F. and BOHER, B **Ecology of cassava bacterial blight: epiphytic survival of *Xanthomonas manihotis* on aerial parts of the cassava plant.** *In* International Conference on Plant Pathogenic Bacteria, 4th., Angers, France, 1978. Proceedings. Angers, Institut National de la Recherche Agronomique, 1978. pp 763-771 Engl., Sum. Engl , 8 Refs., Illus.

Cassava. *Xanthomonas manihotis*. Ecology. Symptomatology. Isolation.

A study of bacterial microflora of cassava plants (var. Mpembé) localized in fields already infected with CBB in Congo Brazzaville revealed the presence of *Xanthomonas manihotis* on healthy aerial parts. The pathogen has never been detected in healthy fields. During the rainy season the no. of bacteria/leaf is high (10^5-10^7), thus providing a sufficient source of inoculum to ensure contamination. During the dry season it decreases, sometimes in such proportions that it becomes undetectable. (*Extracted from author's summary*) E02

0222-10499 NYANGO, A.K. **Cassava bacterial blight in four regions of the United Republic of Tanzania.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp 44-48. Engl , 9 Refs., Illus.

Also in French

Cassava. *Xanthomonas manihotis*. Field experiments. Epidemiology. Maps. Cassava programs. Tanzania.

The incidence and severity of CBB was determined in the area adjacent to Lake Victoria. Samples were taken at random during the rainy season, the no. varying according to field size (0.25-20 ha). CBB appears to be widespread in the zone. Selection for resistance is of immediate importance, and crop rotation and mixed cropping should be encouraged. Future research will be based on resistant local material, the development of rapid multiplication techniques, cultural control methods, identification of the strain of *Xanthomonas manihotis* found in this zone; and the training of local agricultural workers so they can identify the disease. (*Summary by F.G. Trans. by T B.*) E02

0223-11705 IKOTUN, T. **Histopathology of cassava tissues infected by *Xanthomonas manihotis*.** Acta Phytopathologica Academiae Scientiarum Hungaricae 13(3/4):383-390. 1978. Engl., Sum Engl., 12 Refs., Illus.

Cassava. *Xanthomonas manihotis*. Plant tissues. Leaves. Stems. Laboratory experiments. Analysis.

The histopathology of cassava leaf and stem tissue infected by *Xanthomonas manihotis* was investigated by electron microscopy. The pathogen multiplied in the intercellular spaces of cells, from where it attacked and degraded the pectic substances in the middle lamella. Undegraded cellulose microfibrils in the cell walls were exposed and dispersed, and cytoplasmic contents of cells were disorganized and scattered. The degraded cell walls were separated, and the pathogen entered the cytoplasm, destroying the cellular contents. All tissues of infected plants were invaded and disintegrated enzymatically. *X. manihotis* should be regarded as a parenchyma not a vascular pathogen since vessels were not physically blocked by the pathogen but were degraded and disintegrated. (*Author's summary*) E02

0224-11001 PERREAUX, D., MARAITE, H. and MEYER, J. **Histopathological study by fluorescent microscopy of cassava stems infected by *Xanthomonas manihotis*.** *In* International Conference on Plant Pathogenic Bacteria, 4th., Angers, France. 1978. Proceedings. Angers, Institut National de la Recherche Agronomique, 1978. pp.935-941. Engl., Sum. Engl., 14 Refs , Illus.

Cassava. *Xanthomonas manihotis*. Plant tissues. Stems. Plant injuries. Laboratory experiments.

Besides angular leaf spots and blight, *Xanthomonas manihotis* also causes systemic infection leading to exudation, leaf wilt and tip dieback. The day-by-day progression of infection and tissue deterioration in a susceptible cassava cv. inoculated by stem puncture was studied by fluorescent microscopy. The 1st reactions to infection are visible at 4 days. from the inoculation level to 4 cm above it, some cells between the vessels corresponding to the needle penetration axis appear opaque under UV light and filled with a dark brown substance under natural light. In the same stem portion some vessels are partially or totally obstructed by tyloses Afterwards, lytic pockets develop in the protoxylem parenchyma, extend to the whole xylem, the phloem and the cortex, finally extruding an exudate. The parenchyma cell walls surround the infected vessels and bacterial pockets show increased primary fluorescence under UV light, starting from the corner of the cells. The pockets are filled with mucilage-containing bacteria, the fluorescence of which increases with time. The laticiferous cells are the 1st to show increased fluorescence in the phloem. In the cortex the collenchyma cells walls also show a characteristic increase in fluorescence during infection progression. Intensity of fluorescence is related to the amount of tissue destruction. During the up- and downward migration of the bacteria, the vessel cell walls 1st show an accentuation of fluorescence, followed by the corner of xylem parenchyma cells, suggesting a main migration through the xylem vessels and then to the intercellular spaces of parenchyma. Fluorescence is generally associated with the presence of substances reacting with phloroglucinol. (*Author's summary*) E02 C00

0225-4421 ARENE, O.B. **Preliminary results on the effect of nitrogen, phosphorus and potassium as fertilizer factors on cassava bacterial blight in Nigeria.** *In* Ene, L.S.O. *et al*, eds National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.202-207. Engl., 7 Refs

Cassava. *Xanthomonas manihotis*. Fertilizers. N. P. K. Field experiments. Nigeria.

The effect of fertilization on CBB was studied in a randomized block design with 3 replications, using a very susceptible cv. (53101) and 0-30-60, 0-15-30 or 0-90-180 NPK. Disease severity and incidence were determined 4 mo after planting. Only K had a significant effect (5% level) on CBB, reducing incidence and severity by approx 12.3 and 12.5%, respectively. There was no interaction between N and P or N and K, but there was between P and K (in the absence of P the response to K was high). It is concluded that apparently any factor increasing yield and therefore vigor will reduce the effect of CBB. (*Summary by I.B Trans. by T.B*) E02

0226-4616 BOOTH, R.H. and LOZANO, J.C. **Cassava bacterial blight in South East Asia.** Plant Disease Reporter 62(6):529-530. 1978. Engl., 9 Refs.

Cassava. *Xanthomonas manihotis*. Disease control. Symptomatology. Asia.

The presence of CBB in W. Malaysia, Indonesia and Thailand in 1976-77 is reported; in Taiwan it is one of the major factors limiting to production (ca. 30% losses). Pathogenicity tests conducted under controlled conditions at CIAT showed the causal agent to be the same as in S.A. and Africa

but varying in virulence It appears that there is less systemic stem infection and that dissemination of *Xanthomonas manihotis* is largely confined to rain splash and movement of water or dew. Variations in disease expression are probably due to climatic factors, particularly those affecting water relationships. (*Summary by I B. Trans by T.B.*) E02

0227-10495 ONYANGO, D M. and RAMOS, A.H. **Bacterial blight of cassava in Kenya.** *In* Terry, E R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.25-28. Engl., 5 Refs., Illus.

Also in French

Cassava. *Xanthomonas manihotis*. Isolation. Laboratory experiments. Symptomatology. Maps. Kenya.

Samples of infected leaves and stems were collected approx every 10 km in Nyanza and W. Provinces to study the characteristics of the causal agent of CBB. White and/or yellow colonies were isolated from the suspensions and inoculated in 1-mo-old cassava cuttings with about 20 nodes. Both bacteria produced lesions but progressed at a different rate and intensity, the white bacterium spreading rapidly upwards and downwards, and causing wilting of the whole plant in 1 mo. It is concluded that the white bacterium is *Xanthomonas manihotis* and the yellow one *X. cassavae*. It is suggested that the latter is a constant component of cassava epiphytic microflora and is thus present in all cassava-growing areas. It is not usually subcultured since the faster growing *X. manihotis* is cultured 1st and it is often taken for granted that the presence of yellow colonies constitutes contaminant *Erwinia*. *X. cassavae* causes a mild nonlethal disease, indicating long-standing association between it and the host plant. (*Summary by F.G. Trans. by T.B.*) E02

0228-10903 KORANG-AMOAKOH, S. and ODURO, K.A. **Present situation of cassava bacterial blight disease in Ghana.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.58-59. Engl., 2 Refs.

Also in French

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

CBB is still confined to the S. sector of Ghana, and quarantine measures have been adopted to prevent its spread. Many farmers have adopted cultural control measures (removal and burning of plants with symptoms, collection and burning of debris, fallowing of affected land, use of disease-free planting material) and thus disease incidence was reduced in 1977. AMD- and CBB-resistant material has been obtained from IITA and will be evaluated under Ghana conditions. (*Summary by F.G. Trans. by T.B.*) E02

0229-10417 HAHN, S.K. and WILLIAMS, R J. **Investigations on cassava in the Republic of Zaire.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1973 12p. Engl.

Cassava. Cassava programs. Diseases and pathogens. *Xanthomonas manihotis*. Symptomatology. Disease control. Zaire.

A disease of cassava, characterized by leaf wilt and tip dieback, was finally identified as CBB, the causal agent of which is *Xanthomonas manihotis* and not the insect *Pseudotheraptus devastans* as previously reported. Control measures include the use of susceptible var., the partial planting of a nonhost (sweet potatoes) in severely affected areas and the use of disease-free planting material. (*Summary by T.B.*) E02

0230-10496 IKOTUN, T. **Effects of *Xanthomonas manihotis* on cassava tissues.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.29-32. Engl., 22 Refs., Illus.

Also in French

Cassava. *Xanthomonas manihotis*. Symptomatology. Plant tissues. Isolation. Laboratory experiments. Physiological disorders (plant). Nigeria.

A study was made of physiological disorders caused by *Xanthomonas manihotis* in cross sections of stems taken at 3-day intervals from infected cassava plants until they were completely wilted. It was shown that bacterial cells were not found in the lumen of xylem cells but rather along cells surrounding the walls of the lumen. Structural and ultrastructural studies also showed that the invasion and multiplication of the bacteria occur in the intercellular spaces; the major enzyme responsible for the degradation of the cell wall is the polygalacturonate *trans*-eliminase. It is concluded that *X. manihotis* should be regarded as a parenchymatous, not a vascular pathogen. (*Summary by F.G. Trans. by T.B.*) E02

0231-11239 TERRY, E.R. **Vegetatively-borne root crops pathogens and techniques for their elimination.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.27-38. Engl., Sum. Engl.; 35 Refs.

Cassava. Bacterioses. Viroses. Propagation materials. Disease control. Nigeria.

Because of the vegetative propagation of root and tuber crops, pathogens that persist in the vegetative organs are transmitted simultaneously. A review is made of some important vegetatively borne virus, bacterial and fungal pathogens of cassava; and virus, bacterial and nematode pathogens of yams and sweet potatoes. The distribution, transmission and techniques for eliminating some of these pathogens are analyzed. (*Author's summary*) E02 E04

See also 0293 0307

E03 Mycoses

0232-10940 MONJELO, L.A. DOS S. **Incidência de fungos em sementes de *Manihot esculenta* Crantz; uma comparação entre variedades do Amazonas e de São Paulo.** (*Incidence of fungi on cassava seed Comparison of varieties from the Amazonas and São Paulo*). Acta Amazônica 7(4):455-458 1977. Port, Sum Port, Engl., 1 Ref

Cassava. Cultivars. Seed. Mycoses. Brazil.

Aspergillus sp. and *Penicillium* sp were the most common fungi found in 5 var. of cassava seeds from Amazonas and São Paulo. The Amazonian var. Poré was the least susceptible to fungal development while the most affected var was Yara x Vassouras from São Paulo. (*Summary by Abstracts on Tropical Agriculture*) E03

0233-4313 RAJAN, K.M. and RAJ, J.S. **Relation of certain chemical constituents of tapioca to the leaf spot disease.** Journal of Root Crops 3(1):61-62. 1977. Engl., 8 Refs.

Cassava. *Cercospora henningsii*. Leaves. Resistance. Cultivars. C. N. HCN content. Analysis. Carbohydrate content.

Since *Cercosporidium* (*Cercospora*) *henningsii* appears only on older cassava leaves (after 1st 4 leaves), a study was made of the chemical changes (total N and carbohydrate content) occurring in the leaves of plants attacked by brown leaf spot, using the highly susceptible var. Rottikappa. A direct relationship was found between carbohydrate content and the no. of spots. A gradual increase in carbohydrate content was found as leaves matured, and there was a corresponding increase in the no. of spots Young leaves also had a narrower C:N ratio (2.6.1) than older leaves (3.3.1) Similar results found in other crops are mentioned. The possible effect of high N on increased HCN content and the role of the latter in resistance are discussed. (*Summary by T.B*) E03 C03

0234-10063 CHEN, C.T. [**Preliminary study on a new leaf-spot disease of cassava caused by *Periconia manihoticola***]. National Science Council Monthly 6(4):410-414. 1978. Chin., Sum. Chin., Engl., 10 Refs., Illus.

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

A previously undescribed leaf spot disease caused by *Periconia manihoticola* was found on cassava in Taiwan in 1975. *P. manihoticola* sporulated well on PSA and V-8 juice agar, producing dark brown, globose and verrucose conidia, which varied widely in size (ϕ 22-43μm). Small circular brown spots with yellow halos developed on inoculated leaves 24-36 h after inoculation. These spots enlarged to 2-4 mm with a dark brown border, and the center of the spot gradually turned light brown. All cassava clones tested including Wu-Chi, I-Chi-Hsiang and Pai-Fen were susceptible. Optimum temp for mycelial growth of *P. manihoticola* was 22°C. Spores germinated

better at 18 and 22° than at 30°C, which indicates that the fungus tends to grow and survive at lower temp. This was in accordance with the fact that Periconia leaf spot always occurred on the hillsides at higher elevations. (*Author's summary*) E03

0235-9978 ILAG, L.L. **Isolation of *Aspergillus flavus* and other mycotoxin-forming fungi.** *In* ——. Advances in food, agriculture and community research and development. Los Baños, University of the Philippines. 1974. pp.452-454. Engl., 2 Refs.

Cassava. *Aspergillus*. Isolation. Culture media.

Pure culture isolates of mycotoxin-forming fungi were obtained from different crops including cassava, from which *Aspergillus flavus* and *A. tamarii* were isolated. (*Summary by T.B.*) E03

0236-4435 LOZANO, J.C. **Cassava superelongation.** Cassava Newsletter no. 2:5-6. 1977. Engl, 7 Refs., Illus.

Also in Spanish.

Cassava. *Sphaceloma manihoticola*.

Superelongation disease was 1st reported in 1972. It causes losses in cassava of >80% on susceptible var. in Colombia, Brazil, C.A. and Venezuela. Its causal agent is the fungus *Sphaceloma manihoticola*, the spores of which are disseminated in the air by wind. In susceptible var. the plants elongate considerably, causing weak stems, dieback and defoliation. Resistance should be used and propagating material can be treated with the fungicide captafol. When the plants are at least 6 mo old before becoming infected, then the reduction in yield is not so severe. (*Summary by Abstracts on Tropical Agriculture*) E03

0237-11241 MAKAMBILA, C. **L'anthracnose du manioc en République Populaire du Congo.** (*Cassava anthracnose in the People's Republic of the Congo*). *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.61-69. Fr., Sum Engl., 3 Refs., Illus.

Cassava. *Glomerella cingulata* Epidemiology. Mycoses. Congo.

Anthracnose has been found in all cassava-growing regions of the People's Republic of the Congo; but severity varies according to the region, being more important in the savanna than in the forest region. Rain seems to be a very important factor in its development. Some local cv. and some improved genotypes received from IITA show resistance. All isolations made from diseased material have given pure cultures of fungi belonging to *Glomerella cingulata*, the conidial state of *Colletotrichum manihotis*, and to the genus *Vermicularia*. Isolates were heterogeneous in their pigmentation, growth and sporulation rates. (*Author's summary*) E03

0238-4214 NARASIMHAN, V. and ARJUNAN, G **Fungicidal control of brown leaf spot of tapioca** (*Manihot esculenta* Crantz). Pesticides 11(5) 46-47. 1977 Engl, 7 Refs.

Cassava. *Cercospora henningsii*. Disease control. India.

In an evaluation of 5 fungicides for controlling brown leaf spot [*Cercosporidium* (*Cercospora*) *henningsii*] in cassava, all were effective in reducing disease incidence; but Benlate (0.1%) was significantly better than the control (31.9 vs. 57.7% disease incidence; 16.8 vs. 10.0 t roots/ha). (*Summary by T.B*) E03

0239-11002 MARAITE, H. and MEYER, J.A. **La verticilliose du manioc en Afrique Centrale.** (*Cassava wilt caused by Verticillium dahliae*). Bulletin des Séances de la Académie Royale des Sciences Coloniales d'Outre-Mer 3·443-446 1976 Fr., Sum. Fr., Flem., Engl., 5 Refs.

Cassava. *Verticillium dahliae*. Rwanda.

Verticillium dahliae was isolated from wilting cassava plants from Rwanda. Inoculations of young rooted cuttings with *Verticillium* strains from cassava, tomatoes and cotton confirmed the susceptibility of cassava to this parasite. Symptoms induced by the tomato strain were less severe than those produced by the other 2. (*Author's summary*) E03

0240-11004 MARAITE, H. and MEYER, J.A. **Cassava wilt due to *Verticillium dahliae*.** FAO Plant Protection Bulletin 25(3):129. 1977. Engl.

Cassava. *Verticillium dahliae*. Rwanda.

Cassava grown in the high alt of Rwanda was attacked by a wilt in 1975. The causal agent is *Verticillium dahliae*. The danger of dissemination on cuttings is pointed out. (*Summary by T.B.*) E02

0241-11772 LARIOS C., J.F. Epifitiología de algunas enfermedades foliares de la yuca (*Manihot esculenta* Crantz) en diferentes sistemas de cultivo. (*Epiphytology of some leaf diseases of cassava in different cultivation systems*). Tesis Mag. Sc. Turrialba, Universidad de Costa Rica. Centro Agronómico Tropical de Investigación y Enseñanza, 1975. 115p. Span , Sum Span., Engl., 79 Refs., Illus.

Cassava. Sweet-potatoes. Maize. Beans. Intercropping. *Uromyces manihotis. Cercospora henningsii Sphaceloma.Oidium.* **Planting. Spacing. Epiphytology.. Costa Rica.**

The relative importance and development of leaf diseases of cassava were studied at Turrialba, Costa Rica under the following cultivation systems: cassava alone, cassava + sweet potatoes, cassava + beans, cassava + maize, and cassava + beans + maize. A randomized complete block design with 4 replications was used. Max severity, infection rate and variability among treatments was studied and data correlated with 15-18 agroclimatic variables According to leaf area affected, the most important diseases were cassava ash (*Oidium manihotis*), superelongation (*Sphaceloma* sp.), rust (*Uromyces manihotis*), brown leaf spot (*Cercosporidium henningsii*) and white leaf spot (*Phaeoramularia manihotis* = *Cercospora caribaea*). It was found that the progress of an epidemic can be modified according to the cultivation system. Precipitation, RH and temp were closely related to disease development. Crop age and conditions prevalent during the growth period were very important for the onset, progress and end of an epidemic. Most of the diseases were present at the end of the growth cycle. (*Author's summary*) E03 K01

0242-11240 BOHER, B., DANIEL, J.F. and KOHLER, F. **Les maladies cryptogamiques du manioc en République Populaire du Congo.** (*Fungal diseases of cassava in the People's*

Republic of the Congo). In Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.53-60. Fr., Sum. Engl., 1 Ref., Illus.

Cassava. Mycoses. *Glomerella cingulata. Cercospora henningsii. Cercospora caribaea.* **Congo.**

The main fungal diseases of some economic importance are brown and white leaf spots [*Cercosporidium (Cercospora) henningsii* and *Phaeoramularia manihotis (Cercospora caribaea)*], stem cankers and shoot necrosis caused by *Glomerella cingulata (Colletotrichum gloeosporoides)*, dieback and destruction of cuttings by *Botryodiplodia theobromae*, drying of roots by *Sphaerostilbe repens*, and leaf spots caused by *Mycosphaerella helenae*, *Leptosphaerulina* sp. and *Alternaria* sp. A list of fungi of minor importance is also included. Although widespread, the fungal parasites are of less importance than *Xanthomonas manihotis*. In a no. of cases a *Glomerella/Xanthomonas* association has been observed The prevalence of family-type farming, as well as the lack of production statistics, does not permit the assessment of losses caused by these parasites (*Author's summary*) E03

0243-4320 THANKAPPAN, M. **Addition to the Indian Cercosporae.** Journal of Root Crops 3(1):59. 1977. Engl., 5 Refs.

Cassava *Manihot esculenta. Cercospora caribaea.* **India.**

Phaeoramularia manihotis (Cercospora caribaea) is reported for the 1st time on cassava growing in Kerala State (India). Symptoms and synonyms are given. (*Summary by I.B. Trans. by T.B.*) E03

0244-10932 ATHAYDE, J.T., FURTADO, M.J. and NETO, A.M. **A antracnose (*Colletotrichun gloeosporiodes* f. sp. *manihotis*) da mandioca (*Manihotis esculenta* Crantz) no estado do Espíritu Santo.** (*Anthracnose in the state of Espíritu Santo*). Cariacica-ES, Brasil. Empresa Capixaba de Pesquisa Agropecuária. Comunicado EMCAPA no. 02. 1978. 7p Port., 3 Refs.

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

A study was made of the intensity of attack of anthracnose (*Glomerella manihotis* = *Colletotrichum gloeosporioides* f. sp. *manihotis*) under natural field conditions. The 30 cassava cv. were planted in 6-m rows (12 plants each) and 1 m between rows. Readings were taken at the 1st visible sign of infection, using the grading system proposed by Sudo & Nunes (1973), with modifications in the no. (I-IV). The only highly resistant cv. was Entre Rios. (*Summary by F.G. Trans. by T.B*) E03

E04 Viroses

0245-11242 VERHOYEN, M. **Some observations on cassava mosaic in Zaire.** *In* Maraite, H. and Meyer, J A., eds International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.71-84. Engl., Sum. Engl., 27 Refs., Illus.

Cassava. Cassava African mosaic virus. Disease transmission. Vectors. Disease control. Mosaic diseases. Zaire.

Field observations on AMD from Zaire, as well as expt conducted to identify the causal agent, are reported. A graft technique (bark chip budding) is described, and its implications on clonal control for resistance are discussed in comparison with the detopping method. (*Author's summary*) E04

0246-4292 DANIEL, R.S., THANKAPPAN, M. and HRISHI, N. **Metabolic changes in cassava (*Manihot esculenta* Crantz) due to cassava mosaic virus infection.** Journal of Root Crops 3(1):39-42. 1977. Engl , Sum. Engl., 27 Refs.

Cassava. Cassava African mosaic virus. Leaves. Metabolism. Ca. P. K. Ascorbic acid. India.

Certain changes in the metabolism of leaves of cassava cv. H-97, infected by AMV, were studied. There was a reduction in contents of total phenolics, ortho-dihydroxy phenols, flavonoids, ascorbic acid and Ca, but an accumulation of P and K subsequent to virus infection. It is concluded that this cv. does not have an effective metabolic defense mechanism to counteract AMV infection even though it has a high degree of field resistance (*Author's summary*) E04 C00

0247-4295 THANKAPPAN, M. and CHACKO, C.I. **HCN content of cassava leaves in health and virus infection.** Journal of Root Crops 3(1):37-38. 1977. Engl., Sum. Engl., 8 Refs.

Cassava. Cassava African mosaic virus. HCN content. Leaves. Cultivars. Plant tissues. India.

A study was made of the effect of AMV infection on HCN content in the leaves of cassava cv. M-4, H-97 and H-165. The leaves of the infected plants showed appreciable reduction of HCN content at all stages of maturity. (*Author's summary*) E04 C03

0248-9954 JENNINGS, D.L. **An evaluation of some sources of resistance to two virus diseases of cassava.** Journal of Root Crops 1(1) 19-23. 1975. Engl., 8 Refs., Illus.

Cassava. Cultivars. Hybrids. Plant breeding. Resistance. Cassava African mosaic virus. Cassava brown streak virus. *Manihot esculenta. Manihot glaziovii.* East Africa.

Results of breeding expt in E. Africa show that the determination of parental values for genotypes

provided very close estimates of progeny performance for brown streak resistance and less close ones for AMD resistance, for which specific combining ability was important (*Summary by Abstracts on Tropical Agriculture*) E04

0249-9956 SINGH, S.R. **Cassava mosaic in Africa.** Journal of Root Crops 1(1).39-46. 1975. Engl., 61 Refs.

Cassava. Cassava African mosaic virus. Cultivars. Resistance. Vectors. Africa.

A history of AMD since it was 1st reported in E. Africa (1894) is given. Symptomatology, transmission, causal agent, host range, effect on yield, control and the development of resistant var. are described. (*Summary by T.B.*) E04

0250-10479 BOCK, K.R., GUTHRIE, E.J. and MEREDITH, G **Distribution, host range, properties and purification of cassava latent virus, a geminivirus.** Annals of Applied Biology 90 361-367. 1978. Engl., Sum. Engl., 11 Refs., Illus.

Cassava. Cassava latent virus. Disease transmission. Host range. Antisera. Analysis. Electron microscopy. Laboratory experiments. Kenya.

Cassava latent virus (CLV) in East Africa is almost entirely confined to upland cassava-growing areas W of the Rift Valley, where it is often associated with AMD (it was isolated from 27 of 38 plants with mosaic but not from 24 without mosaic); however, it is not the causal agent since it was not recovered from any of 31 plants with AMD in coastal districts. All attempts to return CLV to cassava failed. The host range of CLV appears to be limited to Euphorbiaceae (*Manihot*) and Solanaceae (*Nicotiana, Datura, Nicandra, Solanum*). *N. clevelandii* proved the most useful assay and propagation host. The dilution end-point of CLV was ca. 10^{-3}, the thermal inactivation point ca. 55°C and longevity in vitro ca. 3 days. CLV was purified by clarifying leaf extracts with butanol/chloroform mixtures. Purified preparations (*A* 260/*A* 280, ratio ca 1:6) contained numerous 30 x 20 nm paired particles with a S_{20w} of 76. Treatment with RNase and DNase showed that the viral nucleic acid is DNA; CLV closely resembles maize streak virus but is not related to it serologically. The cryptogram for CLV is D/1:1:0.8/*:S/S:S/*, geminivirus group. (*Author's summary*) E04

0251-9932 SHANTA, P. **Mosaic diseases of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.62-65. Engl., Illus

Cassava. Cassava African mosaic virus. Disease control. Leaves. *Bemisia*. Vectors. India.

The only virus disease attacking cassava in India is AMV, 1st reported in 1894. A brief description is given of the symptoms, methods of dissemination and control measures. (*Summary by T.B.*) E04

0252-4858 BOCK, K.R. and GUTHRIE, E.J. **Transmission of African cassava mosaic by mechanical inoculation.** Plant Disease Reporter 62(7):580-581. 1978. Engl., Sum. Engl., 9 Refs.

Cassava. Cassava African mosaic virus. Shoots. Stems. Leaves. Laboratory experiments. Disease transmission. Kenya.

The causal agent of AMD was transmitted from one cassava plant to another by means of manual inoculation of infective sap. Transmissions were made in phosphate or borate buffers and in deionized water. (*Author's summary*) E04

0253-11254 FEREO, L. **Multiplication végétative et élimination de la mosaïque du manioc par thermothérapie sur des plantes cultivées in vitro.** (*Vegetative multiplication and elimination of AMD by heat treatment on plants grown in vitro*). *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops. Louvain-la-Neuve; Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.285-295. Fr., Sum. Engl., 16 Refs., Illus.

Cassava. Propagation. Cassava African mosaic virus. Virus inhibition. Temperature. Disease control. Laboratory experiments.

Cassava can be reproduced in vitro from stem cuttings with at least one bud, making it possible to obtain thousands of plants in 1 yr. Plants grown in vitro can be freed of AMD by heat treatment, growing the plants at 2 different high temp applied alternately: 37°C for 15 days, then 40° for 1 mo and back to 37° for 1½ mo. Plants can be reproduced during the 37° period. Some clones require a complementary treatment, undergoing another 40 and 37° period. With these techniques total disappearance of symptoms was obtained in all clones treated (H 58, H 60, CB, Mbengui, Kataoli and Abidjan). Grafting healthy but susceptible scions on treated plants proved the absence of the causal agent after this treatment. (*Author's summary*) E04

0254-4583 LOZANO, J.C. **El mosaico africano de la yuca: una amenaza para el cultivo en América y Asia.** (*African cassava mosaic: a threat to the crop in America and Asia*). Yuca Boletin Informativo no. 1:5-6 1977. Span., 6 Refs , Illus.

Also in English.

Cassava. Cassava African mosaic virus. Asia. America.

The virus disease commonly known as African mosaic is one of the most important problems of cassava in Africa and India. Losses range from 20-90% The disease has not been reported from the Americas or from the rest of Asia It is easily spread by insects (whiteflies). CIAT in Colombia offers technical assistance in identifying the disease, and quarantine officers are alerted to the danger of its introduction into a country where it does not yet occur. (*Summary by Abstracts on Tropical Agriculture*) E04

0255-4148 NARASIMHAN, V. and ARJUNAN, G. **Mosaic disease of cassava - Loss in yield and tuber splitting.** Indian Phytopathology 29(4):428-429. 1976. Engl., 2 Refs.

Cassava. Cassava African mosaic virus. Pest damage. Tuber productivity. Field experiments. India.

Relative losses in yield due to the planting of cuttings from AMD-infected plants were assessed at the Tapioca Research Station, Salem, Tamil Nadu (India). AMD was severe on new leaves 1 mo after planting of diseased cuttings; only 1% of plants from healthy cuttings were infected. Tuber

splitting and malformation also occurred in the former. In the 2nd yr cuttings from the previous trial were used. There was severe reduction in yield (84.2%) in the cuttings from plants infected over 2 continuous yr and 53.3% in those infected for 1 yr. Although plants from the disease-free cuttings developed AMD later due to secondary infection, they gave max yield. (*Summary by I.B. Trans. by T.B.*) E04 D03

See also *0012* *0097* *0231* *0257* *0293* *0306*

E06 Nematodes

0256-4326 ALI, S.S., GERAERT, E. and COOMANS, A. **Some spiral nematodes from Africa.** Biologisch Jaarboek 41:53-70. 1973. Engl., Sum. Engl., Fr., 11 Refs., Illus.

Cassava. Nematodes. Zaire. Nigeria.

Intraspecific variation of some species of *Helicotylenchus, Rotylenchus* and *Scutellonema* was studied in populations from Zaire and Nigeria. *S clathricaudatum* was found around the roots of cassava and tobacco at Nioka, Kaliko and Palwo, Zaire. It was found that the structure of the scutella is useful in differentiating species of *Scutellonema* (*Summary by T.B.*) E06

F01 Injurious Insects and their Control

0257-3154 LEUSCHNER, K. *et al.* **Report of the subcommittee on entomological aspects.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.216-218. Engl.

Cassava. *Zonocerus variegatus. Bemisia.* Injurious mites. Resistance. Cultivars. Cassava African mosaic virus. Nigeria.

Areas of high and low priorities for entomology research were established for the different crops. With regard to cassava, evaluation of yield losses and screening for resistance to *Zonocerus variegatus* will be done at Ibadan These same aspects should be evaluated for the red mite *Oligonychus gossypii* The whitefly *Bemisia tabaci* is considered of low priority, but population dynamics and screening for resistance are recommended. Scale insects and mealybugs should be watched carefully. (*Summary by T.B*) F01 E04

0258-4308 MAINI, S.B. and LAL, S.S. **Influence of tetranychid spider mites attack on biochemical changes in cassava leaves.** Journal of Root Crops 3(1):51-53. 1977. Engl., Sum. Engl , 14 Refs.

Cassava. Injurious mites. Pest damage. Leaves. HCN content. Starch content. Dry matter. Plant pigments. Biochemistry. India.

A study was made of the impact of mite attack on cassava leaves in relation to biochemical changes. Infested leaves were grouped in 6 categories based on degree of attack. Total chlorophyll, HCN, crude protein, starch and DM contents were analyzed. Total chlorophyll and HCN showed a decreasing trend with increased intensity of attack, whereas the reverse was true for DM content. There was little variation in crude protein and starch contents. (*Author's summary*) F01 C03

0259-4847 NWANA, I.E. **Entomological problems in root crops production in Nigeria.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.71-80. Engl., 12 Refs.

Cassava. Injurious insects. Entomology. Storage. Nigeria.

A description is given of common pests of root crops in Nigeria, the extent of damage caused and methods of control. *Zonocerus variegatus* is often regarded as the most serious pest during the dry season. Also of major importance are the mite *Oligonychus gossypii* and whiteflies (*Bemisia tabaci*), the vectors of AMD. Mealybugs (*Planococcus citri* and *Ferrisia virgata*) are also implicated in the transmission of virus diseases. Other pests damaging leaves are the chrysomelid *Clythra fasciata*, the lagrid *Ligria villosa*, the coreids *Anoplolepsis tristator* and *Homocerus*

pallens, and the hornworm *Erinnyis* (*Dilophonota*) *ello*. Recently planted cuttings and young plants can also be damaged by termites, crickets and mole crickets. Processed cassava (tapioca and chips) are damaged by *Tribolium castaneum*, *Tenebroides* spp., *Aracerus fasciculatus* and *Stegobium paniceum*. (*Summary by T.B.*) F01

0260-9929 PILLAI, K.S. **Arthropod pests of cassava and their control.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp 76-80. Engl., Illus.

Cassava. *Bemisia. Tetranychus urticae.* **Injurious mites.** *Aonidomytilus albus. Pseudococcus.* **Thrips.** *Leucopholis. Coptotermes.* **Entomology. India.**

Insect pests of cassava in India are whiteflies (*Bemisia tabaci*), mites (*Tetranychus telarius*, *T. neocaledonicus*, *Oligonychus biharensis*, *Eutetranychus orientalis*), scale insects (*Aonidomytilus albus*), mealybugs (*Pseudococcus* sp), thrips (*Retithrips syriacus*), white grubs (*Leucopholis* sp., *Phyllophaga* sp.) and termites (*Coptotermes* sp.). The most serious pests of dried chips are *Araecerus fasciculatus*, *Tribolium castaneum*, *Stegobium paniceum*, *Rhyzopertha dominica* and *Lasioderma serricorne*. Brief notes on the damage caused and control measures are presented. (*Summary by R.A.*) F01

0261-9948 MATILE-FERRERO, D. **Cassava mealybug in the People's Republic of Congo.** *In* Nwanze, K F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae), M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.29-46. Engl., 7 Refs., Illus.

Cassava. *Phenacoccus manihoti.* **Maps. Entomology. Congo.**

Some 53,000 ha of 148,000 ha of cultivated land in the Congo are planted to cassava. Although most of the production comes from small farms, 3 agro-industrial units were established in 1970 Expt have been seriously hindered by the appearance of the mealybug *Phenacoccus manihoti*. Data are given on climatology, initial reports of infestation, morphology, microscopic characteristics, biology and habitat of *P. manihoti*; association with ants and incidence of other mealybugs, aleyrodids and phytophagous mites. (*Summary by T.B*) F01

0262-10454 BRICEÑO, V. *et al.* **Evaluación de cuatro acaricidas comerciales en el control del ácaro (*Mononychellus caribbeanae*, Mc. Gregor) en yuca, (*Manihot esculenta*, Crantz).** (*Evaluation of four acaricides in the control of the green mite Mononychellus caribbeanae on cassava*). Revista de la Facultad de Agronomía 3(2) 59-66. 1975. Span., Sum. Span., Engl., 9 Refs., Illus.

Cassava. *Mononychellus caribbeanae.* **Acaricides. Field experiments. Venezuela.**

Three acaricides (Acarin, Galecron, Kelthane) and the fungicide Top-Schering (wettable sulfur) were evaluated at 3 different rates. After 7 days Kelthane, independent of application rate, was the best. None of the acaricides produced phytotoxic effects on the cassava plants. (*Summary by T.B.*) F01

0263-9951 EZUMAH, H.C. and KNIGHT, A. **Some notes on the mealybug (*Phenacoccus manihoti*, Mat.-Ferr.) incidence on manioc (*Manihot esculenta*) in Bas-Zaïre.** *In* Nwanze, K.F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae). M'vuazi, Zaire, 1977. Proceedings.

Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978 pp.7-14. Engl., Sum. Engl., 2 Refs., Illus.

Cassava. *Phenacoccus manihoti* Insect control. Soil moisture. Rainfall data. Resistance. Soil fertility. Leaves. Field experiments. Zaire.

Preliminary observations on the biology of the cassava mealybug suggest that severity of attack increases with drought and on eroded, infertile soils. On fertile soils with a high water table, there was no reduction in root yield. Although no data are available on the exact magnitude of reduction in leaf yield, completely defoliated fields have been observed in Bas-Zaïre. Based on field observations, the following cultural control measures are suggested: elimination of brush fires and soil erosion, incorporation of OM in the soil and/or its utilization as a mulch, conservation of soil moisture. Treatment of cuttings with malathion does not seem to affect mealybug severity and incidence. (*Summary by T.B.*) F01

0264-1492 REYES, J.A., ARIAS, B and MARTIN, C. **Observaciones sobre el gusano cachón de la yuca *Erynnyis ello* (L) y algunas recomendaciones para su manejo (CIAT Septiembre, 1978 para el dia de campo en Caicedonia).** (*Observations on the cassava hornworm and recommendations for its control*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1978. 6p. Span., Illus.

Cassava. *Erinnyis ello Bacillus thuringiensis. Trichogramma minutum. Polistes.* Biological control. Insect agents. Colombia.

For the biological control of *Erinnyis ello*, an application of *Bacillus thuringiensis* (400-500 g/ha for aerial applications or 2-3 g/l of water for land applications), together with a surfactant with adherent properties, is recommended. When a hornworm population increase is foreseen due to the increase in the no. of eggs laid, another good control measure is the release of the egg parasite *Trichogramma* spp in the cassava fields; *T. australicum* has been found to be the most effective. Other effective practices for reducing the hornworm populations are the establishment of colonies of *Polistes*, a predator of the larvae, in bamboo shelters 1 8-2.0 m high, covered with palm leaves, and the collection of the *Erinnyis* pupae found in the debris around the plants. The biological cycle of the hornworm and the sexual differentiation of the pupal stage are explained and illustrated. (*Summary by T.B*) F01

0265-10476 ARIAS, B. and BELLOTTI, A. **Eficiencia del *Bacillus thuringiensis*, sobre el gusano cachón de la yuca *Erinnyis ello*, en un programa de control biológico.** (*Efficiency of Bacillus thuringiensis in the biological control of the cassava hornworm Erinnyis ello*). Revista Colombiana de Entomología 3(3/4).93-97. 1977. Span., Sum. Span., Engl., 3 Refs.

Cassava. *Erinnyis ello Bacillus thuringiensis. Trichogramma minutum.* Biological control. Entomology. Leaves. Laboratory experiments. Field experiments. Insect agents. Colombia.

Expt were conducted at CIAT under lab and field conditions to determine the quantity of cassava leaves treated with *Bacillus thuringiensis* consumed by larvae of *Erinnyis ello* (Lepidoptera.Sphingidae), as compared with larvae given untreated leaves In the lab, instars III, IV and V fed treated leaves decreased their intake 80, 93 and 98%, respectively, as compared with larvae on untreated leaves. These instars survived only 2.7, 2.3 and 2.1 days, respectively; and instar III consumed foliage for only 1.3 days and those of instars IV and V for only 1.1 days. In the field, 6 days after treatment with *B thuringiensis*, populations decreased from 6 to 1 larva/plant (82 7%); whereas in the untreated plot, there was an increase of 11 to 14 larvae (27%). Furthermore, there was no adverse effect of this bacterium on the egg parasite *Trichogramma* sp (Hymenoptera Trichogrammatidae); in fact, parasitism increased after the spray with the bacillus (*Author's summary*) F01

0266-10478 BELLOTTI, A and GUERRERO, J.M. **Resistencia varietal en yuca contra los ácaros** *Tetranychus urticae* y *Mononychellus tanajoa*. (*Varietal resistance in cassava to the mites Tetranychus urticae and Mononychellus tanajoa*). Revista Colombiana de Entomología 3(3/4) 87-91. 1977. Span., Sum. Span., Engl., 4 Refs

Cassava. *Tetranychus urticae. Mononychellus tanajoa.* **Resistance. Cultivars. Germplasm. Laboratory experiments. Selection. Colombia.**

Mite attack causes losses of economic importance in cassava, especially in areas with long dry periods. The best form of control is the use of resistant var. since the use of miticides is not only uneconomical but also destroys beneficial insects. Since natural conditions at CIAT-Palmira and in Colombia in general are not the most favorable for the development of high mite populations, a method was developed to evaluate, under greenhouse conditions, var. from the CIAT germplasm bank for resistance to *Tetranychus urticae* and *Mononychellus tanajoa* (Acarina Tetranychidae). Preliminary results show a low level of resistance to the former and intermediate resistance to the latter. No immune var with high resistance levels were found. Promising var. were selected for further studies and crosses. (*Author's summary*) F01

0267-10483 PEÑA, J E and BELLOTTI, A.C. **Estudios sobre las moscas del tallo y fruto de yuca** *Anastrepha pickeli* y *Anastrepha manihoti* (*Studies on the cassava fruit and stem flies, Anastrepha pickeli and A. manihoti*) Revista Colombiana de Entomología 3(3/4):79-86 1977. Span., Sum Span, Engl, 11 Refs., Illus

Cassava. *Anastrepha pickeli Anastrepha manihotis.* **Insecticides. Insect control. Laboratory experiments. Entomology. Colombia.**

To contribute to the knowledge on the biology and control of the cassava fruit and stem flies *Anastrepha pickeli* and *A. manihoti* (Diptera:Tephritidae), 4 diets were tested and fecundity was determined. Observations were made within cylindrical screen cages for 13 wk The diet based on brewer's yeast produced an increase in fecundity of 50 eggs/10 females/wk over the other diets. The same yeast was used as bait for adult control in the field, mixed with EPN 0.1%, applied to 4-mo-old cassava plants and compared with 3 other treatments: EPN alone, EPN + molasses, and EPN + yeast + molasses EPN + yeast gave the best results In addition, 2 types of traps (McPhail and tack traps) for capturing adults were evaluted, the most efficient being of the McPhail type Within these traps natural and synthetic substances were evaluated as attractants A higher no of adults was captured with hydrolyzed maize (2%), even with low populations. For larval control under field conditions, 2 insecticides at 3 rates were compared: carbofuran as a soil application and fenthion as a foliage spray. The most efficient and economical product was fenthion 0.15%. (*Author's summary*) F01

0268-10056 PILLAI, K.S. and HRISHI, N. *Retithrips syriacus* **a new pest on cassava and Ceara rubber in Kerala.** Journal of Root Crops 1:88. 1975. Engl., 3 Refs.

Cassava. Injurious insects. *Retithrips syriacus. Manihot esculenta. Manihot glaziovii.* **India.**

A description is given of the insect *Retithrips syriacus* and the damage it causes to cassava and *Manihot glaziovii* in Kerala. Under field conditions, the pest multiplies rapidly during hot, dry seasons. Other reported hosts are listed. (*Summary by T.B.*) F01

0269-9950 LEUSCHNER, K. **Preliminary observations on the mealybug (Hemiptera Pseudococcidae) in Zaire and a projected outline for subsequent work.** *In* Nwanze, K.F. and

Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae), M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.15-19. Engl., Illus.

Cassava. *Phenacoccus manihoti.* **Entomology. Insect control. Resistance. Plant breeding. Cassava programs. Zaire.**

The following aspects of the cassava mealybug in Zaire are discussed briefly: host parts attacked, economic damage, life history, methods of dispersal, parasites, alternate hosts. Projections for future work include breeding for resistance, biological, chemical and cultural control methods. (*Summary by T.B.*) F01 G01

0270-1491 DIAZ, R.O., BELLOTTI, A.C. and SCHOONHOVEN, A. VAN. **Insectos y ácaros que atacan el cultivo de la yuca en Colombia.** (*Insect and mite pests of cassava in Colombia*). Turrialba 28(1):43-49. 1978. Span., Sum. Engl., Span., 3 Refs.

Cassava. Cecidomyiidae. *Bemisia. Anastrepha pickeli. Silba pendula. Vatiga manihotae. Erinnyis ello.* **Injurious mites. Pest damage. Productivity. Thrips. Colombia.**

Approx 20 insects and mites were found attacking cassava in several regions of Colombia at different growth stages and seasons. Thrips (*Frankliniella williamsi*), gall midges (Cecidomyiidae) and whiteflies (*Bemisia* sp. and *Trialeurodes* sp.) were present in > 50% of the plantations visited. Pests found at all stages of plant growth were the cassava fruitfly (*Anastrepha* sp.), leafhoppers (*Empoasca* sp.), lace bugs (*Vatiga manihotae*) and mites (*Oligonychus peruvianus*). Pests limited to different regions were cutworms (*Agrotis ipsilon* and *Spodoptera frugiperda*) found in the states of Valle and Quindío and stemborers (*Acanthoderes nigricans*) in the state of Cauca High parasitism of hornworm (*Erinnyis ello*) eggs was observed. Yield losses due to thrips were estimated. (*Author's summary*) F01

0271-9990 WADDILL, V.H. and WEEMS JUNIOR, H.V. **The cassava shoot fly, *Neosilba perezi* (Romero and Ruppel) (Diptera:Lonchaeidae).** Gainesville, Florida. Department of Agriculture & Consumer Services. Division of Plant Industry. Entomology Circular no. 187. 1978, 2p. Engl , 4 Refs., Illus.

Cassava. *Neosilba perezi.* **Entomology. USA.**

The most important pest of cassava in S. Florida is the shoot fly *Neosilba perezi.* Heavy damage results in branching and stunted growth, but yield does not appear to be significantly affected. A description is given of the fly, which closely resembles *N. batesi.* It has been reported only from cassava in the USA, Puerto Rico and probably other Caribbean islands. (*Summary by T.B.*) F01

0272-9959 PAGE, W.W. **The biology and control of the grasshopper *Zonocerus variegatus*** PANS 24(3):270-277. 1978. Engl., Sum. Engl., 23 Refs., Illus.

Cassava. *Zonocerus variegatus.* **Insect control. Entomology. Nigeria.**

Zonocerus variegatus is recognized as a pest of many crops in West Africa. Evidence that it is becoming an increasing problem in southern Nigeria prompted research into the biology, bionomics and control of this grasshopper. The main points of these aspects are summarized. It is

concluded that although a chronic pest, it causes economic damage to cassava only periodically; and community self-help is the best level at which to effect control. (*Author's summary*) F01

0273-9969 PASCHOAL, A.D. **A review of the Caribbeanae group (Acarina:Tetranychidae).** Revista Peruana de Entomologia 14(1):177-179. 1971. Engl., Sum. Engl., Port., 11 Refs.

Cassava. *Mononychellus tanajoa.* **Entomology. Brazil.**

Mononychellus (*Mononychus*) *tanajoa, M. mcgregori, M. bondari* and *M. chaemosetosus* have been placed in the Caribbeanae group, the general features of which are presented. *M. caribbeanae nd M. planki* are redescribed. A key to the species of this group is also included. (*Author's summary*) F01

0274-10437 QUIROS L., M. **Estudio preliminar de algunos insectos y ácaros, plagas en el cultivo de la yuca** (*Manihot esculenta,* **Crantz) en el Estado Zulia, Venezuela.** (*Preliminary study of some insect and mite pests of cassava in the state of Zulia, Venezuela*). Revista de la Facultad de Agronomia de la Universidad de Zulia 4(1):63-95. 1977. Span., Sum. Span., Engl., 32 Refs., Illus.

Cassava. *Chilomina clarkei. Erinnyis ello. Eudiplosis brasiliensis.* **Injurious insects. Injurious mites. Entomology. Pest damage. Insect agents. Venezuela.**

Based on a survey of 32 farms in the state of Zulia from April 1972-Sept. 1973, a preliminary list was made of insects and mites found on cassava. A brief description is given of each pest, habits, damage and economic importance. The most important pests in this area are *Chilomina clarkei, Mononychellus caribbeanae, Tetranychus* spp. and *Erinnyis ello.* A list of cassava pests reported in literature for Venezuela is also included. (*Summary by T.B.*) F01

0275-9949 NWANZE, K.F. **Biology of the cassava mealybug,** *Phenacoccus manihoti* **Mat.-Ferr. in the Republic of Zaire.** *In* ____ and Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae) M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.20-28. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. *Phenacoccus manihoti.* **Entomology. Laboratory experiments. Leaves. Cuttings. Insect agents. Zaire.**

Data are given on the biology (oviposition, female fecundity and nymphal development) of the cassava mealybug *Phenacoccus manihoti* in Zaire. Most of the insects settle on the midrib and secondary veins of the leaves, as well as on the growing points. The 1st instar nymph (crawler) is very important in the spread and survival of the species, the former occurring via wind dispersal and the latter within dormant leaf buds during the rainy season. Treating cuttings with an appropriate insecticide prior to planting, selecting planting time according to pest incidence (highest during the dry season) and conserving soil moisture may aid in reducing crop damage. The occurrence of a predator of this pest, *Spalgis Emolea,* is also reported. (*Author's summary*) F01

0276-9946 BEARDSLEY, J.W **Some thoughts on mealybugs and mealybug management.** *In* Nwanze, K F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug, *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae). M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.65-69. Engl.

Cassava. *Phenacoccus manihoti.* **Insect agents. India.**

Mealybugs; the most widespread of the Coccoidea, are characterized by female neoteny, the true imago is the adult male. There are bisexual and parthogenetic populations Problems of taxonomic complexity, synonymy and supraspecific relationships are discussed. The recognition and clarification of complexes is of vital importance in biological control since many of the parasites have been found to be highly host specific. (*Summary by T.B*) F01

0277-9947 WILLIAMS, D.J. **Taxonomy of mealybugs on cassava.** *In* Nwanze, K.F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae), M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.47-52. Engl., 1 Ref., Illus.

Cassava. *Phenacoccus manihoti.* **Entomology. Zaire.**

A key is given to the external and microscopic characters of mealybugs found on cassava in West Africa (*Ferrisia virgata, Pseudococcus longispinus, Dysmicoccus brevipes, Planococcus citri, Phenacoccus manihoti, P. madeirensis*) and in other parts of the world (*Nipaecoccus nipae, Maconellicoccus hirsutus, D. bispinosus, Phenacoccus gossypii*). A method for preparing Pseudococcidae for routine identification is also explained. (*Summary by T.B.*) F01

0278-4008 AMANTE, E. **Pragas da mandioca e seus produtos.** (*Pests of cassava and its products*). São Paulo, Instituto Biológico, 1972?. 18p. Port., 14 Refs.

Cassava. Entomology. Cassava products. Injurious insects. Brazil.

Descriptions are given of the following pests of cassava and its products in Brazil (damage caused and habit are not always specified): Thripidae (*Scirtothrips manihoti*), Tingidae (*Gargaphia lunulata, Leptopharsa* sp., *Vatiga longula, V. manihotae*), Aleyrodidae (*Aleurothrixus aepim, Bemisia tuberculata, Trialeurodes manihoti*), Coccidae (*Saissetia oleae*), Margarodidae (*Eurhizococcus brasiliensis, Monophelebus niveus*), Saturniidae (*Rothschildia aurota aurota*), Sphingidae (*Erinnyis alope, E. ello*), Anobiidae (*Stegobium paniceum, Lasioderma serricorne*), Cerambycidae (*Ozineus prolixus*), Chloropidae (*Teleocoma crassipes*), Lonchaeidae (*Silba pendula*), Tephritidae (*Anastrepha manihoti, A. montei, A. pickeli*), Tineidae (*Setomorpha rutella*), Phycitidae (*Anagasta kuehniella*) and Pyralidae (*Pyralis farinalis*). (*Summary by T.B.*) F01

0279-1396 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Pest management - a new concept in cassava crop protection.** Cali, Colombia. Noti-CIAT. Series AE-5. 1977. 4p. Engl., Illus.

Also in Spanish

Cassava. Insect agents. Mite control. Insect control. Biological control. ***Mononychellus tanajoa. Tetranychus urticae. Erinnyis ello.*** **Thrips. Colombia.**

Although cassava is generally considered highly resistant to pests, mites and insects can severely limit root yield. CIAT is currently developing a pest management program based on host-plant resistance and biological control. Work with a complex of mites (*Mononychellus tanajoa, M. mcgregori, Tetranychus urticae* and *Oligonychus peruvianus*), thrips (*Frankliniella williamsi*) and the cassava hornworm (*Erinnyis ello*) is reported. (*Summary by T.B.*) F01

0280-4200 AGUDELO S., F. *et al.* **Notas biológicas sobre** *Erinnyis ello* **en yuca en la República Dominicana.** (*Biological aspects of Erinnyis ello on cassava in the Dominican Republic*). Santo Domingo, República Dominicana, Secretaría de Estado de Agricultura. Departamento de Investigaciones Agropecuarias, 1978?. 27p. Span., 2 Refs., Illus.

Cassava. ***Erinnyis ello.*** **Biological control. Insect agents. Defoliation. Entomology. Dominican Republic.**

The adult and larval stages of *Erinnyis ello* are described and illustrated in color. Emphasis is placed on biological control of this important pest of cassava. The following natural enemies are described and illustrated: (a) Parasites of eggs - *Telenomus sphingis* and *Trichogramma* sp. (Hymenoptera); (b) parasites of the larva - *Drino* sp. (Diptera) and *Apanteles americanus* (Lepidoptera); (c) predators - *Polistes crinitus* (Hymenoptera) and the cattle egret *Bulbulcus ibis;* (d) the microbial product *Bacillus thuringiensis* Populations are highest from May-Oct. Larvae in the 5th instar consume 85% (562.9 cm^2) of the total area consumed during the 5 instars. At the field level, farmers are recommended to check plantations to determine the no. of hornworm eggs/leaf and % of parasitism, and no. of larvae/leaf. These data are graphed and help to make decisions as to what control measures should be adopted. (*Summary by F.G. Trans. by T.B.*) F01

0281-10402 SILVA, A. DE B. **Ocorrência e contrôle químico da cochonilha dos brotos da mandioca** (*Phenacoccus manihot*). (*Incidence and chemical control of the cassava mealybug Phenacoccus manihoti*). Belém-PA. Empresa Brasileira de Pesquisa Agropecuária. Centro de Pesquisa Agropecuária do Tropico Umido. Comunicado Técnico no. 6. 1978. 7p. Port., Sum. Port., Engl., 3 Refs.

Cassava. ***Phenacoccus manihoti.*** **Insect control. Entomology. Brazil.**

The cassava mealybug *Phenacoccus manihoti* has been reported on cassava shoots in Belém, Pará and Macapá, Amapá (NE Brazil) since 1973. Of 6 insecticides evaluated, parathion (0.1%) gave best control (ca. 96.3%), followed by mephosfolan (Cytrolane) with 87.9%. These values were determined on the basis of Abbot's formula. (*Author's summary. Trans. by T.B.*) F01

0282-9945 GREATHEAD, D.J. **Biological control of mealybugs (Homoptera:Pseudococcidae) with special reference to cassava mealybug** (*Phenacoccus manihoti,* **Mat-Ferr.).** *In* Nwanze, K.F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug, *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae). M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria. International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.70-80. Engl., 15 Refs.

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

A brief analysis is made of successes and failures reported in literature on the biological control of

mealybugs. With regard to *Phenacoccus manihoti*, IDRC-Canada has funded a 3-yr project in which the Commonwealth Institute of Biological Control (Trinidad) will assess natural enemies of this pest from S.A. for later introduction into Africa. (*Summary by T.B.*) F01

0283-11716 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **El control de *Erinnyis ello* gusano cachón de la yuca; unidad audiotutorial.** (*The control of the cassava hornworm Erinnyis ello; audiotutorial unit*). Cali, Colombia, 1978. 70 diap color 5 x 5 cm.; cinta magnetofónica 25'38"; acompañada de guión 17p. y guía de estudio 30p. Span., Sum. Span., 3 Refs., Illus.

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

This audiotutorial unit (cassette, printed script, 70 color slides, study guide, self-evaluation test), prepared by the Communications Support Unit at CIAT, is available for use with a manually or automatically synchronized slide projector/cassette tape recorder. Each unit is available from the Distribution Office at a cost of US$50; photocopies of the study guide alone can be obtained from the Cassava Information Center. Data are given on the biology of the hornworm, its economic importance and possible methods of control. Integrated control of *Erinnyis ello* should begin immediately after the previous harvest, applying cultural practices such as plowing between rows and weed control. Biological control should be continuous even though severe attacks do not occur; a good option is the combined use of egg parasites (*Trichogramma* spp.) with larval predators (*Polistes* sp.) and parasites (*Apanteles* sp. and *Euplectrus* sp.). The farmer should keep constant track of the no. of parasitized and nonparasitized eggs, especially in young plantations. If the no. of nonparasitized eggs increases, there will be an increased no. of larvae. In this case *Trichogramma* wasps should be released in the field (10-20 in.^{2}/ha), or the crop should be sprayed with *Bacillus thuringiensis* (350-400 g/ha). Chemical control should be avoided since its continued use will upset the balance between the pest population, the natural enemies and the fauna in general, intensifying later attacks. Therefore, chemical control should be used only when there is a very severe attack (high larval populations/plant) and when the plants are young (up to 6 mo) (*Summary by T.B.*) F01

0284-10451 SHUKIA, P.T. **Preliminary report on the green mite (*Mononychellus tanajoa*, Bondar) resistance in Tanzanian local cassava varieties.** East African Agricultural and Forestry Journal 42(1):55-59. 1976. Engl., Sum. Engl., 11 Refs.

Cassava. Cultivars. Resistance. *Mononychellus tanajoa*. Selection. Field experiments. Tuber productivity. Plant development. Tanzania.

Local cassava var. are being screened for resistance to *Mononychellus tanajoa*, a recently introduced pest in Tanzania. Higher levels of infestation were found on bitter var. Preliminary results from 4 sites showed that Mzimbitala, Dalama, Kanyanzige, Njemu and Kongolo are resistant. Resistance appears to be related to pubescence, the probable mechanism involved being host nonpreference and antibiosis. (*Author's summary*) F01

0285-10440 RAO, Y.R.V.J. and PILLAI, K.S. **Effect of some insecticides on the scale insect, *Aonidomytilus albus* Ckll., infesting tapioca stems in storage.** Indian Journal of Entomology 34:181-182. 1972. Engl., 3 Refs.

Cassava. Insect control. Insecticides. *Aonidomytilus albus*. Timing. Stems. Storage. India.

Five insecticides were evaluated in the control of the scale insect *Aonidomytilus albus* on stored cassava planting material: endrin (0.03%), endosulfan (0.05%), parathion (0.03%), monocrotophos (0.05%) and dimethoate (0.05%). These were sprayed on the stacked bundles 3 times at 15-day intervals For data analysis only the % of total and severe infestation were considered. The parathion treatment showed the min % of incidence and was superior to all other treatments, reducing the % of infestation over the control by 93.3% and 100% in the case of severe infestation. (*Summary by I.B Trans. by T.B.*) F01

0286-11738 McCAFFERY, A.R. *et al.* **Utilisation of food by *Zonocerus variegatus* (L.) (Orthoptera: Pyrgomorphidae).** Bulletin of Entomological Research 68:589-606. 1978. Engl., Sum. Engl., 43 Refs., Illus.

Cassava. Entomology. *Zonocerus variegatus*. Nigeria.

Individuals and groups of adult *Zonocerus variegatus* were fed on various food plants. Somatic growth, maturation and reproduction were all faster in group-fed insects. Dry-season insects grew faster and produced greater no. of egg pods than wet-season ones. Short-winged insects developed faster than long-winged ones. Those that fed on cassava had a shorter somatic growth period and produced greater no. of egg pods than those on other foods. Cassava-fed *Zonocerus* had a greater efficiency of conversion of digested food to body substance, particularly during oocyte growth. The success of the large dry-season population of *Zonocerus* in S. Nigeria is probably due to the increase in cassava cultivation. (*Author's summary*) F01

See also 0038 0054 0063 0181 0182 0184 0191 0212

F02 Rodents and other Noxious Animals

0287-9928 PILLAI, K.S. **Rodent damage on cassava and its control.** *In* Hrishi, N. and Gopinathan Nair, R., eds Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.81-82. Engl.

Cassava. Rats. Pest damage. Pest control. India.

Rodents are a serious pest of cassava in India, causing losses estimated at 10%/yr. The use of poison baits (zinc phosphide) and fumigation of the burrows with aluminum phosphide are the most effective control measures. (*Summary by T.B.*) F02

0288-10433 LAL, VON S.S. and MAINI, S.B. **Zur Abhängigkeit des Nagerbefalls vom HCN-Gehalt der Knollen von** *Manihot esculenta* **Crantz.** (*Studies on rodent damage in relation to cyanogenic glucoside content in cassava roots*). Anzeiger für Schaedlingskunde Pflanzenschutz-und Umweltschutz 50.138-140. 1977. Germ., Sum. Engl., 8 Refs.

Cassava. Tubers. HCN content. Cultivars. Rodents. India.

Rodents are major pests of cassava and inflict heavy losses in the field. The possibility of controlling these pests by developing resistant var. in relation to HCN content was studied at Central Tuber Crops Research Institute, Trivandrum. Studies of 7 cv. for extent of damage and root characters indicated that those with min HCN content in the peel (Ce 178, Ce 281, Ce 96) were highly susceptible to rodent attack and were preferred over those with higher concn of HCN in the peel (Ce 432, Ce 119). Thus there is ample scope for evolving a var. with higher concn of cyanogenic glucosides in the peel and negligible quantities in the flesh to ward off heavy rodent attack in the field. (*Author's summary*) F02 .

G00 GENETICS AND PLANT BREEDING

0289-9989 MADHAVADIAN, P., ABRAHAM, S. and NINAN, C A. **Hermaphroditism in cassava (*Manihot esculenta* Crantz).** Journal of the Bombay Natural History Society 71(3):635-639. 1976. Engl., Sum. Engl., 7 Refs.

Cassava. Flowers. Cultivars. Hybrids.

Among the 400 cassava var. at the exptl farm of the U. of Kerala, H.450 was found to produce hermaphrodite flowers also. The hermaphrodite flowers in this hybrid between 2 local strains are of 2 types: with free perianth lobes like the normal female flowers and with cup-shaped perianth like the normal male flowers. Hermaphrodite flowers have been observed in all 10 plants of this strain. This is the 1st known report of hermaphroditism in cassava. (*Author's summary*) G00

G01 Breeding, Germplasm, Varieties and Clones, Selection

0290-10041 NORMANHA, E.S. and LORENZI, J.O. **Sugestões para a sistematização de bancos de germoplasma de mandioca.** (*Recommendations for systematizing cassava germplasm banks*). São Paulo, Brasil. Instituto Agronômico. Circular no. 89. 1978. 9p. Port., Sum. Engl.

Cassava. Germplasm. Cultivars. Leaves. Tubers. Plant anatomy. Cassava programs. Brazil.

A design for planting germplasm collections in the field is presented, in which var. are organized in different groups based on the no. of characteristics they have in common These characteristics may be narrow or broad leaflets, white or colored phelloderm, plant height (short, medium, tall) white or brown root skin, green or colored stem and leaves, etc. This model should be standarized for international use since there is a wide range of variation in the morphological and physiological characteristics of the cassava plant. (*Summary by T.B*) G01 B00

0291-4766 HAHN, S.K., HOWLAND, A.K. and WILSON, J.E. **Breeding of root and tuber crops.** *In* Ene, L.S.O. *et al.*, eds. Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings, Umudike, National Root Crops Research Institute, 1978. pp.36-47. Engl., Sum. Engl., 17 Refs.

Cassava. Selection. Plant breeding. Cassava programs. Nigeria. Africa.

Constraints to the production of cassava, yams and sweet potatoes in Nigeria are stated. Research results and experiences of the Root & Tuber Improvement Program at IITA are used to discuss appropriate breeding systems, the creation of source populations, selection and the use of selections. Intervarietal and interspecific hybridization, as well as population improvement through cyclic selection and recombination procedures, are different methods of creating source populations. Factors affecting the effectiveness of selection are also discussed. (*Summary by T.B.*) G01

0292-10049 ROGERS, H.H. **Plant breeding: recent achievements and future prospects.** Span 21(2):51-53. 1978. Engl., 9 Refs., Illus.

Cassava. Plant breeding. Colombia. Nigeria.

Under optimum conditions a crop will attain its max yield. Only the breeder is able to improve the yield potential of a crop plant further by breeding techniques that modify the genotype. In this review from the UK some aspects of such plant breeding improvements are chosen as examples. They include wheat (*Triticum aestivum*), rice (*Oryza sativa*), cassava (*Manihot* sp.) and fruit (*Rubus* sp. and *Ribes* sp.). Future prospects through chromosome engineering, cell culture, protoplast fusion and recombining DNA techniques are also mentioned. (*Summary by Abstracts on Tropical Agriculture*) G01

0293-11251 HAHN, S.K. **Breeding of cassava for resistance to cassava mosaic disease (CMD) and bacterial blight (CBB) in Africa.** *In* Maraite, H. and Meyer, J.A., eds. International Symposium on Diseases of Tropical Food Crops, Louvain-la-Neuve, Belgium, 1978. Proceedings. Louvain-la-Neuve, Université Catholique de Louvain, 1979. pp.211-219. Engl., Sum. Engl., 22 Refs., Illus.

Cassava. Plant breeding. Cultivars. Selection. Resistance. *Xanthomonas manihotis.* **Cassava African mosaic virus. Cassava programs. Africa.**

Sources of resistance to both AMD and CBB were identified from the interspecific cross *M. esculenta* x *M. glaziovii* and successfully incorporated into improved breeding populations, from which high-yielding, AMD- and CBB-resistant selections were obtained. Resistance to AMD and CBB was genetically related. This correlated response of resistance made it possible to improve cassava rapidly for resistance to both diseases at the same time, while maintaining other desirable characters. These var. have been rapidly multiplied and released to many Nigerian farmers. This resistance holds true in many African countries. AMD- and CBB-resistant var. produced 3 times more yield than local var. (*Author's summary*) G01 E02 E04

0294-9979 ABRAHAM, A. *et al.* **Tuber crops. Cassava.** *In* ____. An inventory of germplasm of plants of economic importance in South India. Trivandrum, India, University of Kerala. Department of Botany, 1976. pp.1-93. Engl., Illus.

Cassava. *Manihot esculenta.* **Germplasm. Cultivars. Hybrids. Identification. Plant anatomy. India.**

The expt farm at Kariyavattom, Trivandrum has 379 accessions of *Manihot esculenta* from Kerala, Malaya, Brazil, Colombia and Papua. The collection includes local and introduced var., intervarietal hybrids, triploids and tetraploids, inbred lines and a few mutations. The most important morphological differences, root yield and characteristics are given for each. Malayan-4 (4.3 kg/plant or 15.9 t/ha), the most popular var. in Kerala, is used as the point of reference. (*Summary by T.B.*) G01 B00

0295-10052 NASSAR, N.M.A. **Evaluation of some wild cassava species native of Central Brazil.** Tropical Root and Tuber Crops Newsletter no. 10:24-28. 1977. Engl., Sum. Engl., 15 Refs.

Cassava. *Manihot.* **Selection. HCN content. Germplasm. Tuber development. Protein content. Fibre content. Brazil.**

Results are given of screening 7 wild *Manihot* species (*oligantha, tripartita, zehntneri, anomala, nana, tomentosa, gracilis*) for root formation, HCN content, growth habit and nature of wild habitat. The 1st 2 species were notable for their high % of protein on a dry wt basis. (*Summary by T.B.*) G01 C03

0296-9977 NASSAR, N.M.A. **Some further species of *Manihot* with potential value to cassava breeding.** Canadian Journal of Plant Science 58:915-916. 1978. Engl., Sum. Engl., 8 Refs.

Cassava. Plant breeding. *Manihot.*

Screening of some wild *Manihot* spp. for root formation, growth habit and nature of habitat revealed several species with potential for *M. esculenta* breeding programs. Characteristics of *M. paviaefolia, M. falcata, M. reptans, M. alutacea, M. pruinosa* and *M. pentaphylla* are given. (*Summary by T.B.*) G01

0297-9944 HRISHI, N. **Breeding techniques in cassava.** *In* ____ and Gopinathan Nair, R., eds Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.1-5. Engl., Illus.

Cassava. Plant breeding. Selection. Hybridizing. Resistance. Productivity. Polyploidy. Mutation. Mukibat system. Hybrids. Cultivars.

The following aspects of breeding are discussed briefly: (1) vigorous selection of native populations to improve local var., (2) intervarietal and interspecific hybridization, (3) replacement of var. that break down in resistance and productivity, (4) enhancement of protein content through polyploid breeding techniques, (5) rectification of defects in clones through mutations produced by gamma rays or chemical mutagens, and (6) the Mukibat system. Characteristics are given of 5 hybrids released with great success to Indian farmers: H-2304, 1687, 97, 165 and 226. (*Summary by T.B*) G01

0298-10438 TINEO G., J.R. **Selección masal en yuca (*Manihot esculenta* Crantz).** (*Mass selection in cassava*). Revista de la Facultad de Agronomía de la Universidad de Zulia 4(1)·23-29. 1977. Span., Sum. Span., Engl., 5 Refs.

Cassava. *Manihot esculenta*. Plant breeding. Selection. Cultivars. Tuber productivity. Venezuela.

Results are given of work done on the genetic improvement of root production in cassava var. Llanera, using stratified mass selection. Yield improvement through selection was 20.44% for total root production and 24.71% for commercial root production (35,490 and 31,900 kg/ha, respectively). These populations will be used in other selection cycles and further improvement work. (*Author's summary. Trans. by T.B.*) G01 D03

0299-10413 PEREIRA, A S *et al.* **Taxa de fecundação cruzada no cultivar de mandioca Branca-de-Santa-Catarina.** *(Evaluation of natural cross-pollination in cassava cv. Branca de Santa Catarina)* Bragantia 37:XCV-XCVI. 1978 Port., Sum Engl, 3 Refs.

Cassava. *Manihot esculenta*. Plant breeding. Cross breeding. Pollination. Cultivars. Brazil.

The % of natural cross-pollination in cassava cv. Branca de Santa Catarina was determined during 1970 and 1973. This cv. has homozygous alleles for wide leaf lobe *(vv)* and white root pellicle *(mm)*. Alternate rows of Branca de Santa Catarina and Vassourinha *(VvMm)* were established for this evaluation. Analysis of the plants obtained from seeds collected on Branca de Santa Catarina indicated 63 and 100% natural cross-pollination, respectively, for the leaf lobe and root color characteristics. *(Author's summary)* G01

0300-9943 RAJENDRAN, P.G. **A new approach to evaluate the germplasm in cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.6-9. Engl.

Cassava. Germplasm. Resistance. Cassava African mosaic virus. *Xanthomonas manihotis.* Productivity. Plant development. Cassava programs.

Because of the innumerable genotypes in cassava, efficient evaluation techniques are required for screening. At CTCRI all genotypes with moderate to severe susceptibility to AMD, CBB, bacterial wilt and other undesirable characteristics are discarded immediately. The rest are classified into different groups based on yield, plant growth habit and quality. Data to be recorded for each line are classified as indispensable, highly valuable, valuable and unnecessary. (*Summary by T.B.*) G01

0301-4763 OKOLI, O.O. **Source-materials for the genetic improvement of root and tuber crops in Nigeria.** *In* Ene, L.S O. *et al.*, eds. National Seminar on Root Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978 pp.48-57. Engl, Sum Engl., 14 Refs

Cassava. Plant breeding. Germplasm. Nigeria.

It is recommended that plant introductions be made only as a source of gene combinations for use with local genotypes. Plant collection, evaluation and documentation in all root and tuber crops should be initiated to prevent genetic erosion and losses due to large-scale deforestation in Nigeria and other countries where these crops are either native or widely grown. Main breeding objectives in cassava include incorporation of genes for resistance to CBB and AMD, as well as Phytophthora root rot, *Zonocerus* spp. and *Meloidogyne* spp. Cv. with low HCN content are also being sought. (*Summary by T.B.*)G01

0302-11849 SINTHUPRAMA, S. *et al.* **[Clonal selection in cassava].** *In* Thailand. Department of Agriculture. Division of Field Crops. Cassava research report for 1973. Bangkok, 1974?. Thai., Sum. Engl.

Cassava. Cultivars. Field experiments. Clones. Selection. Thailand.

A 3-yr expt was conducted to evaluate clones in the cassava breeding program. Var were collected from Rayong Province and also selected from seed-grown plants included in this expt. Plants were grown in single rows at 1 x 1 m, and fertilizers were applied at a rate of 8-8-4 kg/rai (6.25 rai = 1 ha) of N, P_2O_5 and K_2O. Growth, yield and other characteristics were studied. Var. no. 27 gave the highest yield (5.51 kg/plant). This line should be registered as a recommended var to be named Rayong 1. (*Summary by Kasetsart University*) G01

0303-11865 SINTHUPRAMA, S. and THIRAPORN, C. **[Cassava collection].** *In* Thailand. Department of Agriculture Division of Field Crops. Cassava research report for 1973. Bangkok, 1974?. Thai., Sum. Engl.

Cassava. Cultivars. Selection. Productivity. Cassava programs. Starch content. Field experiments. Thailand.

The objectives of this expt were to collect introduced var. and those planted in the country, and to study their botanical and agronomic characteristics for the breeding program. Each var. was grown in 1-3 rows, 10 m long, with 2 replications. Plants were spaced at 1 x 1 m and the fertilizer applied at a rate of 8-8-4 kg N, P_2O_5, K_2O/rai (6.25 rai = 1 ha). Plants were harvested at 10 and 12 mo. Var. no. 30, 43 and Java 6 gave more cassava chips than the other var. Indonesia had a

lower top/root ratio than the other 4 var. Starch content of Java 2 was 26.78% (fresh wt basis) and that of Java 5, 26.78 and 77.64% on a fresh and dry wt basis, respectively. (*Summary by Kasetsart University*) G01

0304-11845 WATANANON, W. **[Cassava collection].** *In* Thailand. Department of Agriculture. Division of Field Crops: Annual Report for 1972. Bangkok, 1973?. pp:223-224. Thai:, Sum. Engl.

Cassava. Cultivars. Field experiments. Germplasm. Plant anatomy. Thailand.

The objectives of this expt were (a) to collect and maintain the var. in existence, (b) to collect the introduced var. and (c) to study their botanical characteristics. The var. in existence were planted in a 300 m² area with a 1 x 1 m spacing; the introduced var. were planted separately. The var. collected are as follows: (a) In existence (26 var.) - No. 1, 3, 7, 8, 11, 13, 14, 18, 22, 25, 30, 31, 43, 45, 50, 69, 70, 1C, 2C, 4C, 2596, Java 2, Java 4, Java 5, Java 6 and Indonesia; and (b) introduced from CIAT (5 var.) - CMC 9, 39, 72, 76 and 84. (*Summary by Kasetsart University*) G01

0305-11710 MAGOON, M.L. *et al.* **Some promising high yielding hybrids and selections of cassava.** SABRAO Newsletter 2(1):19-26. 1970. Engl., Sum. Engl., 3 Refs., Illus.

Cassava. Hybrids. Selection. Tuber productivity. Cassava programs. Plant breeding. India.

Salient features are given of 6 promising cassava hybrids and 3 seedling selections recently developed at the Central Tuber Crops Research Institute, Trivandrum (India). They have recorded 2-3 times higher root yield as compared to the current local var.; they also possess the desired commercial attributes not at present found in the local var. Some information is also given regarding the lines of work that have led to the production of these hybrids. (*Author's summary*) G01

0306-11735 IBE, D.G. **Resistance of cassava to mosaic.** Ibadan, Nigeria. International Institute of Tropical Agriculture. IITA Trainee Report no. 10. 1973. 21p. Engl., Sum. Engl., 15 Refs.

Cassava. Selection. Cassava African mosaic virus. Resistance. Crossbreeding. Nigeria.

Of 96,906 plants at IITA-Nigeria (crosses, open pollination, local collections from Africa and introductions) screened for resistance to AMD, > 15,000 appeared to be resistant after 6 mo. Among the promising crosses were TMX 6, 1, 747 and 737. Crosses with introductions were the poorest in terms of resistance. It appears that resistance to AMD is controlled by quantitative genes and some level of resistance seems to have been transferred to the local cv. Isunikankiyan. Based on these results, screening should not be done earlier than 6 mo, after which time resistance seems to be stable. (*Author's summary*) G01 E04

0307-10493 PERREAUX, D., TERRY, E.R. and PERSLEY, G.J. **Studies on screening methods of cassava resistance to bacterial blight.** *In* Terry, E.R., Persley, G.J. and Cook, S.C.A., eds. Workshop on Cassava Bacterial Blight in Africa; past, present and future, Ibadan, Nigeria, 1978. Report. London, England, Centre for Overseas Pest Research, 1979. pp.13-16. Engl., 2 Refs , Illus.

Also in French

Cassava. Plant breeding. Resistance. *Xanthomonas manihotis*. Cultivars. Laboratory experiments. Selection.

The 3 methods studied for screening cassava var. for resistance to CBB were stem puncture with a hypodermic needle, leaf clipping with infected scissors and leaf spray. The 8 var. were 60444, 60447, susceptible (S); Isunikakiyan, moderately S; TMX 30337, 30555, 30211, 30395, good field resistance (R); and 58308, highly R. The leaf spray inoculation method gave poor results. Results obtained with the clipping method were relatively well correlated with those of natural field infection but were not as reliable as the stem puncture method, which is more tedious and infection pressure much more severe than under natural conditions. Nevertheless, the 2 methods confirm the tolerance of 30211, 30555, 30337 and 58308 and the S of Isunikakiyan, 60444 and 60447. (*Summary by F.G. Trans. by T.B.*) G01 E02

0308-11870 WATANANON, W. *et al.* [Cassava varietal trials]. *In* Thailand. Department of Agriculture. Division of Field Crops. Cassava research report for 1975. Bangkok, 1976?. Thai., Sum. Engl.

Cassava. Cultivars. Selection. Field experiments. Germination. Tuber productivity. Thailand.

In expt at 2 field crop expt stations (Huai Pong and Khon Kaen), var. introduced from CIAT (CMC 9, 39, 72, 76, 84) and the Thai-recommended var. Rayong were arranged in a randomized complete block design with 4 replications. Plants were spaced at 1 x 1 m, fertilized with 8-8-8 kg N, P_2O_5 and K/rai (6.25 rai = 1 ha), and harvested at 10 mo. Results at both sites showed that % germination, vigor and yield of the 5 CIAT var. were lower than for Rayong The expt will be repeated in the next 2 yr. (*Summary by Kasetsart University*) G01

0309-11871 A-AS-SAQUI, M. **Present status of root and tuber crops research.** Monrovia, Liberia, Ministry of Agriculture, 1978. 6p. Engl., 2 Refs.

Paper presented at the Regional Root and Tuber Improvement Workshop, Freetown, Sierra Leone, 1978.

Cassava. Cassava programs. Plant breeding. Germplasm. Resistance. Diseases and pathogens. Liberia.

Cassava is the 2nd most important food crop (250,000 t produced annually on 156,000 ac) in Liberia. Despite its importance, there is a decreasing trend in production due to low yields, high incidence of AMD and *Tetranychus urticae*, and poor stand establishment due to termite attack. The root and tuber crops improvement project at the Central Agricultural Expt Station in Suakoko places emphasis on cassava and sweet potatoes. Research highlights include evaluations of IITA material, obtention of high-yielding, disease-resistant clones (13-70 t/ha for 36 improved clones vs. local av yield of 2.2 t) and the establishment of a seedling nursery (580 seedlings). Within 4-5 yr they hope to provide farmers with 5-6 recommended var. (*Summary by F.G. Trans. by T.B.*) G01

0310-11842 THIRAPORN, C. *et al.* [Cassava selection]. *In* Thailand. Department of Agriculture. Division of Research and Experiment. Progress report for 1971. Bangkok, 1972?. pp.1406-1407. Thai., Sum. Engl.

Cassava. Cultivars. Tuber productivity. Selection. Field experiments. Thailand.

Four-yr expt (1967-70) were conducted using a randomized complete block design to select for high-yielding var. Ten lines (13, 14, 22, 30, 31, 43, 45, 70, 1C, 4C), which had been selected from the previous yr, were replicated 8 times. None of the selected lines gave higher yields than the local var. (*Summary by Kasetsart University*) G01

0311-11732 NASSAR, N.M.A. **Genetic resources of cassava: 4-chromosome behaviour in some wild *Manihot* species.** Indian Journal of Genetics & Plant Breeding 38(1):135-137. 1978. Engl., Sum. Engl., 15 Refs.

Cassava. *Manihot*. Chromosomes. Genetics. Brazil.

The gametic no. was found to be 18 in 7 wild *Manihot* species (*M. tripartita* Muell., *M. anomala* Pohl., *M. zehntneri* Ule., *M. oligantha* Pax., *M. gracilis* Pohl., *M. nana* Muell., *M. tomentosa* Pohl.) collected from different localities in the state of Goiás (Brazil). Meiosis was quite regular in all 7 species, resulting in quite high pollen fertility as compared to varying degrees of sterility reported for *M. esculenta* cv. (*Author's summary*) G01

0312-3056 LADEINDE, T.A. *et al.* **Report of subcommittee on breeding.** *In* Ene, L.S O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st, Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp 219-223. Engl.

Cassava. Cassava programs. Plant breeding. Nigeria.

It is recommended that germplasm collecting, screening, characterization and utilization should be done on a cooperative basis in Nigeria. With regard to cassava, the physiology of HCN content should be taken into account in breeding. Other important objectives include development of var. that can be mechanized and that are resistant to the important pests and diseases in Nigeria. (*Summary by I.B. Trans. by T.B.*) G01

0313-11006 KAWANO, K. **Genetic improvement of cassava (*Manihot esculenta* Crantz) for productivity.** Yatabe, Tsukuba, Ibaraki Ministry of Agriculture and Forestry. Tropical Agriculture Research Series no 11 1978. 21p. Engl., 19 Refs., Illus.

Cassava. Cultivars. Germplasm. Plant anatomy. Leaf area. Plant breeding. Hybridizing. Japan.

Reference is made to the methodology being used at CIAT to improve cassava yields. Botanical characteristics related to breeding work, identification of a plant type with an optimum LAI for root yield, existing genetic variability in the germplasm bank at CIAT and the different hybridization techniques used are discussed briefly. Selection is based on seedling trials, single-row and population trials. After 4 yr work, hybrid selections (e.g., CM 308-197) have outyielded local cv. in 2 regions of Colombia by 50-150%. (*Summary by F.G. Trans. by T.B.*) G01

See also 0007 0009 0167 0171 0211 0269

G02 Cytogenetics

0314-10447 NASSAR, N.M.A. **Chromosome number and meiotic behaviour of some wild *Manihot* species native to Central Brazil.** Brazilian Journal of Genetics 1(1):51-57. 1978. Engl , Sum Engl., 15 Refs., Illus

Cassava. *Manihot* Genetics. Chromosomes. Brazil.

Chromosome behavior in meiosis was studied in 7 wild *Manihot* spp native to Central Brazil: *M. tripartita, M anomala, M. zehntneri, M. oligantha, M. nana, M. gracilis* and *M tomentosa.* All had regular meiosis with a haploid no. n = 18 No multiassociations, laggards or irregular distributions were observed. Pollen had fair viability. (*Author's summary*) G02

0315-9942 JOS, J.S. **Cytogenetical aspects of cassava.** *In* Hrishi, N. and Gopinathan Nair, R , eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978 pp 10-14 Engl.

Cassava. Chromosomes. Cytogenetics. Cultivars. Flowers. Polyploidy. Hybridizing. India.

Although cassava is highly heterozygous and is known for its great variability (400 indigenous types from Kerala alone), the no. of chromosomes is consistent (36). Nevertheless, cryptic structural differences have been identified. The karyomorphology of cultivated types, male sterility, production of chromosomal races (tetra- and triploids), interspecific hybridization and amphidiploidy are discussed briefly. (*Summary by T.B.*) G02

H00 NUTRITION

0316-10429 **COMO COCINAR la yuca.** *(Cooking with cassava).* Veracruz, México, Instituto Nacional de Investigaciones Agricolas, 1979. 2p. Span.

Cassava. Uses. Human nutrition. Mexico.

Twelve recipes are given in which sweet cassava var. are used to prepare vegetable dishes, fried chips, soup and desserts such as puddings and cake. *(Summary by T.B.)* H00

H01 Cassava Foods and Nutritive Value

0317-10445 FAFUNSO, M. and BASSIR, O. **Variations in the loss of vitamin C in leafy vegetables with various methods of food preparation.** Food Chemistry 2(1):51-55. 1977. Engl., Sum. Engl., 9 Refs., Illus.

Cassava. Leaves. Ascorbic acid. Cooking. Nutrient loss. Human nutrition.

The vitamin C content of 12 freshly harvested, common edible leaves ranged from 109-421 mg/100 g dry wt basis (lowest value for cassava). There were lowered by cooking for 5 min in 2, 4, 6, 8 and 10 vol of water by 15-22%, 28-39%, 54-60%, 59-70% and 63-76%, respectively. Significantly, cooking in the same vol of water for 10 min slightly increased ascorbate loss. There was greater loss of vitamin C with increased vol of the blanching water, although the rate differed for different leaves. Generally, there was an increase in the rate of ascorbate loss/vol of blanching water until about 6 vol during the 2 periods considered. (*Author's summary*) H01

0318-4247 OMOLE, A. *et al.* **Nutritive value of tropical fruit and root crops.** Nutrition Reports International 17(5):575-580. 1978. Engl., Sum. Engl., 14 Refs.

Cassava. Nutritive value. Laboratory experiments. Laboratory animals. Cyanides. Analysis. Dry matter. Protein content. Ash content. Thiocyanates. Starch crops. Nigeria.

The nutritive value of 6 tropical root and tuber crops commonly consumed in Nigeria — cassava (*Manihot esculenta*), cocoyam (*Xanthosoma sagittifolium*), yellow yams (*Dioscorea rotundata, D. cayenensis*), plantain (*Musa sapientum* var. *paradisiaca*) and breadfruit (*Treculia africana*) — was determined by feeding trials with rats using a level of 30%. All gave high PER values (2.0), with casein at 2.5. Bests results were obtained with breadfruit (2.81), followed by cocoyam (2.79); cassava was the lowest (2.21). Plasma urea level was inversely proportional to the PER, with cassava giving the highest value (47.0 mg/100 ml) and cocoyam, the lowest (24.0). Serum thiocyanate was low in all cases (1.1-1.8 μg/ml), except in cassava (4.4 μg). It was inferred that plasma urea level could be used as an index for nutritive value and that differences in nutritive value were due to differences in the starch of these crops. The high serum thiocyanate of cassava was due to the cyanogenic glycoside present. (*Author's summary*) H01

0319-11219 LEITAO, R.F.F., VITTI, P. and MORI, E.E.M. **A mistura de trigo, milho, mandioca e soja em pastas alimenticias.** (*A mixture of wheat, maize, cassava and soybean flours in food pastes*). Boletim do Instituto de Tecnologia de Alimentos no. 50:187-204. 1977. Port., Sum. Port., Engl., 20 Refs.

Cassava. Cassava pastes. Composite flours. Cassava flour. Organoleptic examination. Analysis. Food products. Brazil.

Two types of composite flours were studied for making food pastes: one contained soybean flour, pregelatinized cassava flour, maize flour and 50% wheat semolina; the other contained the same

ingredients but in nongelatinized form. The pastes were examined by organoleptic, physical and chemical analyses. Although chemical compositions were identical, better results were obtained with the pregelatinized flours. (*Author's summary*) H01

0320-9981 VRIES, C.A. DE **New developments in production and utilization of cassava.** Abstracts on Tropical Agriculture 4(8/9):9-24. 1978. Engl., 187 Refs.

Cassava. Feeds and feeding. Production. Productivity. Industrial starches. Breads. Alcohol. Cassava meal. Cassava leaves. Protein content. Fibre content. Cassava programs.

A review is made of cassava production and utilization; new developments have been mainly in the animal feed industry and the motor fuel market since cassava is the highest producer of carbohydrates of all cereal and tuber crops. Under favorable conditions, future yield potential is estimated at ca. 90 t/ha. Aspects dealt with are toxicity and detoxification, research programs, world production and av yields in 1976 and factors affecting yield, cassava products (starch, bread, sugars, alcohol, SCP, animal feed, leaf protein, residue). Research needs include mechanical harvesting, processing techniques and equipment on a large as well as on a small scale. (*Summary by T.B.*) H01 I00 J00

0321-10938 SHIROSE, I, AGUIRRE, J.M. DE and FERREIRA, V.L.P. **Teste X^2 de aderência em duas etapas e sua aplicação na avaliação organoléptica da preferência entre misturas de resíduo do extrato protéico de soja (Vital) e farinha de mandioca.** (*The application of the two-stage Chi-squared test to sensory analysis. study of preferences for different mixtures of a soybean protein extract and cassava flour*). Coletânea do Instituto de Tecnologia de Alimentos 8:573-586. 1977. Port., Sum. Port., Engl., 4 Refs

Cassava. Organoleptic examination. Protein enrichment. Cassava flour. Statistical analysis. Brazil.

Initially, mixtures of 0-50-100% cassava flour (CF) + 100-50-0% soybean protein extract (Vital) residue were compared. The 2-stage X^2 test showed a preference for pure CF in the 1st stage, using 15 testers. Estimated preference %s for the 3 mixtures were 13.33, 13.33 and 73.33%, respectively. Then the following mixtures were compared: 60-65-70% CF + 40-35-30% soybean protein extract using another 15 testers. There were no significant preferences. Estimated preference %s were 33.33, 30.00 and 36.67%, respectively (*Author's summary*) H01

0322-4334 AGBEDANA, E.O., TAYLOR, G.O. and BASSIR, O **Serum lipids in protein malnourished animals.** Nutrition Reports International 17(4):483-493. 1978. Engl., Sum. Engl., 19 Refs.

Cassava. Animal health. Diets. Animal nutrition. Protein deficiencies. Biochemistry. Nutritive value. Nigeria.

Rats, monkeys and pigs were fed maize and cassava diets, commonly eaten in some areas of Nigeria, where kwashiorkor is still prevalent Exptl animals showed reduced total protein and globulin levels and growth failure. Reduction in body wt was observed in the protein-malnourished animals whereas edema was observed only in the malnourished rats. Serum cholesterol and triglyceride levels were reduced in the protein-malnourished monkeys and pigs, but free fatty acid levels remained within normal range. In the rats, triglyceride and free fatty acid

levels were raised insignificantly, while cholesterol levels were normal. The different species used showed differences in reactions to the effect of protein deprivation, but for lipid studies in exptl protein malnutrition, the monkey appears to be most suitable. (*Author's summary*) H01

0323-4575 ROJANARIDPICHED, C. **Cassava leaf pellets as a protein source in Thailand.** Cassava Newsletter no. 1:5. 1977. Engl., Illus.

Also in Spanish

Cassava. Pellets. Proteins. Leaves. Thailand.

Cassava is an important source of carbohydrate. The roots are low in protein, but the leaves and green shoots are rich in protein, both in quantity and quality. From Thailand cassava leaf and green shoot pellets have been exported to West Germany as a protein source. It is also recommended that the leaves be used as green manure in the country itself. (*Summary by Abstracts on Tropical Agriculture*) H01

0324-11724 KILONZO, J.M. **The improvement of the biological value of food-plants from Kenya by combinations with vegetal proteins, animal proteins, and limiting amino acids.** Nutrition Reports International 18(5):599-609. 1978. Engl., Sum. Engl., 28 Refs.

Cassava. Laboratory experiments. Protein enrichment. Amino acids. Proteins.

A study was undertaken at the Swiss Federal Dairy Research Institute to improve the biological value (BV) of rice, maize, sorghum, wheat, cassava and beans by adding vegetable protein (soybeans), animal protein (skim milk, whey protein concentrate, buttermilk, egg and fish protein) and limiting amino acids. In a series of 10 expt with young rats the digestibility coefficient, BV, NPU and PER were determined. The enrichment with proteins as well as amino acids generally led to an improvement of their nutritive value in various degrees but not of the digestibility coefficient (except for sorghum). (*Author's summary*) H01

0325-11718 MADUAGWU, E.N. **Cyanide content of gari.** Toxicology Letters 3:21-24. 1979. Engl., Sum. Engl., 17 Refs., Illus.

Cassava. Gari. HCN content. Analysis. Cyanogenic glycosides. Toxicology. Nigeria.

HCN content was determined in 500 samples of gari taken at random in Ibadan markets. Most samples contained detectable amounts, ranging from 0.8-38 mg/kg; only 0.4% contained no cyanide. Limit of HCN detection was 0.1 ppm. There was no significant difference ($P < 0.01$) between mean total cyanide (glycoside-bound + nonglycosidic) and free cyanide (nonglycosidic) contents, which were 8.0 ± 6.9 and 7.2 ± 5.8 mg HCN/kg, respectively, indicating that an overwhelming proportion of the residual cyanide content of commercial gari could be present in the "free" form. Implications of toxicity of free cyanide in cassava diets are discussed briefly. (*Author's summary*) H01

0326-4631 ANAZONWU-BELLO, J.N. **Forms and quality of root crops in human nutrition.** *In* Ene, L.S O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike,

Nigeria, 1977. Umudike, National Root Crops Research Institute, 1978. pp.166-177. Engl., 3 Refs.

Cassava. Food products. Cassava leaves (vegetable). Fermented products. Nutritive value. Nigeria.

An evaluation is made of the nutritive value of the most important root crops in Nigeria: cassava, yams, cocoyams and sweet potatoes. Regarding cassava, the difference between sweet and bitter var., HCN content, food value and traditional methods of elaboration are discussed briefly. These foods (including sweet cassava leaves for vegetables) are nutritious and should be popularized. (*Summary by I.B. Trans. by T.B.*) H01

See also 0047 0375 0404

H02 Nutritive Disorders in Humans

0327-10407 BOURDOUX, P. *et al.* **Evidence that cassava ingestion increases thiocyanate formation: a possible etiologic factor in endemic goiter.** Journal of Clinical Endocrinology and Metabolism 46(4):613-621. 1978. Engl , Sum. Engl., 36 Refs , Illus.

Cassava. Thiocyanates. Metabolism. Endemic goitre. Etiology. Toxicology. Human health. Epidemiology. HCN. Zaire.

In inhabitants of Ubangi (an endemic goiter area in Zaire) with severe iodine deficiency, serum and urinary thiocyanate (SCN) concn (1.06 and 1.92 mg/100 ml) were higher ($P < 0.001$) than levels observed in Belgian controls (0 22 and 0.60 mg). Urinary SCN levels rose with thyroid hyperplasia, and variations with age and sex were comparable to the curve of goiter distribution. In 30% of the patients, serum SCN level was > 1 mg/100 ml, above which value SCN inhibits the iodine pump in persons with normal I intake. An intensive cassava diet for 3 days significantly raised serum and urinary SCN concn in patients with low levels at the outset; stopping the diet decreased concn in patients with high levels at the outset. A large cassava meal raised urinary iodide excretion from 9.3 to 18.1 μg/day ($P < 0.001$) and reduced ^{131}I thyroidal uptake in girls of a Ubangi boarding school ($P < 0.05$). In 2 groups of adolescents with a similar I deficiency (urinary iodide excretion 13.5 and 11.5 μg/day), subjects with a high serum SCN level (1.06 mg/100 ml) had lower serum thyroxine ($P < 0.01$) and higher TSH ($P < 0.001$) levels than subjects with low serum SCN levels (90.26 mg). These data suggested that the thiocyanate exposure was linked with the consumption of cassava and played a decisive part in the etiology of endemic goiter. In such conditions of chronic thiocyanate overload, adjustment to the I deficiency was achieved only through a greatly enhanced thyrotropic stimulation, probably intended to compensate for inhibition of the I transport mechanism by thiocyanate. (*Author's summary*) H02

0328-10999 DOROZYNSKI, A. **Cassava may lead to mental retardation.** Nature 272(5649):121. 1978. Engl., Illus.

Cassava. Toxicity. Human health. Clinical manifestations.

A report is given of research being done in the Ubangi region in NE Zaire, where goiter is endemic (60-70% of the population, 1-10% of whom are affected with cretinism), and a no. of people suffer from varying degrees of mental retardation. The possible role of cassava in hypothyroidism—which may lead to mental retardation in children if not corrected at an early stage—is discussed. (*Summary by T.B.*) H02

0329-10994 ERMANS, A.M. *et al.* **Possible role of cyanide and thiocyanate in the etiology of endemic cretinism.** *In* Stanbury, J.B. and Kroc, R.L., eds. Human development and the thyroid gland. New York, N.Y. Plenum Publishing Corporation, 1977. pp.455-486. Engl., Sum. Engl., 89 Refs., Illus.

Cassava. Human physiology. Thiocyanates. Iodine. Cretinism. Food products. Enzymes.

Cyanogenic glycosides. Toxicity. Etiology. Cyanides.

With regard to the possible intervention of the thiocyanate ion in the pathogenesis of endemic goiter and cretinism, the following conclusions were reached: Continuous intake of cassava is capable of causing changes in iodine and thiocyanate metabolism which are both qualitatively and quantitatively identical to those obtained by prolonged administration of thiocyanate. Ingestion of thiocyanate or cassava entails marked depletion of I stores; depletion is fairly moderate in nondeprived rats but very severe in I-deprived rats During I deprivation, the 2 substances cause major changes in intrathyroidal metabolism which I deficiency alone is incapable of causing. Chronic ingestion of thiocyanate does not necessarily cause blocking of the thyroidal iodide pump; on the contrary, I uptake seems to be increased, probably due to thyrotropic stimulation triggered by I depletion. However, this does not preclude transitory inhibition during the phase of thiocyanate absorption. Chronic administration of thiocyanate or its precursors does not necessarily entail a very marked rise of SCN concn in the blood. A diagram illustrates the goitrogenic action of cassava and thiocyanate on the basis of present exptl data and why this etiological mechanism can be completely reversed by stepping up I intake. Investigations reveal the difficulty of verifying the role of thiocyanate-like goitrogens in the mechanisms of goiter development in man. In view of the severity of the metabolic changes induced by the association of I deficiency with ingestion of thiocyanate-like compounds, the question arises as to whether the action of these factors on the fetal thyroid could not give rise to transitory or permanent lesions responsible for the development of cretinism. (*Extracted from author's summary*) H02

0330-11293 BOURDOUX, P. *et al.* **Mise en évidence d'un facteur alimentaire distinct de la carence iodée dans la pathogénie du goitre.** (*Pathogenesis of endemic goiter: evidence of a dietary factor different from iodine deficiency*). Annales d'Endocrinologie 39:153-154. 1978. Fr., Sum. Fr., Engl., 4 Refs.

Cassava. Endemic goitre. Thiocyanates. Iodine. Deficiency diseases. Human health. Zaire.

The role of cassava in a particularly severe endemic goiter area (Ubangi) was investigated. Dietary intake of cassava induced an increase in plasma thiocyanate concn and in urinary excretion of stable iodine. Generalized I deficiency induced very high thyroid uptake; the other parameters of thyroid function were more or less affected according to the dietary intake of thiocyanate. When thiocyanate intake was high, adaptation of the thyroid function was possible only when there was a drop in plasma T4 level and a very high increase in plasma TSH. (*Author's summary*) H02

H03 Animal Feeding

0331-10918 SZYLIT, O. *et al.* **Valeur nutritionnelle pour le poulet en croissance, de cinq amylacés tropicaux en relation avec quelques caractéristiques physico-chimiques de leur amidon.** (*Nutritional value for growing chickens of five tropical amylaceous feeds in relation to some physicochemical characteristics of their starch*). Annales de Zootechnie 26(4).547-563. 1977. Fr., Sum. Fr., Engl , 29 Refs., Illus.

Cassava. Chicks. Taro. Yams. Nutritive value. Tubers. Composition. Diets. Feeds and feeding. Cassava starch. Analysis. Animal nutrition.

The feed efficiency of 5 tropical roots was estimated. Starch of cassava, taro (*Colocasia antiquorum*) and yams (*Dioscorea dumetorum*) is characterized by small-diameter granules and an X-ray diffraction pattern of the A type, similar to starch of cereals Canna (*Canna edulis*) and yellow yams (*D. cayenensis*) have much larger starch granules (60-75μ) with a high amylose level (26%) and an X-ray pattern of the B types, as potato starch In vitro breakdown of these starches in the presence of bacterial α-amylase from *Bacillus subtilis* decreases in the following order: cassava, *D. dumetorum*, taro, canna and *D. cayenensis*. Three-wk-old chicks received a diet based on peanut meal and the roots for 21 days. Very slight differences were observed with the 1st 4 diets concerning av wt gain (40, 36, 37 and 36 g/day, respectively), but daily food intake was different (82, 83, 99 and 91 g/day). Best feed efficiency was obtained with cassava; poorest growth (12 g/day) and lowest feed intake (64 g/day) was recorded with *D cayenensis*. Starches with A-type X-ray diffraction patterns were completely digested (98%), while that of the B type was lower (90% for canna and 69% for *D. cayenensis*). This leads to the reduction of the level of protein utilization in yams; similar results had already been obtained with high amylose maize starch (B type). None of the physicochemical or enzymatic parameters studied can be used as sole grading criteria for the nutritional value of a given starch. A small-diameter starch granule, a low amylose content and an X-ray diffraction pattern of the A type were all favorable factors contributing to a good apparent digestibility of starch. Feed efficiency may be especially related to the rate of the in vitro amylolysis of starch (*Summary by Biological Abstracts*) H03 I01

0332-11216 COURSEY, D G. and HALLIDAY, D. **Developments in the use of tropical root crops as animal feed.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. pp.139-143. Engl., 22 Refs.

Cassava. Uses. Animal nutrition. Starch crops.

The major interest in tropical root crops use for animal feeds is in cassava as it is normally by far the cheapest to produce. Sweet potatoes are also used and could well be planted more in the future. Nutritional value, toxicity and acceptability, methods of presentation as stable dried products and the use of foliage of the major tropical root crops are reviewed. In addition recent progress in the use of cassava and imports of cassava products into the EEC during the period 1962-73 is discussed. (*Summary by Abstracts on Tropical Agriculture*) H03

0333-10065 BOEVE, J., SMITS, B. and DAMMERS, J. **Gedroogde bollen, knollen, wortelen en onderaardse stengeldelen.** (*Digestibility trials with pigs. 6. Dried bulbs, tubers and roots*). *In* ——. Veteringsproeven met varkens. Wageningen, Netherlands, Centrum voor Landbouwpublikaties en Landbouwdocumentatie, 1973. pp.18-22. Dutch, Sum. Dutch, Engl., 2 Refs.

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

In trials with 2 batches of cassava meal, it was found that chemical composition as well as digestibility differed considerably. The high crude fiber and/or ash content had a significant negative effect on the digestibility of the other components, except crude protein. (*Summary by J.V.*) H03

0334-3479 TEIXEIRA, L.B. **Uréia, estilosantes e raspa de mandioca como suplementos do capim-elefante para bovinos em confinamento.** (*Urea, Stylosanthes and cassava chip meal as supplements to Pennisetum purpureum for cattle in feed lots*). Tese Mag. Sc Viçosa, MG, Universidade Federal de Viçosa, 1975. 34p. Port., Sum. Port., 35 Refs.

Cassava. Cassava meal. Feeds and feeding. Diets. Cattle. Digestibility. Statistical analysis. Brazil.

In a 63-day trial with a 17-day adjustment period, 20 steers (Friesian x zebu), 3 yr of age (av initial wt 353 kg) were given elephant grass ad libitum + (A) 0.10 kg urea, (B) 6 kg Stylosanthes, (C) A + 1.20 kg cassava meal (CM) and (D) B + 1.20 kg CM. Four animals/treatment were used to determine apparent digestibility from days 34-50. Treatments A and B gave equal wt gains; wt gains increased significantly ($P < 0.05$) when cassava was included. DM intake and digestible energy were significantly better ($P < 0.05$) in Stylosanthes and CM treatments. Apparent digestibility of DM and gross energy increased significantly ($P < 0.05$) when CM was included; however, apparent digestibility of cellulose was higher ($P < 0.05$) in the treatment with Stylosanthes but lower in that with urea. (*Author's summary. Trans. by T.B.*) H03

0335-4749 OBICHA, F.C. **Forms and quality of root crops products in livestock feeds.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.177-194. Engl., Sum. Engl., 40 Refs.

Cassava. Cassava chips. Pellets. Cassava meal. Leaves. Wastes. Poultry. Swine. Calves. Dairy cattle. Feeds and feeding. Nutritive value. Composition. Animal nutrition. Nigeria.

In addition to a review on the traditional forms of cassava (chips, pellets, meal, leaf meal) utilized for animal feed, the Nigerian use of gari by-products is described. These are gari sievate (fermented cassava is fried and sieved), meal residue (ungratable material, high in fiber and grit), peels (when ensiled, HCN content is reduced from 1300 to 300 mg/kg) and starch (decanted effluent solution from pressed, grated cassava). The economic advantage of substituting cassava for grains is best sustained where demand for cassava as human food is minimal. Emphasis should be placed on the development of industrial by-products from cassava in those countries where it is in heavy demand as a human food. There is a need for systematic research on animal tolerance to HCN and lethal dosages. (*Summary by T.B.*) H03

0336-10442 ADENYANJU, S.A. and PIDO, P.P. **The feeding value of fermented cassava peel in broiler diets.** Nutrition Reports International 18(1):79-86. 1978. Engl., Sum. Engl., 13 Refs.

Cassava. Chicks. Feeds and feeding. Cortex. Fermented products. Feed constituents. Dietary value. Animal nutrition. Costs. Nigeria.

Fermented cassava peels were incorporated at 0-10-20-30% levels, respectively, into diets for broiler chicks for 9 wk, and the feeding value of the diets determined. There was a significant depression in feed intake, daily wt gain and feed efficiency ratio, but nonsignificant increases in giblet wt and abdominal fat as the level of cassava increased. Significant economic benefits in reduced feed cost and increased income/feed cost were derived from increased levels of cassava. Results suggest that 20% is the optimum level at which fermented cassava peel can be incorporated into broiler diets. (*Author's summary*) H03

0337-10435 LEE, P.K. and YANG, Y.F. **[Comparative study on the nutrient digestibility of sweet potato chips, cassava pomace dried and banana chips by pigs].** Journal of the Agricultural Association of China no. 102:96-102. 1978. Chin., Sum. Chin , Engl., 9 Refs.

Cassava. Feeds and feeding. Swine. Digestibility. Dietary value. Pulp. Animal nutrition.

The effect of feeding sweet potato chips, dried cassava pulp or banana chips as a substitute for 30% DM of a basal maize/soybean diet on nutrient digestibility of 6 male crossbred pigs (av 50 kg initial wt) housed in metabolism cages was studied. The trial period was 10 days, including a 5-day adjustment and 5-day collection period. Mean digestibility coefficients of DM, OM, crude protein, crude fat, crude fiber, N-free extract and energy for the pigs feed sweet potato chips were 88.5, 90.5, 78.9, 68.5, 28.9, 95.0 and 66.1%, respectively; for the animals given dried cassava pulp, 90.0, 91.4, 81.7, 76.5, 66.4, 95.4 and 65.4%; and for those on banana chips, 90.1, 91.7, 81.3, 68.7, 55.4, 95.1 and 65.4%. Differences were not significant, except for the crude fiber digestibility coefficient This was probably due to the higher crude fiber content of the dried cassava pulp, as compared to that of the sweet potato and banana chips. (*Author's summary*) H03

0338-10456 ZAPATA A., O. **La yuca como alimento para ganado de leche.** (*Cassava in rations for dairy cattle*). ICA-Informa no. 4 5-8. 1977. Span.

Cassava. Dairy cattle. Forage. Animal nutrition. Concentrates. Food energy. Nutritive value. Proteins. Colombia.

Expt were conducted at the Instituto Colombiano Agropecuario to determine the effect of supplementing rations for heifers and dairy cattle with cassava forage (young leaves) and ground, dried roots and leaves, respectively, as compared to alfalfa or concentrated feed supplements. Equally good wt gains for heifers and milk production for cows were obtained with economies of 46 and 72%, respectively It is recommended that no more than 8 kg/animal/day green forage should be given. (*Summary by T.B.*) H03

0339-10485 OYENUGA, V.A. and FETUGA, B.L. **Chemical composition, digestibility and energy values of some varieties of yam, cassava, sweet potatoes and cocoyams for pigs.** Nigerian Journal of Science 9(1):63-110. 1975. Engl., Sum. Engl., 34 Refs.

Cassava. Digestibility. Composition. Fat content. Fibre content. Analysis. Feeds and feeding. Animal nutrition. Swine. Tubers.

The chemical composition, apparent nutrient digestibility, digestible energy (DE), metabolizable energy (ME) and total digestible nutrients (TDN) were determined at the U. of Ibadan for raw,

cooked peeled and unpeeled yams, cassava and sweet potatoes and for cooked peeled and unpeeled cocoyams, using growing pigs. All tubers had low fat and crude fiber content, the fiber in the unpeeled samples being slightly higher than in the peeled. The range of crude protein in cassava (1.8-2.8%) was distinctly lower than that in the other tubers. The different tubers showed similar high digestibility values for DM and N-free extract, but the digestion coefficients for other nutrients were much lower. Peeling significantly enhanced the digestion of crude protein, ether extract and crude fiber in all the tubers except cassava. DE and ME were highest for the different cassava forms and least for the yams. Peeling significantly influenced the energy values of the yams but not those of cassava, cocoyams and sweet potatoes. Cooking did not significantly improve the utilization of energy in the cassava and sweet potato forms. (*Author's summary*) H03 C03

0340-10461 VALDIVIE, M. **Producción avícola con algunos productos y subproductos nutritivos de climas cálidos.** (*Poultry production with different products and by-products from warm climates*). Revista Cubana de Ciencias Agrícolas 12:1-16. 1978. Span , 42 Refs.

Cassava. Poultry. Cassava meal. Leaves. Protein content. Water content. Ash content. Fiber content. Fat content. Nutritive value. Feeds and feeding. Animal nutrition. Cuba.

The results obtained by different researchers in the evaluation of products and by-products from the sugar industry, rice, wheat, plantain and cassava (meal and leaf meal) for poultry nutrition are summarized. As for cassava, the chemical composition of the meal, leaf meal, peeled and unpeeled roots is given in a table. The different %s recommended for broilers and laying hens are specified. (*Summary by T.B.*) H03 C03

0341-10920 WEBB, B.H., WHOLEY, D.W. and HUTAGALUNG, R.I. **Protein from cassava foliage.** Kuala Lumpur, University of Malaya, 1978. 34p. Engl., Sum. Engl., 22 Refs., Illus.

Paper presented at Regional Conference on Technology for Rural Development, Kuala Lumpur, 1978.

Cassava. Leaves. Protein content. Forage. Feeds and feeding. Productivity. Production. Costs. Nutritive value. Animal nutrition. Malaysia.

Cassava leaves are widely recognized as rich in apparent protein. Expt in L.A. and Malaysia have shown that to obtain high yields of forage, cassava must be grown at high populations (50,000 plants/ha) and cut at frequent intervals. In dry areas irrigation may be necessary and adequate fertilizer inputs will be required on impoverished soils. Yields $>$30 t dry forage are anticipated on mechanized plantation-scale enterprises. Existing technology from grass/lucerne production systems can be adapted to produce and process cassava forage. The product requires additional methionine before compounding for animal feed, but its high carotene and lysine contents compensate for this. The setting up of pilot schemes to evaluate this potentially productive industry for Malaysia is encouraged. (*Author's summary*) H03 J00 C03

0342-4163 HANSEN, V., BRESSON, S. and JENSEN, A. **Tapiokamel som foder til slagterisvin.** (*Cassava meal as feed for bacon-type hogs*). Kobenhavn, Denmark, Beretning fra Statens Husdyrbrugsforsøg no. 440. 1976. 20p. Dan., Sum. Dan., Engl., 21 Refs.

Cassava. Cassava meal. Swine. Dietary value. Feed mixtures. Animal nutrition. Finishing.

Two expt were carried out with increasing amounts of cassava meal (CM) for bacon-type hogs. In the 1st expt with 4 pigs/group and 10 replications, 0, 15 and 30% CM were evaluated; and in the 2nd expt (6 replications) 45 and 60% CM were evaluated. The feed mixtures were the only rations during the growing- finishing period (20-90 kg liveweight). The Scandinavian Feed Units/kg liveweight gain and the daily gain, respectively, for the 5 different treatments (0-60% CM) were as follows: 100, 100; 100, 100, 103, 98; 107, 95; and 105, 95. Levels of CM > 15% implied an increased intake of SFUs/kg liveweight gain and a decreased daily gain; therefore, >20-30% CM in feed mixtures for bacon pigs under normal price relationships is not recommended, especially as CM seemed to cause an increased no. of cases of diarrhea This may, however, have been caused by the rather poor quality of the meal, which had among other things a high sand content. With better quality meal, it may be possible to use higher proportions in the mixtures On the whole, carcass quality was similar, regardless of the level of CM caused. When using large amounts of CM, it is necessary to balance for the low protein content and other essential nutrients that CM lacks or contains too little of. (*Author's summary*) H03

0343-0087 HUTANUWATR, N. and SORNSOONGNERN, N. **The utilization of cassava root meal as energy source for finishing beef cattle.** *In* Khon Kaen University. Faculty of Agriculture. Cassava/nutrition project; annual report 1975/76 Khon Kaen, Thailand, 1977. pp.173-181. Engl., Illus.

Cassava. Cassava meal. Finishing. Beef cattle. Nutritive value. Diets. Dietary value. Animal nutrition. Thailand.

Preliminary results are given of an experiment conducted to evaluate the nutritive value of cassava as a finishing ration for beef cattle and to compare production costs and biological response. A completely randomized design with 3 dietary treatments (58 97% cassava; 100% maize; and 29.5% cassava + 34 2% maize) and 3 replications was used. All diets were fed in mash form. Initial wt of the American Brahman x native cattle was 150 kg; the experiment will terminate when they reach 300 kg. (*Summary by T.B.*) H03

0344-11206 GERPACIO, A.L. *et al.* **Cassava meal in swine rations.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no 174. 1977. pp.186-190. Engl., Sum Engl., 2 Refs.

Cassava. Cassava meal. Swine. Feed constituents. Feeds and feeding. Fattening. Finishing. Supplements. Dietary value. Animal nutrition. Philippines.

Cassava meal was prepared by washing whole roots (harvested at 8 mo), chopping, drying at 80°C and grinding to a fine meal. Rations were formulated such that CM rations were approx isonitrogenous and isocaloric with the control ration (normal maize). Trials were conducted to study the possibility of completely replacing maize by CM in pig rations, from starter to slaughter wt. It was shown that pigs can be fed high levels of CM instead of maize. Supplementation of the CM with 0.20% methionine improved feed efficiency by about 10%. (*Summary by Abstracts on Tropical Agriculture*) H03

0345-11205 GERPACIO, A.L. *et al.* **Tuber meals as carbohydrate sources in broiler rations.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. pp.183-185. Engl., 10 Refs.

Cassava. Cassava meal. Feeds and feeding. Chicks. Feed constituents. Animal nutrition. Philippines.

Limitations imposed by, scarcity of and competition with human consumption for maize have forced many farmers to look for other sources. Feeding trials with broiler chicks were conducted with newly harvested tubers of sweet potatoes, cassava, taro (*Colocasia esculenta*), yams (*Dioscorea alata*) and elephant's-foot (*Amorphophallus campanulatus*). All ration ingredients were analyzed for CP content. Rations were isonitrogenous and isocaloric with the control (either normal yellow or white maize). A summary of the results is presented in a table. (*Summary by Abstracts on Tropical Agriculture*) H03

0346-11793 YEONG, S.W. *et al.* **The effect of cassava chip quality on their use in poultry feeds.** MARDI Research Bulletin 6(2) 180-185. 1978. Engl., Sum. Engl., Mal , 7 Refs.

Cassava. Cassava chips. Chicks. Feeds and feeding. Feed constituents. Storage. Solar drying. Dietary value. Animal health. Animal nutrition. Malaysia.

Six finishing diets (5 containing 50% cassava chips of varying quality) were fed over a 6-wk period to 4-wk-old broilers. Chip quality did not affect feed intake but appeared to influence feed efficiency. The presence of high salt concn, used as a preservative, in 2 of the cassava diets resulted in diarrhea and increased mortality. When salt-treated chips were stored for 2 wk prior to sun drying, the high salt concn had no adverse effect on feed intake or efficiency, but storage for a shorter period resulted in reduced feed efficiency and toxicity. Further research is required to determine the nature of this toxicity and the optimum levels of salt-treated cassava in diets for poultry and other farm animals (*Author's summary*) H03

0347-11292 QUDRATULIAH, S. and SIDDIQUI, S.M **A study on the inclusion of tapioca flour in broiler rations.** Indian Journal of Poultry Science 12(3):56-59. 1977. Engl., Sum. Engl., 13 Refs.

Cassava. Chicks. Cassava flour. Feeds and feeding. Feed constituents. Animal health. Animal nutrition. Dietary value. India.

A study on the inclusion of 50 and 100% cassava flour as a substitute for maize in broiler rations, conducted at A P. Agricultural U. in Hyderabad, showed that it significantly depressed body wt and reduced feed efficiency. With isonitrogenous diets, however, feed efficiency was restored to a great extent although wt gains remained impaired. (*Author's summary*) H03

0348-11725 FFOULKES, D., DOÑE, F and PRESTON, T R. **Forraje de yuca como alimento para el ganado: digestibilidad y consumo del forraje integral.** (*Cassava forage for cattle: digestibility and intake of complete forage*). Producción Animal Tropical 3(3):234-236. 1978. Span., Sum. Span., 8 Refs.

Cassava. Forage. Digestibility. Cattle. Animal nutrition. Dominican Republic.

The digestibility of cassava forage (leaves, petioles and green stems) was evaluated for 2 wk using 4 zebu bulls (200 kg, 2 yr old) at an expt station (CEDIPECA) in Santo Domingo. One animal selected the leaves and petioles while the other 3 consumed the complete forage Digestibility (av of 3 animals) was 66 5 ± 0.16 kg/ 100 kg liveweight. These values compared favorably to those for sweet potato and plantain forage. (*Author's summary. Trans. by T.B.*) H03

0349-11752 ACUÑA, C.A **Eficiencia de la harina de yuca (*Manihot esculenta*) descortezada como sustituto parcial del maíz en el engorde de cerdos.** (*Efficiency of cassava meal as a partial substitute for maize in rations for fattening pigs*). Oriente Agropecuario 3(1/2): 24-30. 1971. Span., Sum. Span., Engl., 7 Refs.

Cassava. Cassava meal. Swine. Fattening. Feeds and feeding. Feed constituents. Composition. Dietary value. Animal nutrition. Venezuela.

A 30-day expt was conducted at the School of Animal Science of the U. de Oriente (Venezuela) to determine the proportion in which meal from peeled cassava roots could substitute maize in rations for fattening pigs. A randomized block design with 32 Duroc-Yorkshire-Landrace pigs (av wt 40 kg) was used with 4 treatments and 4 replications. A basic ration of 50 kg yellow maize/100 kg was utilized, substituting CM at levels of 0, 20, 40 and 60%. Both feed intake and wt gains were similar in all treatments. Animals in the maize treatment had a feed conversion of 2.79; those with 60% CM, 2 63 The results indicate that CM can replace up to 60% of yellow maize in rations for fattening pigs (*Summary by T.B.*) H03

0350-11771 UMOH, I B., AYALOGU, E.O. and OKE, O.L. **The importance of lysine in cassava-based feeds.** Nutrition Reports International 19(2)·203-207. 1979. Engl., Sum. Engl , 9 Refs

Cassava. Feeds and feeding. Feed mixtures. Supplements. Lysine. Methionine. Laboratory animals. Dietary value. Animal nutrition. Nigeria.

A cassava-based feed was prepared with leaf protein concentrate (LPC) as the source of protein. With the control (LPC + maize starch) the PER was 1 8, BV 74.3 and NPU 66.1. When 40% cassava was included in the diet and supplemented with 0.15% methionine, the PER increased to 2 1, the BV to 83.3 and the NPU to 72 6. When graded levels of lysine were added, there was further improvement of all parameters up to a level of 0.25% when the max PER of 3.1 was obtained. The importance of lysine in cassava-based rations is discussed. (*Author's summary*) H03

0351-11747 GOMEZ, G **Cassava as a swine feed.** World Animal Review no. 29:13-20. 1979. Engl., Sum. Engl , 16 Refs , Illus

Cassava. Swine. Feeds and feeding. Fattening. Finishing. Tubers. Fresh products. Proteins. Supplements. Amino acids. Forage. Silage. Cassava meal. Cassava chips. Animal nutrition. Colombia.

Cassava roots are an excellent source of dietary energy and can be used as fresh, dried or ensiled products in swine-feeding programs. Fresh, chopped roots of sweet var. can be fed to pigs throughout their life cycle, either separately or mixed with a protein/mineral/vitamin supplement. Roots of bitter var. are not readily consumed because of their high linamarin content. High levels of cassava meal (60-70%) were compared at CIAT-Colombia with a conventional common maize diet Litter performance at weaning was inferior for gilts on the CM diets. Methionine supplementation does not appear to be indispensable in CM/soybean meal diets Whole roots can be stored in field clamps and chopped roots in airtight plastic bags or in trench silos without significant loss of nutritive quality. Roots ensiled for up to 6 mo are readily consumed by growing pigs. Because of the low protein content, feeding programs based on high levels of cassava require a considerably larger supply of protein supplement than conventional energy sources such as cereal grains (*Author's summary*) H03

0352-10468 ESCOVAR M., I.B. **Utilización de hojas y tallos deshidratados de yuca (*Manihot esculenta* Crantz) en alimentación animal.** (*Use of dehydrated cassava leaves and stems in animal nutrition*). Tesis Qmca. Sartenejas, Miranda, Venezuela, Universidad Simón Bolívar, 1979. 70p. Span., Sum. Span., 43 Refs.

Cassava. Cassava leaf meal. Analysis. Nutritive value. Cultivars. Amino acids. HCN content. Productivity. Foliage. Protein content. Timing. Ash content. Fibre content. Carbohydrate content. Uses. Animal nutrition. Venezuela.

The nutritional characteristics of the leaves and stems of 11 cassava cv from the U Central de Venezuela's exptl station Experta were evaluated after the 1st and the 4th cuts. A proximal analysis was made of the moisture, crude protein, ether extract, ash, crude fiber and carbohydrate contents; HCN content, % of fatty acids and the amino acid profile were also determined. No conclusions could be reached on the basis of these 2 different analyses; it is suggested that samples from the 6 different cuts should be studied. The best cv. were UVC-2078, -2203, -2385 and -2284. The leaf and stem meal has a nutritive value similar to that of alfalfa. The amino acid profile is deficient in methionine, isoleucine and threonine, but the rest of the essential amino acids are present in levels above those proposed by FAO. Of the 10 fatty acids, ca. 59% were unsaturated; palmitic and linolenic acids were present in the highest %s The meal can be consumed directly by animals because the HCN content is very low; however, it should be supplemented with the amino acids in which it is deficient. (*Author's summary. Trans. by T.B.*) H03

0353-10453 FERNANDEZ, A. and PRESTON, T.R. **Forraje de yuca como suplemento de fibra y proteína en dietas de melaza: efecto del nivel de forraje y suplementación con harina de soya.** (*Cassava forage as a fiber and protein supplement in molasses diets. effect of forage level and soybean meal supplementation*). Producción Animal Tropical 3(2):111-115 1978 Span , Sum. Span., 3 Refs., Illus.

Cassava. Leaves. Forage. Feed constituents. Supplements. Protein content. Fibre content. Dietary value. Beef cattle. Statistical analysis. Animal nutrition. Dominican Republic.

The effect of different levels of chopped fresh cassava forage (2, 3 or 4% of the liveweight), with or without 200 g/day soybean meal (SBM), was evaluated in a 2 x 3 factorial design with 3 groups of 6 zebu steers (av initial wt 170 kg), fed molasses/urea ad libitum. The trial period was 105 days with an initial 35-day adaptation period. In the absence of SBM there was a linear response in gain (367 to 908 g/day) as the level of forage increased; feed conversion was also better (10.7 vs. 5.61 kg DM/kg gain). In the presence of SBM wt gain was not related to forage level (ranging from 607 to 710 g/day), and feed conversion efficiency decreased as forage level increased (5.34 vs. 7.17 kg DM/kg gain). It is concluded that beef cattle can be fed economically on a molasses/urea diet in which the only source of fiber and protein is cassava forage. (*Author's summary. Trans. by T.B*) H03

0354-11288 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Swine unit 1978 report.** *In*_____ Annual Report 1978. Cali, Colombia, 1979. pp E 1 - E.18. Engl., Illus.

Also in Spanish

Cassava. Cassava programs. Tubers. Silage. Swine. Cassava meal. Feeds and feeding. Nutritive value. Storage. Composition. Cassava leaf meal. Protein enrichment. Industrial microbiology. HCN content. Animal nutrition. Colombia.

Research activities were directed primarily to evaluating feeding programs based on cassava roots

and the processed products. Pigs used CM-based diets more efficiently when molasses was added. Ensiled chopped roots could be conserved for a min of 6 mo. Exptl results of the nutritive evaluations suggest a good potential for this conservation process for humid tropical regions and for small- and medium-scale farms where the final product can be used for feeding swine. In diets using 20 and 40% leaf meal to replace conventional protein sources partially, acceptable results were obtained at the 20% level with growing-finishing pigs. Expt at the pilot plant level were continued with a larger fermentor (3000 *l*), using grated roots as the energy substrate for producing SCP. Concn of 34-35% crude protein were obtained from the sun-dried biomass after av fermentation periods of 21 h. Difficulties encountered during the harvesting and drying of the final biomass are discussed Nutritional studies were then conducted with the biomass; SCP (fermented with the fungus *Aspergillus fumigatus* I-21A) was compared to soybean meal as the only protein source in diets for feeding swine. When adequately supplemented with methionine, the nutritional quality of the SCP was good. Results of blood parameter analyses suggest that the SCP was not toxic to pigs; histopathological analyses are being made of organs and tissues. Results obtained from measuring the cyanogenic glucoside contents in the roots and the processed products suggest the necessity of studying in greater detail the effect of methods of storage and processing on changes in content, especially in products to be used for feedstuffs since they normally contain the peels, which have higher HCN levels than the parenchymatous tissue. (*Summary by F.G. Trans. by T.B.*) H03 I03

0355-10405 PINEDA M., J.E **Urea and yucca (*Manihot esculenta*) for dairy cattle in Colombia.** Ph.D. Thesis. Lafayette, Indiana, Purdue University, 1971. 112p. Engl, Sum. Engl., 89 Refs., Illus.

Cassava. Dairy cattle. Diets. Feed constituents. Analysis. Dietary value. Animal physiology. Animal nutrition. Colombia

Two expt were conducted at the exptl station of the Instituto Colombiano Agropecuario in Palmira to determine the effects of urea on the production and reproductive performance of dairy cows when incorporated as a source of protein in concentrate grain mixtures and to evaluate cassava as a substitute for maize for growing dairy heifers In the latter expt 20 8-mo-old Holstein heifers were assigned at random to 2 treatments: I, control animals were fed sugar cane tops ad libitum + 3 kg maize-based concentrate (1 5% urea) daily; and II, sugar cane tops ad libitum + 1.23 kg of a concentrate and 4.5 kg chopped fresh cassava roots (35% DM). DM intake from supplement was 2 64 kg/day for both groups. Statistically significant differences ($P < 0.05$) were found in body wt gains in favor of the cassava-fed heifers between 8 and 16 mo of age (224 days). Av daily gains were 0.781 and 0.833 kg, respectively, for groups I and II. Feed intake (DM basis) was similar in both groups Av ages for 1st breeding were 15 and 14.5 mo and av services/conception 1.88 and 1.77, respectively, for the 2 groups. (*Summary by T.B.*) H03

0356-1183 BRANDAO, J. **A mandioca como forragem. (*Cassava as a forage*).** Chácaras e Quintaes 21(6):469-470. 1920. Port., Illus.

Cassava. Forage. Toxicity. Animal nutrition. Domestic animals. Brazil.

The leaves and tender branches of cassava can be used for forage for cattle, but they should be dried 1st. Remedies are given for cases of HCN poisoning. Horses are fed the fresh roots; poultry, the waste products in the form of meal. (*Summary by F.G. Trans. by T.B.*) H03

0357-11707 AGUIRRE, M., SHIMADA, A. and AVILA, E. **Metabolizable and net energy values of cassava meal for chicks.** Poultry Science 58(3):694-698. 1979. Engl., Sum. Engl., 18 Refs.

Cassava. Cassava meal. Chicks. Feeds and feeding. Feed constituents. Dietary value. Animal physiology. Animal nutrition. Mexico.

In a series of expt with chicks at the Instituto Nacional de Investigaciones Pecuarias in Mexico, metabolizable and net energy values of cassava meal (CM) were obtained. ME determinations were conducted on 5 samples of CM, the av being 3.20 kcal/g Av daily gains and feed/gain ratios were not significantly different ($P \geqslant 0.05$) between CM samples and starch. Net energy values of CM were obtained by calculating the energy gain/unit of ingredient intake by the comparative slaughter technique Av net energy value was 2.28 ± .09 kcal/g. Net energy of CM as a fraction of ME was 74.9%. (*Author's summary*) H03

0358-4010 SAAVEDRA, S. **Grado de digestibilidad de la yuca en la alimentación del cerdo.** (*Digestibility of cassava in swine nutrition*). Veterinaria Ecuatoriana 1(1):73-77. 1969. Span., Sum. Span., 8 Refs.

Cassava. Swine. Digestibility. Protein content. Fattening. Animal nutrition. Ecuador.

Four Duroc Jersey pigs (4 mo old), kept in metabolic cages, were given 700 g chopped cassava in the a.m. and 600 g in the p.m. for 10 days. After an adjustment period with a complete balanced diet, the treatment was repeated. An analysis was made of the feces. Cassava has a low protein content and a high coefficient of OM digestibility (96.5%) so it can be recommended for fattening pigs if it is supplemented with protein. TDN and metabolizable energy were 325.4 ± 8 g and 1350 ± 21 kcal/kg, respectively; a positive balance was recorded for N (3.8 g). (*Summary by I.B. Trans. by T.B*) H03

0359-11264 MANER, J.H. **La yuca en la alimentación de cerdos.** (*Cassava for swine feeding*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1972.17p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Swine. Feeds and feeding. Feed constituents. Composition. Nutritive value. Fattening. Finishing. Supplements. Cassava meal. Fresh products. Animal nutrition. Colombia.

Research results obtained by the Cassava and Swine programs at the Instituto Colombiano Agropecuario are discussed. Low HCN var. should be used for swine feeding; the most promising var. is Llanera, which can yield 78 t/ha/10 mo and has a high crude protein content (7.25%). Balanced diets using the fresh roots or meal + different protein supplements are given for the life cycle of the swine: gestation, lactation, growing and finishing periods. When using CM, molasses should be added to make it more acceptable to the pigs; fresh roots should be supplied on a daily basis since they ferment rapidly. (*Summary by F.G. Trans. by T.B.*) H03

0360-11726 RAVELO, G., BORDAS, F. and HOVELL, F.D. DE B. **El flujo de almidón en el abomaso de animales alimentados con caña de azúcar suplementada con afrecho de trigo o raíz seca de yuca.** (*The movement of starch in the abomasum of animals fed sugar cane supplemented with wheat bran or cassava meal*). Producción Animal Tropical 3(3):259-266. 1978. Span., Sum. Span., 4 Refs., Illus.

Cassava. Cassava meal. Supplements. Animal physiology. Cattle. Wheat bran. Sugar cane. Feeds and feeding. Dietary value. Animal nutrition. Dominican Republic.

Three 2-yr-old bulls (approx 200 kg), with permanently fitted cannulae in the rumen and the

abomasum or the ileum, were fed chopped sugar cane tops ad libitum, supplemented with 1.0 or 2.0 kg/day wheat bran or 0.75 or 1.5 kg/day cassava meal. The animals were given chromic oxide and polyethylene glycol (PEG) and samples taken hourly over a 24-h period. The chromic oxide passed through the rumen more slowly than expected; recovery of PEG was initially slow. Starch digestibility was calculated on the supposition that 50% of the dietary DM was digested in the rumen; thus starch degradation in the rumen was 99.3 and 98.6%, respectively, for the wheat bran and CM. (*Author's summary. Trans. by T.B.*) H03

0361-11719 PIDO, P.P , ADEYANJU, S A and ADEGBOLA. A A. **The effect of graded levels of fermented cassava meal on broilers.** Poultry Science 58(2):427-431. 1979. Engl., Sum. Engl., 16 Refs.

Cassava. Cassava meal. Chicks. Nutritive value. Feeds and feeding. Feed constituents. Costs. Economics. Animal nutrition. Nigeria.

A 9-wk feeding expt with 160 one-wk-old broiler chicks was conducted at the U. of Ife (Nigeria) to determine the nutritive value of fermented cassava meal (FCM) and any economic advantages that might be derived from using FCM as a substitute for maize in balanced starter/grower rations containing 0, 25, 37 5 and 50% FCM. The rations contained approx 3028, 3010, 2999 and 2806 kcal ME/kg and 23.12, 23 00, 23.03 and 22 74% protein, respectively. Incorporating FCM up to 50% produced no significant differences in live performance or carcass characteristics. However, there were reductions in feed cost and cost/kg feed, but increases in revenue to feed cost as the level of FCM increased Revenue to feed cost indicates that it is economical to incorporate up to 50% FCM into broiler rations. (*Author's summary*) HQ3

0362-11751 SZYLIT, O. *et al.* **Raw and steam-pelleted cassava, sweet potato and yam *Cayenensis* as starch sources for ruminant and chicken diets.** Animal Feed Science and Technology 3:73-87. 1978. Engl., Sum. Engl , 32 Refs , Illus

Cassava. Pellets. Fresh products. Cassava starch. Analysis. Cooking. Sheep. Chicks. Digestibility. Tubers. Composition. Yams. Sweet-potatoes.

Three tropical tubers, raw or processed by steam pelleting, were studied in the rumen in vitro or in the chicken in vivo to determine the effects of tuber treatment and nature on urea utilization by rumen microflora, starch breakdown in the crop and the performance of growing chicks. Starch of cassava and sweet potatoes is characterized by an x-ray diffraction pattern of the A-type and is therefore similar to starch of cereals. In vitro these starches were well broken down in the presence of α -amylase from *Bacillus subtilis* and were good sources of energy for rumen microbial growth; in vivo they were completely digested by growing chicks. Compared to cassava the fermentation of sweet potato in rumen and crop led to increased acidity. The cassava diet gave better N retention and growth performance associated with higher food intake. In contrast, yam (*Dioscorea cayenensis*) starch, characterized by a B-type x-ray diffraction pattern and large granules like potato starch, was less susceptible to α -amylase and promoted lower microbial proteosynthesis in vitro. The starch was more slowly degraded in the crop and overall digestibility was only 83% Yams reduced feed intake and gave lower N retention and feed conversion ratios and consequently poor growth. Steam pelleting increased starch availability and permitted better urea utilization by rumen microflora. It improved N retention and feed efficiency of chick diets but not significantly; the greatest effect was observed with yams. Digestibility of a given starch seems to be related to its structure, characterized by the x-ray diffraction pattern, which could help in tuber selection for animal nutrition. Simple processing such as steam pelleting may improve the nutritive value, especially when the starch has a B-type crystallinity. (*Author's summary*) H03 I01

0363-11794 YEONG, S.W. and SYED ALI, A.B. **Effects of sulphates and methionine supplementation in high cassava (*Manihot esculenta* Crantz) based diets for layers.** MARDI Research Bulletin 6(2):202-207. 1978. Engl, Sum. Engl., Mal, 16 Refs

Cassava. Poultry. Supplements. Feeds and feeding. Feed constituents. Maize meal. Animal physiology. Eggs. Dietary value. Animal nutrition. Malaysia.

The effect of sulfate compounds and DL-methionine supplementation for cassava-based diets was studied in 9 treatments for 30 wk using 243 32-wk-old Dekalb layers. Treatments were 60% maize and 60% cassava diets (basal control), 0.1 and 0.2% DL-methionine, 0.1 or 0 2% sodium sulfate, 0.1% met + 0.1% Na_2SO_4, 0.2% sodium thiosulfate, and 0.1% potassium sulfate + 0.1% magnesium sulfate. Egg production was significantly better ($P < 0.05$) in the maize control group; all met and 0.2% Na_2SO_4 supplemented groups compared to groups with other sulfate supplements. Eggs were significantly heavier ($P < 0.05$) in the maize control diet and the met-supplemented diets than those with sulfate-supplemented diets. Chickens on maize and the met groups were superior in feed efficiency to all the sulfate-supplemented groups ($P < 0.05$). It is therefore recommended that 0.1% met is the suitable supplemental level for cassava-based diets. (*Author's summary*) H03

0364-11711 DESAI, P.M. and SHUKLA, P.C. **In vitro evaluation of improvement in nutritive value of wheat straw using buffalo rumen inoculum.** Gujarat Agricultural University Research Journal 2(2) 117-121. 1977. Engl., Sum. Engl., 9 Refs.

Cassava. Uses. Dietary value. Cattle. Animal nutrition. Feeds and feeding. India.

The effect of supplementation of leguminous (alfalfa) and nonleguminous (*Panicum maximum*) fodder on utilization of wheat straw by ruminal microflora of buffalo bulls, with or without energy- and protein-rich feeds (peanut meal and cassava), was studied in vitro in India. Alfalfa increased DM digestibility significantly at each level. Addition of cassava also proved beneficial for increasing DM digestibility but had no effect on cellulose digestibility. Production of total volatile fatty acids (TVFA) also exhibited similar trends. DM and cellulose digestibility of wheat straw was improved by supplementation with *P. maximum* and further increased on supplementation with peanut meal. Significant differences in production of TVFA were observed with different proportions of *P. maximum*. It was also found that 10% peanut meal was more beneficial than 5%; pH values remained within a normal range in all cases. (*Author's summary*) H03

0365-10425 THOMAS, W.G. **Considerations for the use of cassava as the energy source in broiler rations fed in tropical and subtropical regions.** Ph D. Thesis. Urbana, University of Illinois at Urbana-Champaign, 1977. 159p. Engl., Sum Engl., 59 Refs., Illus.

Cassava. Cassava meal. Chicks. Feeds and feeding. Feed constituents. Supplements. Amino acids. Costs. Animal physiology. Animal nutrition.

Six lab expt and 3 field feeding trials were conducted to determine the feasibility of incorporating indigenous Senegalese protein and energy feedstuffs (peanut, fish and cassava meals) into commercial broiler diets There was no depression in wt gain when either peeled or nonpeeled roots were used in high- and low-protein diets although lower gain/feed was noted when unpeeled roots were used. Cassava-maize-peanut meal diets (45% unpeeled root meal) were equally limiting in the essential amino acids lysine and methionine when fed at the 23% protein level. Supplementation of both amino acids was required to obtain significant ($P < 0.01$) gain

responses, which were still less than those obtained with control diets (maize-soya). Addition of 10% fish meal to this diet significantly ($P < 0.01$) improved gains; supplemental lysine but not methionine resulted in a further significant response. At a 20% level, fish meal alone resulted in gains comparable to those from the control; when the 2 amino acids were added, gains exceeded those from the control diet, but not significantly so. Tryptophan was possibly the 3rd limiting amino acid in the diet containing 10% fish meal. In isonitrogenous semipurified diets, unpeeled cassava root meal was at least equal to cornstarch as a source of energy for broiler chicks. Gains were somewhat greater when the CM-based diet contained adequate levels of all known nutrients. In field feeding trials acceptable growth was obtained when broilers were fed diets containing unpeeled cassava roots, which had been sun dried under prevailing climatic conditions, and indigenous protein sources When dried for > 6 days (< 10% moisture), there was no effect on rate of gain; early rate of gain was lower, however, for chicks fed CM with a higher moisture content (dried only 3 days). Unpeeled cassava root meal can be incorporated into broiler diets at levels up to 50% when supplemented with essential nutrients to meet NRC requirements. At 10-30% gains were comparable or superior to the commercial or control diets; at 40-50% gains were inferior but differences were not significant. Gain/feed progressively decreased with increasing levels of CM, probably due to the high fiber content of the peels. Skin color and fat deposition in the cassava-fed broilers were different from those on maize; however, consumer acceptance (based on taste) was not affected. At existing market prices CM is competitive with maize. Present levels of local production appear to be adequate to support both the demand for human food and the commercial broiler industry. (*Extracted from author's summary*) H03

0366-4015 GARCIA, J.A., CAMPOS, J. and PERES, F.L. **Melaço/uréia x raspa de mandioca/uréia na engorda de bovinos em confinamento.** (*Molasses/urea vs. cassava chip meal/urea in feedlot rations for fattening steers*). Seiva 30(7):9-22. 1970. Port., Sum. Port., Engl., 26 Refs.

Cassava. Cassava meal. Feeds and feeding. Feed constituents. Cattle. Proteins. Animal nutrition. Dietary value. Brazil.

The effect of substituting molasses/urea with cassava chip meal (CM)/urea was studied at the U. Federal de Viçosa, using 48 Holstein x zebu steers (av initial wt 229.7 kg), 12-15 mo of age. The treatments were as follows: (1) CM + urea + sorghum silage, (2) molasses + sorghum silage, (3) CM + urea + cottonseed meal + ground corncobs, (4) molasses + urea + cottonseed meal + soybean meal, (5) molasses + urea + ground corncobs, and (6) CM + urea + ground corncobs. The trial consisted of a confinement period (92 days) during the dry season and an exptl period of 212 days during the rainy season when the animals grazed on *Melinis minutiflora*. The sorghum and corncobs were given ad libitum. Analysis of variance of the overall wt gains during the 2 seasons did not show significant differences. There was a highly significant difference ($P < 0.01$) between periods and the interaction period x treatment, treatment 6 being inferior to the other 5. It is concluded that CM cannot be used to replace molasses in the rations containing corncobs. (*Summary by T.B*) H03

See also 0386

H04 HCN Toxicity and Detoxification

0367-10054 ENE, L.S.O. **Processing of cassava.** Tropical Root and Tuber Crops Newsletter no. 10:44. 1977. Engl.

Cassava. Tubers. Detoxification processes. Cassava products. HCN content. Boiling. Steeping.

Soaking cassava roots for 20 h in water, followed by blanching for 2 min, was most effective in reducing HCN content during processing from 95.5 to 3.5 mg/kg. (*Summary by Abstracts on Tropical Agriculture*) H04

0368-10441 SITOMPUL, H.H. **Biological evaluation and detoxification of cassava (*Manihot esculenta* Crantz).** Ph.D. Thesis. Urbana, University of Illinois at Urbana-Champaign, 1977. 114p. Engl., 122 Refs., Illus.

Cassava. Protein content. HCN content. Cyanides. Linamarin. Lotaustralin. Biochemistry. Toxicology. Detoxification processes. Fermentation. Laboratory animals. Chicks. Lambs. Analysis. Storage. Deterioration. Leaves. Tubers. Cortex. Stems. Feed constituents. Diets. Thiocyanates. Pellets. Digestibility. Dietary value. N. Starch content. Toxicity. Energy productivity. Supplements. Animal physiology.

A biological evaluation is made of cassava, with emphasis on detoxification processes. General data are given on the plant, botanical aspects, origin, distribution, potential yield, cultivation, breeding, storage and protein content, the main factor limiting its use in human and animal nutrition The second problem is the presence of 2 cyanogenic compounds — linamarin and lotaustralin — in the roots, leaves and petioles. With emphasis on cyanogenic compounds and the biosynthesis of cyanogenic glucosides, a literature review was made, and detailed results are given of expt with poultry, sheep and rats. Expt with chicks evaluated alcohol-detoxified cassava at different levels of CN; those with sheep, whole cassava, cassava fermented in vitro and supplementation of cyanide as KCN in cassava fermentation in vitro; those with rats, graded levels of CN, acute CN toxicity and metabolizable energy of cassava in diets. Results of chick expt indicated that with proper protein and other micronutrient supplementation, cassava is suitable as a major source of energy for animals, especially sweet var ($<$ 100 ppm CN equivalent as linamarin). At 100 ppm CN wt gain is depressed; at 280, feed intake is reduced; and at $>$ 300 ppm rumen microbial activity is depressed. Metabolizable energy in cassava diets for rats was reduced ca. 3%/100 ppm CN equivalent as linamarin. Since most cassava var. contain $>$ 100 ppm CN, these cyanogenic compounds must be eliminated if cassava is to be utilized as a major source of energy in well-balanced diets for animals (*Summary by I.B Trans. by T.B.*) H04 H03

0369-9970 ACUÑA G., O. **Utilización de la harina de yuca en panificación.** (*The use of cassava flour in breadmaking*). Quito, Ecuador. Escuela Politécnica Nacional. Instituto de Investigaciones Tecnológicas. Boletín Técnico no. 8. 1974. 45p. Span., Sum Span., 8 Refs., Illus.

Cassava. Cassava flour. Bakery products. Cultivars. Analysis. Cyanogen. Tubers. Processing. Laboratory experiments. Statistical analysis. Economics. Marketing. Ecuador.

The use of 10, 20 and 30% cassava flour (CF) in breadmaking was studied, using 9 Ecuadorian commercial cassava var. Exptl yield, production costs and physicochemical characteristics were determined. The CF was made on a lab scale, and the different composite flours were analyzed with a farinograph. The use of the additive calcium stearyl lactylate was also studied. The results were submitted to statistical analysis to determine the sensitivity of the variables var. and % of substitution It is concluded that CF is a good substitute for wheat and can be used up to 20% in bread and up to 30% for rolls. The var. Lago Agrio gave the best results. (*Summary by T.B.*) I01

See also 0174 0331

0370-10428 McCANN, D. J. and PRINCE, R. G. H. **Agro-industrial systems for ethanol production.** *In* Conference on Alcohol Fuels, Sydney, Australia, 1978. Proceedings. Sydney, Institution of Chemical Engineers, New South Wales Group, 1978. pp.4-22 - 4-30. Engl., Sum Engl., 15 Refs., Illus.

Cassava. Ethanol. Processing. Fermentation. Factories. Economics. Cassava programs. Australia.

Power alcohol could be produced from crops like cassava for $0 15-0 20/*l*, provided agro-industrial systems of continuous fermentation are employed Utilization of crop residues for steam and power generation and the return of all nutrient-containing wastes to the soil are important prerequisites of any power alcohol energy cropping scheme. *(Summary by ICE)* I02 J00

0371-9921 MENEZES, T.J.B. DE **Alcohol production from cassava.** *In* Weber, E.J., Cock, J.H. and Chouinard, A , eds Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978. pp.41-45. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Alcohol. Production. Productivity. Washing. Peeling. Fermentation. Costs. Brazil.

A brief history of cassava alcohol production in Brazil is given. The following steps in the process are described: washing, peeling and grating; cooking and saccharification; fermentation. The process needs technological measures to minimize energy inputs and optimize output. Problems of waste disposal may be solved by using the stillage in fertilizers, as a substrate for SCP, or in the manufacture of fermentation products such as enzymes, vitamins and antibiotics. (*Summary by T.B.*) I02

0372-9922 MILFONT JUNIOR, W.N. **Prospects of cassava fuel alcohol in Brazil.** *In* Weber, E.J., Cock, J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978. pp.46-48. Engl., Sum. Engl., 6 Refs., Illus

Cassava. Alcohol. Ethanol. Production. Economics. Industrialization. Costs. Brazil.

Alcohol production in Brazil increased 100% in 1 yr and should continue to grow rapidly in the next 10 yr because of the government's plans to use ethanol for motor fuel. The economics of cassava and sugar cane alcohol production are analyzed Although the latter constitutes a major proportion of the current increase, it is expected that cassava alcohol will account for much of the growth later on since improved agro-industrial processes, together with lower taxes, could make a substantial impact on cassava alcohol costs. (*Summary by T.B.*) I02

0373-10046 HERBLOT, G. **L'eplucheuse-broyeuse de manioc bertin-sodepalm.** (*The Bertin-Sodepalm cassava peeler-crusher*) Machinisme Agricole Tropical no. 62:55-58. 1978. Fr., Illus.

Cassava. Peeling. Mechanization. Tubers. Industrial machinery.

A machine for peeling and crushing cassava roots is described. The machine weighs 1200 kg. Av input is 800 kg/h of fresh roots; av output, 550-600 kg/h. The machine requires 4 people for operation. It can process roots of 10-40 cm length and 5-12 cm thickness. The roots are trimmed off at the ends and then introduced vertically between 4 toothed disks, which split them off in 4 long pieces. These pieces are put by hand into the next part of the machine where they are squeezed between 2 revolving rollers, to strip the skin from the pulp. The upper roller presses the pulp against the lower roller, which is a straight-sided cylindrical grid. (*Summary by Abstracts on Tropical Agriculture*) I02

0374-4440 YEN, D.E. **The storage of cassava in Polynesian Islands.** Cassava Newsletter no. 3:9-11. 1978. Engl., 8 Refs., Illus.

Also in Spanish.

Cassava. Tubers. Storage. Polynesia.

The possibility of "underground" field storage of mature cassava roots, without the necessity of handling before harvesting for consumption, is probably the main single factor for its spreading through the Pacific Islands. Also cassava has the potential of producing 2 crops/yr on several gardens, allowing the subsistence farmer to ensure a continuity in food supply. In that way the traditional cultigens, such as yams and taro, are being supplented by cassava. The storage methods of cassava and its processing are discussed. (*Summary by Abstracts on Tropical Agriculture*) I02

0375-3311 THIYAGARAJAN, K. **An agro industry with tapioca.** Kisan World 4(7):33-37. 1977. Engl.

Cassava. Cassava chips. Dried tubers. Cassava tubers (vegetable). Wastes. Cassava starch. Cassava flour. Tapiocas. Legal aspects. Production. India.

General data are given on world cassava production in 1973, area and production in different districts of Tamil Nadu, composition of fresh and dried roots and Indian specifications for chips, spent pulp, starch for human consumption, flour and tapioca. Brief instructions on cultural practices are also included. (*Summary by T.B.*) I02 H01

0376-4249 CIACCO, C.F. and D'APPOLONIA, B.L **Baking studies with cassava and yam. II. Rheological and baking studies of tuber-wheat flour blends.** Cereal Chemistry 55(4):423-435. 1978. Engl., Sum. Engl., 13 Refs., Illus.

Cassava. Cassava flour. Cassava starch. Composite flours. Wheat flour. Breads. Analysis.

Rheological and baking properties of flour blends containing various levels of cassava flour or starch or yam flour with hard red spring wheat flour were studied. As the tuber flour level increased, developing time and stability of dough decreased. Incorporation of sodium stearyl-2-

lactylate (SSL) increased dough strength for cassava starch and yam flour blends. Extensigram data showed an increase in the proportional no. as the % of cassava starch or yam flour was increased; with 15% cassava starch, however, the proportional no. tended to level off. In all cases the area under the extensigram curve decreased as the % of tuber flour increased. With conventional breadbaking procedures, acceptable bread could be produced up to the 15% level of cassava starch or yam flour. Although acceptable bread could be produced with 10% cassava flour, difficulties were encountered with dough handling properties. Blends containing up to 10% yam flour produced the best french-type bread, while those with 5-10% cassava starch produced the best white pan bread. Cassava starch blends showed the best results with the continuous breadbaking procedure. Addition of 0.5% SSL to the cassava starch blends improved the internal characteristics of the continuous bread; the yam flour blends were the poorest Regardless of breadbaking procedure, cassava starch blends showed a better baking response than did those with cassava flour. (*Author's summary*) I02

0377-4379 NGODDY, P.O. **Determinants in the development of technology for the processing of roots and tubers in Nigeria.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.134-151. Engl., 50 Refs.

Cassava. Storage. Processing. Tuber productivity. Marketing. Production. Nigeria.

A brief summary is given of research done on storage and preservation of tropical roots and tubers (cassava, sweet potatoes, yams). There are many possible patterns for this processing "industry," ranging from small to large operations. The main factors to be taken into account when planning a processing unit (raw materials, factory design and equipment, services and supplies, labor and management, marketing, factory location) are outlined. (*Summary by T.B.*) I02 J00

0378-10434 KETIKU, A.O. *et al.* **Changes in the hydrocyanic acid concentration during traditional processing of cassava into "gari" and "lafun".** Food Chemistry 3:221-228. 1978. Engl, Sum. Engl., 19 Refs., Illus

Cassava. Gari. Processing. HCN content. Dry matter. Tubers. Laboratory experiments. Starch content. Nigeria.

Two groups of 48 cassava plants, harvested at 3 different times, were processed using one of the traditional methods to determine the effectiveness of HCN reduction to innocuous levels in the products gari and lafun (flour). DM content of cassava was 37.6%; this changed significantly with the stages of processing to 84.5% in gari. This change was mainly due to pressing and roasting. Starch content remained constant during gari processing HCN was significantly reduced from an initial concn of 90.1 mg/kg fresh grated pulp to 25.8 mg in gari. The fermentation step was found to be most effective in the reduction. DM content during lafun processing changed from 39.3 to 86.5%, mainly due to sun drying for 96 h. HCN was significantly reduced from 165.5 mg/kg in fresh grated pulp to 19.6 mg in lafun. Soaking in static water was responsible for 3/4 of this decrease. (*Author's summary*) I02

0379-10912 AYERNOR, G.S. . **Processing and preservation of roots and tubers.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1978. 16p. Engl., 19 Refs., Illus.

Paper presented at the Regional Root and Tuber Improvement Workshop, Freetown, Sierra Leone, 1978.

Cassava. Processing. Cassava products. Food products. Uses.

The drying processes traditionally used for root and tuber crops and the resulting products are briefly discussed. With regard to cassava, emphasis is placed on pregelatinized flours (gari) and the possible fortification of foofoo (a cassava paste). The processing of the different cassava products is illustrated in a diagram. (*Summary by T.B.*) I02

0380-10414 ZAPATA, L.E. and RIVEROS S., H. **Preservación de la yuca fresca.** (*Conserving fresh cassava*). IIT Tecnologia no. 115:9-20. 1978. Span., 2 Refs., Illus.

Cassava. Tubers. Fresh products. Storage. Prices. Costs. Colombia.

The effectiveness of the paraffin method in comparison to others for conserving fresh cassava roots is pointed out. The process is described, and economic aspects (total investments required to process 820 t/yr, production costs and their distribution, unitary costs and selling prices) are analyzed. Using this method, roots can be stored for 20-30 days without affecting quality. Further testing should be done with different var. as some are not as suitable for this process as others. (*Summary by T.B*) I02 J00

0381-9968 MENEZES, T.J.B. DE *et al.* **Fungal cellulases as an aid for the saccharification of cassava.** Biotechnology and Bioengineering 20:555-565. 1978. Engl., Sum. Engl, 10 Refs., Illus

Cassava. Cassava starch. Enzymes. Viscosity. Glucose. Analysis. Hydrolysis. Ethanol. Biochemistry.

Culture broths of cellulolytic fungi were used with commercial amylases to enhance the saccharification of cassava starch slurry. It was found that the addition of appropriate concentrations of the cellulases *Trichoderma viride* and a soil-isolated *Basidiomycete* increased both the rate of sugar formation and the degree of solubilization, and decreased the viscosity of the hydrolysates. Because of the improved rheological properties of the must and the additional sugar produced, an increased ethanol yield would be expected from the alcoholic fermentation of this hydrolysate. (*Author's summary*) I02

0382-9935 NAIR, R.G. **Utilisation of cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.37-48. Engl., Illus.

Cassava. Food products. Fresh products. Gari. Cassava meal. Feeds and feeding. Industrial starches. Glucose industry. Tapiocas. Tapioca macaroni. Alcohol.

India is the world's 5th largest producer of cassava (6.3 million t in 1973). The following uses are discussed briefly. (1) Food. Fresh roots, gari, meal (farinha), foofoo, cassareep, landang (cassava rice), chips, flour. (2) Feedstuffs. Composition of cassava-based feeds in Germany, Belgium, France and Italy; formulas using 20-43% cassava roots, chips and meal for dairy cattle and poultry are recommended by the National Dairy Research Institute, Karnal and the Dept. of Animal Husbandry at Kerala. (3) Industrial raw material for starch, dextrin, glucose and dextrose, tapioca, macaroni, the spent pulp (tippi) for animal feed, alcohol. (*Summary by T.B.*) I02

0383-9923 CRABTREE, J., KRAMER, E.C. and BALDRY, J. **Use of fresh cassava products in bread making.** *In* Weber, E.J., Cock, J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-144e. 1978. pp.49-52. Engl., Sum. Engl., 6 Refs., Illus.

Cassava. Breads. Cooking. Processing. HCN content. Tubers. Consumption. Analysis.

The use of 20% fresh cassava in breadmaking and the effect of mincing, blanching and cooking as simple methods of preparation were studied. These products were assessed for ease of preparation and incorporation and their effects on bread quality (i.e., loaf shape, crust color and structure, crumb texture) Loaves were also evaluated for softness, moistness, sponginess, freshness and overall sensory acceptability. Bread containing fresh minced cassava rated higher than the other products in all assessments except sensory evaluation. Bread containing blanched or cooked, minced samples, which were more difficult to prepare, scored high in sensory evaluation. (*Summary by T.B.*) I02

0384-9915 BOOTH, R.H. and WHOLEY, D.W. **Cassava processing in Southeast Asia.** *In* Weber, E.J., Cock, J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978. pp.7-11 Engl., Sum. Engl., 2 Refs., Illus.

Cassava. Cassava chips. Pellets. Drying. Cassava starch. Cassava flour. Factories. Solar drying. Asia.

Cassava utilization patterns, commercial processing (chipping, drying, pelleting, storage) and starch production (flour and tapioca) are described in Thailand, Indonesia, Philippines and Malaysia There are problems in product quality; however, there is little likelihood of much technology being applied under the present marketing and pricing structures. (*Summary by T B.*) I02

0385-9917 THANH, N.C. and LOHANI, B.N. **Cassava chipping and drying in Thailand.** *In* Weber, E.J., Cock, J.H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre IDRC-114e. 1978. pp.21-25. Engl., Sum. Engl., Illus.

Cassava. Cassava chips. Solar drying. Drying. Costs. Statistical analysis. Timing. Temperature. Small-scale equipment. Small-scale processing. Thailand.

Expt were conducted at the Asian Institute of Technology in Bangkok to evaluate solar and artificial cassava drying techniques and the effects of different chip forms and sizes on drying Black concrete surfaces were more efficient than ordinary concrete, but more uniformly dried and better looking chips were obtained when using trays with bamboo netting or chicken wire. Artificial drying (thermostatically controlled hot plate) is more reliable than sun drying but requires a higher initial investment Drying time was influenced by chip shape and size; regression equations for calculating length of time for different drying techniques are available from the authors. (*Summary by T.B.*) I02

0386-9916 BEST, R. **Cassava processing for animal feed.** *In* Weber, E.J., Cock, J H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia,

1978. Proceedings. Ottawa, Canada International Development Research Centre. IDRC-114e. 1978. pp.12-20. Engl., Sum. Engl., 18 Refs., Illus

Cassava. Cassava chips. Drying. Solar drying. Costs. Climatic requirements. Small-scale processing. Small-scale equipment. Colombia.

An inclined tray-drying system for cassava chips was developed at CIAT and compared with traditional concrete-floor drying at 5 locations in Colombia with varying climatic conditions. Results showed that tray drying can double the output/unit area of drying surface. In areas where it does not rain overnight, better performance is achieved if drying is started between 1400 and 1700 h. Loss of moisture at night is greatest where speeds are high. The cost of materials for constructing the trays and their supports is lower than for laying an equivalent area of concrete, but tray maintenance and life have to be determined on a commercial scale. The possibility of combining natural and solar or artificial drying systems is discussed with a view to improving the product and reducing dependence on weather conditions. (*Author's summary*) I02 H03

0387-11211 THANH, N.C., MUTTAMARA, S. and LOHANI, B.N. **Technological improvement of Thai tapioca pellets.** Thai Journal of Agricultural Science 11(2):75-86. 1978. Engl, Sum. Engl., 2 Refs., Illus

Cassava. Pellets. Industrial machinery. Industrialization. Thailand.

The results are presented of a study conducted in Thailand aimed at the production of cassava pellets of constant optimal quality. Steam-heating chips to about 70°C before pressing yields pellets of a strong structure; use of small chips (slices and strips) and steam injection prior to pressing results in dense, glossy and strong pellets; and chips with 12-14% moisture content give excellent pellets. Also, it was found that a quantity of 0 152 kg steam/kg of input material gives dense, glossy and hard pellets. (*Summary by Abstracts on Tropical Agriculture*) I02

0388-4216 NEIVA, J L. **Produção de álcool etílico por fermentação; principais matérias-primas para fabricação industrial de álcool.** (*Ethyl alcohol production by fermentation; principal raw materials for the industrial production of alcohol*). Brasil Açucareiro 89(5):27-35. 1977. Port, Illus

Cassava. Industrialization. Ethanol. Sugar cane. Sweet-potatoes. Brazil.

An analysis is made of the advantages and disadvantages of sugar cane, cassava and sweet potatoes as sources of fermentable sugars for the manufacture of alcohol. Among the advantages of cassava are (1) easier to cultivate and fewer soil requirements, (2) production of 20-25 t roots/ha, equivalent to 3000-4000 *l*/ha; cassava yields the most alcohol/t although the max theoretical yield of 400 *l*/t has not yet been reached; (3) utilization of the aerial part of the plant for animal feed; (4) facility of storage in the form of chips; (5) alcohol easier to purify; (6) lower production costs; (7) nutritional value of the fermentation residue for feeds. Among the disadvantages are (1) the lack of knowledge on plant improvement, (2) need to replant the crop after each harvest, (3) little diffusion of technology, (4) difficulty of mechanization, (5) high labor requirements for planting and harvesting, (6) more complex, costly technical-industrial operations, (7) greater possibilities of contamination affecting industrial yield and quality of the alcohol produced, (8) greater consumption of fuel, energy and water in the operations, (9) more complicated hydrolysis, saccharification, transformation and fractionation. (*Summary by I.B. Trans. by T.B*) I02

0389-10409 COLOMBO, A.J *et al.* **Hidrólise ácida da mandioca.** (*Acid hydrolysis of cassava*). Revista de Farmacia e Bioquímica da Universidade de São Paulo 13(1):75-90. 1975. Port., Sum. Port., Engl., 4 Refs.

Cassava. Cassava flour. Hydrolysis. Sugar content. Alcohol. Laboratory experiments. Analysis. Brazil.

The influence of hydrolysis length, pressure, acidity and flour mass to vol ratio in fermentable sugar production was studied. The highest contents of reducing sugars were obtained when hydrolysis of cassava flour was carried out at 1 atm pressure for 3 h with flour to acid ratio of 1:5 and acidity 0.2 N. (*Summary by Biological Abstracts*) I02

0390-10040 LORENZI, J.O. **Produção de álcool de mandioca.** (*Alcohol from cassava*). *In* Goldemberg, J. Energia no Brasil. São Paulo, Brasil, Academia de Ciências do Estado de São Paulo. Publicação ACIESP no. 2. 1977?. pp.101-108. Port., 7 Refs

Cassava. Production. Productivity. Alcohol. Cultivation. Industrialization. Uses. Brazil.

A general description is given of agronomic and industrial aspects of cassava in Brazil: cultural practices, product prices, starch content and problems involved in expansion of the crop (multiplication of selected var., insufficient technical assistance and research). The following industrial aspects are discussed: saccharification in the distillation of alcohol, yield of alcohol, use of the residues. Research should be intensified to improve low crop yields (national av 12.6 t/ha). Tables give data on production in the different states, promising var. and their yields (1969-75) in São Paulo and av alcohol yields in a Minas Gerais factory (1932-34). (*Summary by I.B. Trans. by T.B.*) I02 D00

0391-11722 KAPLINSKY, R. **Innovation in gari production: the case for an intermediate technology.** Brighton, England. University of Sussex. Institute of Development Studies. Discussion Paper no. 34. 1974. 24p. Engl., Sum. Engl., 4 Refs., Illus

Cassava. Gari. Small-scale equipment. Industrial machinery. Costs. Labour. Economics. Statistical analysis. Nigeria.

Two techniques used for processing gari are compared: a fully mechanized imported machine (ND) in Gambia and an intermediate, locally generated technique (FABRICO) in Nigeria. The analysis is based on limited data obtained from brief visits to these 2 plants; a 2nd limitation is that no comparisons were made with the labor-intensive village technique and other mechanized or local techniques. It is concluded that notwithstanding the economic efficiency of the ND technique, it is a high unit-cost producer relative to the intermediate FABRICO technique (i.e., 20% higher), thus the optimal choice for both private and social considerations would be the latter. (*Summary by T.B.*) I02

0392-9919 DAHLBERG, B **Large-scale cassava starch extraction processes.** *In* Weber, E.J., Cock, J.H and Chouinard, A , eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-114e. 1978 pp.33-36. Engl., Sum. Engl , Illus.

Cassava. Cassava starch. Processing. Industrialization. Waste utilization.

A description is given of a typical large-scale ($\geqslant$6 t roots/h) cassava starch processing plant.

Problems to be dealt with are the ensuring of a continual supply of roots, utilizing the by-products, which amount to 30% of the dry substance and are currently being wasted by most producers; and controlling the factory effluences by recycling and reusing the processing water. (*Summary by T.B.*) I02

0393-4037 LIMA, U. DE A and BORZANI, W. Alcool etílico. (*Ethyl alcohol*). Ciência e Cultura 28(9):1048-1050. 1976 Port.

Cassava. Ethanol. Costs. Brazil.

A comparative analysis is made of the production of ethyl alcohol by direct fermentation, using sugar cane or cassava as the raw materials. The pros and cons of the two are discussed on the basis of the degree of technology used in the 2 crops, production costs and machinery and specialized labor requirements. (*Summary by F.G. Trans. by T.B.*) I02

0394-9920 MEUSER, F. **Cassava flours and starches: some considerations.** *In* Weber, E.J , Cock, J H. and Chouinard, A., eds. Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings Ottawa, Canada International Development Research Centre. IDRC-114e. 1978 pp 37-40. Engl., Sum. Engl., 1 Ref., Illus.

Cassava. Cassava flour. Cassava starch. Processing. Industrialization. Detoxification processes. Fermented products. Drying. Composition.

The differences in processing nonfermented cassava meal, flour or starch and fermented gari or sour starch are explained briefly; fermentation increases DM yield ca. 20%. Analytical composition of 5 different products did not reveal major differences, except for the lactate content of the fermented products, which lowers pH and helps preserve the mash. Under an electron microscope, however, greater differences were apparent, the fermented products having higher viscosity and less gelatinized starch granules. Linamarin must be eliminated from all products by a dewatering process, which is briefly described. Three types of driers (fluid-bed, tray, flash) are illustrated (*Summary by T.B*) I02

0395-1178 L.B. **La farina di mandioca nella panificazione.** (*Cassava flour in breadmaking*). Giornale di Risicoltura 1938-132-134. 1938 Ital.

Cassava. Cassava flour. Composition. Composite flours. Breads. Italy.

Results are given of several breadmaking expt with composite flours (5-30% cassava flour), conducted by the Laboratorio per le Industrie dei Cereali (Italy). The chemical composition and qualities of cassava flour are given. Best results were obtained at the 5% level. (*Summary by I.B. Trans. by T.B.*) I02

0396-11721 THANH, N.C., MUTTAMARA, S. and LOHANI, B.N. **Drying techniques for improvement of tapioca chips in Thailand.** Thai Journal of Agricultural Science 11:45-55. 1978. Engl., Sum. Engl., 4 Refs., Illus.

Cassava. Cassava chips. Drying. Water content. Solar drying. Timing. Thailand.

In expt at the Asian Institute of Technology (Thailand) cassava chips of various shapes and sizes

(circular, rectangular, cubic, strips and slices) produced by Thai and Malaysian cutters were sun dried to < 14% moisture content on (a) cement floors, (b) black concrete floors or air dried in (c) perforated shelf driers or (d) artificially dried using a hot plate in the dry season (Mar.-July) and wet season (Sept.-Oct.). Although (d) was more efficient than sun drying, it was considered impracticable at present because of high costs. Drying time was greatly reduced in (b) and (c), the latter giving uniform drying at low costs while eliminating the need for frequent turning of chips, but was impracticable on a large scale. Hence (b) was suggested as a compromise between drying efficiency and practical feasibility. Drying efficiency was best with slices or strips, and smaller, thinner slices or strips are recommended to improve the efficiency of (a). There was no difference in drying efficiency between seasons; heat transfer by convection in the wet season appeared to compensate for the heat transfer by conduction in the hot season. (*Summary by Field Crop Abstracts*) I02

0397-1393 CHANG, TIEN-HUNG. **[An introduction on the utilization of cassava and its starch waste].** Shih P'in Kung Yeh 9(10):12-19 1977. Chin , 32 Refs., Illus.

Cassava. Wastes. Waste utilization.

A review is made of cassava and its starch waste, with respect to its consumption as a food and animal feed, nutritional value, biochemical composition and utilization in industry and organic solvent production. (*Summary by Chemical Abstracts*) I02

0398-11257 LAREZ A., A. *et al.* **Poder de retención antitóxica in vitro del casabe.** (*The in vitro capacity of casave for retaining toxic substances*). Rivista di Tossicologia Sperimentale e Clinica 7(1/2):5-7 1977. Span., 3 Refs

Cassava. Casave. Analysis. Composition.

The retention capacity (adsorption/absorption) of casave was compared to that of bread as a possible antidote to be used in emergency 1st aid treatments. Equal quantities of bread and casave were processed in titrated acid solutions of different drugs (salicylates, chlorpromazine hydrochloride, thioridazine, mercury, barbiturates, iodine, imipramine hydrochloride, ethyl alcohol). The %s of retention varied from one drug to another, but casave was superior to bread (by 6% in the case of salicylates and 22% in the case of thioridazine). (*Summary by F. G. Trans. by T. B.*) I02

See also 0064 0176 0178 0407 0415 0420

I03 Industrial Microbiology

0399-10939 ABE, M.O. and LINDSAY, R.C. **Evidence for a lactic streptococcal role in Nigerian acidic cassava (*Manihot esculenta* Crantz) fermentations.** Journal of Food Protection 41(10) 781-784. 1978. Engl., Sum. Engl , 15 Refs.

Cassava. Fermented products. Industrial microbiology. Analysis. *Streptococcus faecium. Corynebacterium manihot.* Culture media. Laboratory experiments.

The predominant acid-producing organism isolated from Nigerian cassava mixed fermentation cultures was *Streptococcus faecium. Corynebacterium manihot* was also abundant in the mixed cultures; but contrary to earlier reports, this organism grew slowly and lacked significant acid-producing capabilities. Cultural characteristics of *S. faecium* indicated that it was the primary fermentation organism in acidic cassava fermentations rather than *C. manihot.* Diacetyl production in both milk cultures and fermented cassava was demonstrated for *S faecium.* Detection of diacetyl in fermented cassava products indicated that *S. faecium* may also play an additional role in the flavor development of these products. (*Author's summary*) I03

0400-4993 MEIERING, A.G., AZI, F.A. and GREGORY, K.F. **Microbial protein production from whey and cassava.** Transactions of the ASAE 21(3) 586-593. 1978 Engl., Sum. Engl., 20 Refs., Illus

Cassava. Industrial microbiology. Protein enrichment. Culture media. Fermentation. Temperature. Proteins. Biomass production. Statistical analysis.

A simple fermenter based on the Waldhof principle was developed for producing SCP from whey and cassava. A *Kluyveromyces fragilis* culture was used for fermenting the whey, with an initial lactose concentration of 50 g/l. An *Aspergillus fumigatus* mutant I-21A was used to enrich the protein-deficient cassava with microbial biomass. The true protein concentration of the cassava was raised to 27%. Fermentation processes were simulated in order to predict fermenter performance under different conditions in batch as well as continuous flow operation. The nutritional value of the protein-enriched cassava was analyzed in feeding tests with rats and showed no significant differences from standard feed rations (*Author's summary*) I03

0401-3861 SILVA, G.A. DA **Influência do zinco e do ferro sôbre a produção de proteína fúngica em amido de mandioca (*Manihot esculenta* Crantz).** (*Influence of zinc and iron on single-cell protein production from cassava starch*). Tese Mag. Sc. Piracicaba, S.P., Brasil, Universidade de São Paulo. Escola Superior de Agricultura "Luiz de Queiroz", 1978. 108p. Port., Sum. Port., Engl., 62 Refs., Illus.

Cassava. Zn. Iron. Cassava starch. Industrial microbiology. Protein enrichment. Culture media. pH. Statistical analysis. Proteins. Biomass production. Brazil.

This study was conducted to determine the amount of Zn and Fe required for max fungal growth

when using a cassava starch substrate as the source of carbon for protein production. The use of urea or ammonium nitrate as a source of N was also evaluated. The microorganisms used were *Aspergillus niger* IZ-9, *A. wentii* IZ-1625 and *Fusarium* sp. Best results were obtained with *A. niger*, grown at pH 3 0, and urea as the source of N; final pH values higher than 8 were indicative of poor development. The cassava cv. used (IAC-YARA) did not contain adequate levels of Fe and Zn (17 and 15 ppm, respectively) for max production of biomass and crude protein, which was attained at 20.51 and 5.45 ppm, respectively. Zn concentrations of ≥10 ppm had a toxic effect on *A. niger*. Since the amount of Fe and Zn utilized by *A. niger* from the roots to correct deficiencies is unknown, about 20 ppm Fe should be added to the substrate as it is not toxic at higher concentrations and also eliminates the inhibitory effect of Zn. Observations of the essential amino acid profile revealed that the microorganism is a good producer of threonine and that the culture media should be enriched with other components such as P, K, Ca and Mg to produce the other essential amino acids in greater amounts (*Summary by T.B.*) I03

0402-9963 BALAGOPAL, C., MAINI, S.B. and HRISHI, N. **Microbial treatment of starch factory effluents and the production of single cell protein.** Journal of Root Crops 3(2):47-50 1977. Engl., Sum. Engl., 9 Refs

Cassava. Waste utilization. Industrial microbiology. Protein enrichment. Yeast production. India.

Cassava starch effluents were subjected to settling, nutrient enrichment and aeration. Treatment of these effluents with *Candida* yeast was studied. Overall BOD reduction was ca. 70%; biomass yield varied from 100-403 mg/100 ml of effluent and contained 34.70% protein (*Author's summary*) I03

See also 0354 0368

J00 ECONOMICS AND DEVELOPMENT

0403-10933 SAINT, W.S and GONZAGA M., L. **Acesso aos fatores de produção pelos mandiocultores de baixa renda em Cruz das Almas-BA.** (*Access to factors of production by low-income cassava farmers in Cruz das Almas, Bahia*). Cruz das Almas-BA, Brasil, Universidade Federal da Bahia. Escola de Agronomia, Série Pesquisa no. 1. 1976. Port., Sum. Engl., 3 Refs.

Cassava. Production. Costs. Income. Socio-economic aspects. Cultivation. Brazil.

A study was made of the access to factors of production by low-income cassava farmers in Cruz das Almas county, Bahia. Based on INCRA land registers, farmers were classified as cassava (predominant crop) or noncassava farmers. A randomized sample of 62 cassava farmers were interviewed. It was found that they have minimal access to land, labor, capital, technology and information. Of the farmers interviewed, 70% had < 10 ha of land; families had an av of 2.9 man-days of labor. Access to bank credit was almost nonexistent. The use of technology and fertilizers was very limited, and contact with extension agents and local institutions, rare. In view of the minimal access to factors of production, any strategy to increase cassava production that is based on improving said access should meet with considerable success. (*Author's summary*) J00

0404-10907 SAIDU, S.M **Economic aspects of root and tuber production in Sierra Leone.** New England, Ministry of Agriculture and Natural Resources, 1978. 9p. Engl , Sum. Engl

Paper presented at the Regional Root and Tuber Crop Improvement Workshop, Freetown, Sierra Leone, 1978.

Cassava. Gari. Cassava flour. Cassava pastes. Feeds and feeding. Fermented products. Uses. Marketing. Sierra Leone.

An overview is presented of the 3 major root and tuber crops (cassava, sweet potatoes and yams) in Sierra Leone Production cost estimates are hard to come by since the main object of the farmer is to secure subsistence for his family. When there is a surplus offered for sale, prices received are very low, often representing a loss to the farmer. More than 40,000 acres are planted to cassava, but av yield is only 1.97 t/ac. Local uses for human and animal nutrition are discussed There is a good potential market in the Far East (mainly Japan) for dehydrated cassava leaves, which are equivalent in feed value to alfalfa There is also a good potential for fermented products (alcohol and high-protein dried yeast), but the country's traditional processing industry needs to be modernized. (*Summary by T.B*) J00 H01

0405-10448 INSTITUTO CENTROAMERICANO DE INVESTIGACION Y TECNOLOGIA INDUSTRIAL GUATEMALA. **Guía para la exportación de productos agrícolas no tradicionales: yuca.** (*Guide for exporting nontraditional agricultural products: cassava*) Ciudad de Guatemala, 1976. 57p. Span , 3 Refs , Illus

Cassava. Cassava products. Production. Trade. Marketing. Prices. Legal aspects. Post-harvest losses Packaging. Storage. Central America. USA. Europe.

The main purpose of this guide is to promote the exportation of nontraditional agricultural goods that can be produced in Central America or that are already being produced on a commercial scale, with emphasis on cassava. The guide has 2 main sections the 1st includes basic information on production, export perspectives, marketing specifications and product handling The 2nd section deals with aspects common to any fresh agricultural commodity Storage, packing and transportation facilities existent in C.A. are studied Legal regulations, procedures and other requisites for the home port and port of entry are listed as well. Tables give data on different export tariffs, a directory of land/sea shipping firms with refrigerator car facilities in C A., and the volume and value of cassava imports by country of origin. (*Summary by S.G.V. Trans. by T.B.*) J00

0406-11256 TITAPIWATANAKUN, B. **Analysis of export demand for Thai tapioca.** Ph.D. Thesis. Minneapolis, University of Minnesota, 1979. 177p. Engl., Sum Engl., 42 Refs, Illus.

Cassava. Cassava chips. Pellets. Cassava flour. Production. Consumption. Marketing. Trade. Prices. Statistical analysis. Costs. Thailand.

Analyses of the markets for animal feed exports, flour exports and domestic flour are made. A simultaneous equations model was constructed to describe the interrelationships of the Thai cassava industry Animal feed export demand was estimated from the total quantity of feed exported to the 5 EEC countries (ca. 96% of total feed exports). Flour export demand was estimated from the quantity of flour exported to the USA (ca. 45% of total flour exports); for other regions, export data were not sufficient for an estimation. Domestic flour consumption data were available; thus a domestic flour demand equation was constructed on the basis of derived income and price elasticities so that the econometric models would reflect the effects of domestic flour consumption on the cassava industry. A root production data series was constructed to estimate the root supply function, which is inelastic (0.43) in the short run but elastic (2 2) in the long run. Estimated feed export demand confirmed the hypothesis that cassava products imported by the EEC for use in animal feed have a complementary relationship with soybean meal and a competitive relationship with maize. The quantity of EEC cassava imports was strongly influenced by the import weighted maize threshold price and the animal production index, which have elasticities of 2.25 and 2.30, respectively. The estimated own price elasticity is -0.26. In estimating flour export demand (U.S.), the hypothesized competitive relationship between cassava flour and cornstarch in the U.S. market was confirmed by the negative relationship fouud to exist between the quantity of flour exported from Thailand to the U.S. and the deflated maize price in the U.S. Imports into this market show a decreasing trend. The own price and cross price elasticities are very close in absolute values (-0.74 and 0.78, respectively). Two models using 2 and 3 structural equations, respectively, a constructed domestic flour demand equation and 6 identity equations were developed. Both models are nonlinear so the Gauss-Seidel method (iterative simulation) was used to solve the models. Simulated results of the models were used to explain and predict the historical performance of the Thai cassava industry from 1961-62 to 1976-77. Both models predicted quantity of exports, production of cassava products, roots used and root production more accurately than they predicted quantity of domestic flour consumption and prices. Root production and the import weighted maize threshold price in the EEC were found to have the greatest impact on the endogenous variables; the processing and handling margin of chip manufacturers had the least impact. This analysis suggests that to improve cassava industry earnings, the following policies would be appropriate. cut back root production to increase price, control processing capacity, control product quality more strictly, expand export markets by active promotion and promote domestic use of cassava for animal feed. (*Author's summary*) J00

0407-11259 **MANIOC (Cassava).** *In* Workshop on Natural Products for Sri Lanka's Future, Colombo, Sri Lanka, 1975. Report. Colombo, Sri Lanka, National Science Council. 1975. pp.12, 14. Engl , Illus

Cassava. Production. Uses. Sri Lanka.

The purpose of this workshop was to identify scientifically sound projects that exploit natural resources and that can significantly contribute to Sri Lanka's economic development. Among the crops meriting further development is cassava, already grown on a wide scale (ca. 150,000 acres). Av yields are low (5 t/ac; 10 t on exptl plots) A small solar drying unit (2000 lb fresh cassava/day) has been designed for location in the growing area. The chips will be used for flour. (*Summary by T.B.*) J00 102

0408-10541 SMITH, N.J.H. **Agricultural productivity along Brazil's Tranzamazon highway.** Agro-Ecosystems 4:415-432. 1978 Engl , Sum Engl., 190 Refs., Illus.

Cassava. Cultivation. Socio-economic aspects. Ecology. Brazil.

Agricultural problems associated with Brazilian efforts to colonize a 3000-km rain forest highway are discussed, with emphasis on short-cycle cash crops (cassava, rice, maize and beans). It is concluded that a diversified crop base, with cassava as a major source of cash and subsistence during the 1st years of settlement, not only reduces pest and disease damage but also provides security against oscillating prices Cassava cultivation also fosters cooperative and social cohesion since the families assist each other in processing the meal A brief description is given of an aboriginal agro-ecosystem as an example to be considered by agricultural planners when devising colonization schemes. (*Summary by T.B*) J00

0409-11217 MICHAEL, G. **Root crops production in the Cook Islands.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia South Pacific Commission. Technical Paper no. 174. 1977. pp.92-93. Engl.

Cassava. Production. Starch crops. Cook Islands.

A rough estimate is made of total production and utilization figures for root crops in the S. Cook Islands. Some 1500 acres are planted to cassava. From 1970-75 4500 kg were sold on the local market and 25,000 kg consumed locally. (*Summary by T.B.*) J00

0410-9955 NESTEL, B.L. **World cassava research — a review.** Journal of Root Crops 2:10-13. 1976 Engl

Cassava. Research. Cassava programs.

Research on cassava was given priority by the International Development Research Centre since it is of major importance in > 40 countries in Africa, L.A. and Asia. This crop appears to be capable of producing more calories per unit of land than any other known food crop. At present 70% of the world production is used as food, 20% for animal feed and 10% for starch and other industrial uses. Research is being done mainly by 2 international centers (CIAT en Colombia & IITA in Nigeria); however, a no. of national research institutions (e.g , CTCRI in India and MARDI in Malaysia) are also carrying out programs with cassava. The aspects being studied in

the different disciplines are highlighted. Collaborative research and training efforts are of vital importance in the transference of technology to the farmer. (*Summary by T.B.*) J00

0411-9952 HAHN, S.K. **IITA's role in tropical agriculture with special reference to Program National Manioc, Zaire.** *In* Nwanze, K.F. and Leuschner, K., eds. International Workshop on the Cassava Mealybug *Phenacoccus manihoti* Mat-Ferr. (Pseudococcidae). M'vuazi, Zaire, 1977. Proceedings. Ibadan, Nigeria, International Institute of Tropical Agriculture. Proceedings Series no. 1. 1978. pp.3-6. Engl.

Cassava. Cassava programs. Zaire.

In this paper opening the workshop, a brief description is given of the IITA Root & Tuber Improvement Program, which covers cassava, yams, sweet potatoes and cocoyams in order of priority. Broad objectives are to develop improved cultural practices and var. with high stable yield, good quality and improved plant characteristics for efficient cropping systems. At present they have outreach programs in Zaire, Nigeria and Cameroon. At Zaire emphasis is placed on screening cassava var. for resistance to AMD and CBB; anthracnose is also of major economic importance. The 2 major pests are the mealybug *Phenacoccus manihoti* and the green mite *Mononychellus tanajoa*. (*Summary by T.B.*) J00

0412-4204 MENDOZA, G. and AMEZQUITA, M.C. **Utilización de la estadística y el diseño experimental en investigación en yuca.** (*Utilization of statistics and experimental design in cassava research*). Cali, Colombia, Centro Internacional de Agricultura Tropical. Unidad de Biometría, 1978. 50p. Span , 8 Refs., Illus.

Paper presented at Curso Intensivo de Adiestramiento en Producción de Yuca, Cali, Colombia, 1978.

Cassava. Experiment design. Field experiments. Statistical analysis. Colombia.

Emphasis is placed on the usefulness of statistics in analyzing exptl results. Definitions are given of basic concepts and terminology. The designs most frequently used in cassava expt are completely randomized, randomized complete blocks, split plots and systematic (response surface, fan-shaped and parallel rows). A brief description is given of how and when to use these designs, calculations needed for statistical analysis and examples to illustrate their use. (*Summary by T B*) J00

0413-4201 FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS. **Proyecciones de la FAO sobre productos básicos. Yuca: proyecciones de la oferta, la demanda y el comercio para 1985.** (*FAO projections for basic commodities. Cassava: 1985 projections for supply, demand and trade*). Roma, Italia, ESC. PROJ/78/7, 1978 7p Span.

Cassava. Trade. Production.

Factors leading to the decrease in %s of annual increases in world cassava production from 3% in the 50s to 2 4% from 1962-64 to 1972-74 are discussed. FAO has prepared 2 series of projections analyzing cassava production, demand and trade in 1985. In the Basic Projections, it is assumed that economic growth will follow the same trends as in the past, introducing necessary readjustments in accordance with recent developments. The Supplementary Projections are

based on a more rapid economic growth. The need to increase yield and production, as well as to improve processing in order to increase storage life and marketability, is pointed out The EEC market is very important for developing countries; export perspectives depend on the continued free access to this market. (*Summary by T.B*) J00

0414-10469 UNIVERSIDAD CENTRAL DE VENEZUELA. FACULTADES DE AGRONOMIA Y CIENCIAS VETERINARIAS. **La yuca; valiosa alternativa para la alimentación humana y animal.** (*Cassava: a good alternative for human and animal nutrition*). Caracas, Venezuela, 1974?. Span , Illus.

Cassava. Cassava programs. Venezuela.

Data are given on the land distribution in Venezuela for different agricultural activities; some 19 million ha are dedicated to native pastures, much of which could be profitably dedicated to cassava. Among the advantages of this crop are its adaptability and resistance to drought, pests and diseases. Outside economic interests and other factors negative to the adoption of cassava are discussed. Dried cassava is considered as an important raw material for export by the tropical countries (*Summary by T.B.*) J00

0415-9927 PHILLIPS, T.P. **Economic implications of new techniques in cassava harvesting and processing.** *In* Weber, E.J., Cock, J.H. and Chouinard, A.,eds Workshop on Cassava Harvesting and Processing, Cali, Colombia, 1978. Proceedings. Ottawa, Canada. International Development Research Centre. IDRC-144e. 1978. pp 66-74 Engl , Sum Engl., 13 Refs., Illus.

Cassava. Harvesting. Mechanization. Gari. Cassava meal. Cassava flour. Alcohol. Ethanol. Cassava starch. Economics. Animal nutrition. Human nutrition. Processing.

An analysis is made of the possible economic benefits of mechanical harvesting technology (MHT) and postharvest processing (PHP) in the light of what the new technologies are supposed to do and how they fit into the system. There are many constraints to the introduction of MHT; and the economic advantages for the typical producer are not clearly apparent With regard to the PHP of cassava for food, gari in West Africa, meal (farinha) in Brazil flour and the fortification of processed cassava are discussed PHP for industrial uses (alcohol and starch) and for animal feedstuffs is also dealt with briefly (*Summary by T.B*) J00 D02 I02

0416-10460 SIMPOSIO NACIONAL SOBRE PERSPECTIVAS DEL CULTIVO DE YUCA EN COLOMBIA. 1o., CALI, COLOMBIA, 1979. Conclusiones (*National symposium on perspectives of cassava growing in Colombia. Conclusions*). Cali, 1979. 16p Span.

Cassava. Cultivation. Production. Alcohol. Industrialization. Storage. Consumption. Processed products. Colombia.

The purpose of this symposium was to prepare recommendations for the Colombian Government so that they can follow a definite course of action with regard to the planning of cassava cultivation and to ensure that the technology being generated by the research institutions is transferred to the farmer for the economic welfare of the country. The conclusions reached by the 2 work groups on production and industrialization are given. (*Summary by S.G.V Trans. by T.B*) J00

0417-7563 NORMANHA, E.S. **Mandioca também é "menina dos olhos".** (*The importance of cassava*). n p., n.e , 1971. 6p. Port.

Also in Coopercotia. Julho 1972.

Cassava. Productivity. Production. Research. Cassava programs.

The importance of research in the development of technology for increasing productivity and production in developing countries is pointed out, with emphasis on what is being done by CIAT at the international level. Research activities and objectives are discussed in relation to the Cassava Program An explanation is given of how program reviews work to define specific research goals. CIAT's role in developing an international cassava germplasm bank is also mentioned. (*Summary by T.B*) J00

0418-9971 BRASIL. MINISTERIO DE AGRICULTURA. DEPARTAMENTO ECONOMICO. **Estudo econômico de determinação do custo de produção da mandioca e farinha de mandioca no Estado de Pernambuco.** (*Economic study of the costs for producing cassava and cassava meal in Pernambuco*). Recife, PE-Brasil, 1966. 22p. Port., 7 Refs.

Cassava. Economics. Costs. Production. Cassava meal. Prices. Brazil.

Data are given on cassava production in Pernambuco (Brazil) from 1952-63; cassava was 2nd in importance to sugar cane. Factors limiting to production included low prices due to an excess in the supply of meal, the reluctance of small-scale processors to make chips used for the meal, pests and diseases, and poor yields due to inadequate cultural practices Results are given of evaluations of 168 var. obtained by the Instituto de Pesquisas Agronômicas. Preliminary results are given of a survey of farmers with holdings of 6-40 ha, small farmers (2 ha) and tenant farmers to determine cassava production costs in 2 parts of the state in 1965. The av cost of producing meal is also calculated. (*Summary by T.B*) J00

0419-10439 BULL, T.A. and BATSTONE, D.B. **Potential for multicrop processing within the sugar industry.** *In* Conference on Alcohol Fuels, Sydney, Australia, 1978. Proceedings. Sydney, Institution of Chemical Engineers, New South Wales Group, 1978. pp.4-13 - 4-21. Engl., Sum Engl., 7 Refs., Illus

Cassava. Cassava programs. Ethanol. Costs. Production. Australia.

The potential for combining a biomass for an ethanol project with the established infrastructure of the sugar industry in Bundaberg (Australia) is considered. Cassava production on nearby underdeveloped land plus acquisition of overpeak cane production, coupled with the sharing of some sugar mill facilities, affords a significant cost saving for ethanol production. (*Author's summary*) J00

0420-10426 SHEEHAN, G., J , GREENFIELD, P. F. and NICKLIN, D. J. **Energy, economics, ethanol - A literature review.** *In* Conference on Alcohol Fuels, Sydney, Australia, 1978. Proceedings. Sydney, Institution of Chemical Engineers, New South Wales Group, 1978. pp.6-11 - 6-19. Engl., 46 Refs., Illus.

Cassava. Cassava programs. Ethanol. Production. Costs. Australia.

Estimates are presented for the cost of producing ethanol by fermentation, based on published data from a no. of authors and various raw materials including sugar cane and cassava. The overall energy balance for ethanol production is also examined. It is concluded that sugar cane, coupled with another crop so as to extend the period of production, is the most viable option. The cost of the raw material represents about 65% of the total production cost in a typical process. Should cassava harvesting difficulties be overcome and the tops utilized economically as a fuel, cassava could compete strongly with sugar cane as a contender for ethanol production. *(Summary by ICE)* J00 I02

0421-10427 SMYTHE, B. M **Implementing an alcohol fuel programme.** *In* Conference on Alcohol Fuels, Sydney, Australia, 1978 Proceedings Sydney, Institution of Chemical Engineers, New South Wales Group, 1978. pp.9-1 - 9-6. Engl., Sum. Engl., 10 Refs.

Cassava. Ethanol. Cassava programs. Production. Costs. Australia.

The feasibility of producing fuel alcohol at the level of ca. 2 million kl/yr (10% of Australia's automotive fuel requirements in the mid-1980 s) is considered as one option to ease the expected shortfall in requirements. Approx costs of producing alcohol from cane and cassava are made along with estimates of the land required. Steps necessary to implement a National Alcohol Programme are outlined; these will require extensive coordination between Federal and State governments, growers, processors, blenders, auto manufacturers and consumers Consideration was given to methods for land search, research into cassava agronomy, processing methods and requirements for storage, blending and distribution. The possibility for incremental growth is contrasted with heavy initial capital requirements for other alternative fuels The social and community impacts of a large-scale alcohol program are noted *(Summary by ICE)* J00 I02

0422-10404 NIX, H.A. **Availability of land for energy cropping in Australia.** *In* Conference on Alcohol Fuels, Sydney, Australia, 1978. Proceedings..Sydney, Institution of Chemical Engineers, New South Wales Group, 1978. pp 6-5 - 6-9. Engl., Sum. Engl., 12 Refs., Illus.

Cassava. Cassava programs. Climatic requirements. Soil requirements. Cultivation. Maps. Australia.

Land potentially available for additional food, fiber and alcohol production is limited. Much of the remaining uncomitted land in Australia is marginal with respect to climate and/or terrain and/or soil constraints, and productivity is likely to be low. Estimates of land availability in Australia for energy crops such as cereals, trees, sugar cane, sugar beet and cassava are given. *(Summary by ICE)* J00 D01

0423-3100 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava program 1977 report.** *In* _____. Annual report 1977. Cali, Colombia, 1978. pp C1 - C68. Engl., Illus

Also in Spanish

Cassava. Cassava programs. *Manihot esculenta* **Plant physiological processes. Plant development. Plant physiology. Resistance.** *Tetranychus urticae Mononychellus tanajoa. Cercospora henningsii Cercospora vicosae. Sphaceloma manihoticola* **Cuttings. Insect control. Biological control. Insect agents. Storage.** *Erinnyis ello. Anastrepha pickeli Erwinia cassavae.*

Phenacoccus gossypii. Coptotermes. Aonidomytilus albus. Frankliniella williamsi. Xanthomonas manihotis. **Plant breeding. Cultivars. Tuber productivity. Starch productivity. Cultivation. Aluminium. N. P. K. Ca. Zn. S. Dung. Propagation. Pruning. Colombia.**

During 1977 the Cassava Program at CIAT continued multidisciplinary team efforts to reach its objectives of (1) producing low-input technology for increased production in areas where cassava is presently grown, (2) developing technology for production on infertile acid soils of the tropics, and (3) diffusing these technologies to national and local agencies. Of primary importance is to have a plant that is efficient, per se, in converting solar energy to carbohydrates. Expt this year confirmed the importance of long leaf life and late branching, as well as the variability in photosynthetic rate, a character which could be used for increasing yield potential. One plant genotype (CM 308-197) gave the best yields at 3 sites with different temp (20, 24 and 28°C); however, a more vigorous genotype is required for obtaining max yields at lower temp and less vigorous types for areas with higher temp. Expt have shown that there are lines that do exceptionally well at low Ca levels ($\leq$ 0.5 t/ha) or at very low levels of applied P Rock phosphates are a promising source of cheap fertilizer. With moderate fertilizer levels yields of 25-28 t/ha can be obtained on acid infertile soils. Disease and pest control is a major problem in low-fertility areas; treating planting material with a fungicidal/insecticidal dip (only US$3/ha) is effective in improving germination of cuttings and in controlling *Sphaceloma manihoticola.* Emphasis is on resistant var.; lines resistant to Cercospora leaf spot diseases and the *Mononychellus* and *Tetranychus* mites have been found. Biological control of the hornworm *Erinnyis ello* on a commercial scale has shown promising results thus far. Stem rot caused by *Erwinia carotovora* pv. *carotovora* can be controlled by careful selection of planting material. The breeding section tests > 20,000 hybrids/yr for high yield potential and resistance. The rapid multiplication technique has been further refined and simplified, and is being used to multiply promising material for regional trials in Colombia. The potential of cassava in association with beans was evaluated, obtaining very high LERs (> 1.7) and yields (34 and 2.9 t/ha, respectively). Postharvest physiological deterioration of roots can be prevented by pruning tops 3 wk before harvest or by putting roots in polyethylene-lined paper bags immediately after harvest. Microbial deterioration is prevented by treating roots with a broad-spectrum fungicide. (*Summary by I.B. Trans. by T.B.*) J00

0424-11262 CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL. **Cassava program 1978 report.** *In* ——. Annual report 1978. Cali, Colombia, 1979. pp.A.1 - A.100. Engl, Illus.

Also in Spanish

Cassava. Cassava programs. Field experiments. Branching. Fertilizers. *Erinnyis ello.* **Biological control. Aleyrodidae. Resistance.** *Anastrepha pickeli. Xanthomonas manihotis.* **Cassava superelongation. N. Planting.** *Cercospora henningsii.* **Leaf area. Plant development. Dry matter.** *Cercospora caribaea.* **Selection. P. Tuber productivity. Cultivation systems.** *Phenacoccus. Tetranychus urticae. Mononychellus tanajoa. Xanthomonas cassavae.* **Storage. Cuttings. Germination. K. Tubers. Propagation. Weeding. Harvesting. Socioeconomic aspects. Drying. Colombia.**

The Physiology Section continued to evaluate characters associated with high yield potential. Emphasis was placed on determining the branching characteristics of different clones and how this habit is affected by growing conditions. Response to fertility levels and the plant type required for multiple cropping with beans were also studied. Data suggest that yield increases of ca. 25% can be expected by increasing leaf life from 50 to 100 days. Differences in DM production were due to differences in leaf area (leaf size), not to differences in leaf efficiency. The Entomology Section completed studies of the biology of the cassava hornworm *Erinnyis ello* and intensified

work on the biology of parasites and predators of this pest. Results are also given of work on var. resistance and biological control of the whitefly *Aleurotrachelus* sp., the mealybug *Phenacoccus gossypii*, the black scale *Saissetia miranda* and chemical control of the fruitfly *Anastrepha manihoti*. Screenhouse evaluations of the germplasm bank for resistance to the mites *Tetranychus urticae, Mononychellus tanajoa* and *Oligonychus peruvianus* continued. The Pathology Section is identifying lines resistant or tolerant to the main factors limiting to production in a given ecological zone, including diseases, insects and adverse soil and climatic conditions Expt have been concentrated in 2 different ecological regions in Colombia: Popayán and Carimagua Fungicide/insecticide mixtures have been evaluated for treating cuttings to ensure rooting and bud germination and to reduce termite attack. Results are also given of work to prevent cutting dehydration, disease/insect damage and bud germination during storage. In addition to routine breeding activities and replicated yield trials at 2 ecological sites in Colombia (Caribia and Carimagua), the evaluation of F_1 seedling selections was begun at the latter site. Results are given of screening for resistance to CBB and superelongation and the genetic behavior of this resistance. The Agronomy Section has increased regional testing outside of Colombia; the Cultural Practices Section has completed a series of trials to define the proper management of planting materials to obtain higher yields. Evaluations were also made of 2 mechanical harvesting aids and different bean/cassava cropping systems. The Soils and Plant Nutrition Section concentrated efforts on identifying cv. tolerant to high levels of Al and low levels of P, the main limiting factors for cassava production on the vast, acid, infertile Oxisols and Ultisols of L. A. The Economics Section has established on-farm trials to evaluate different technological packages developed at CIAT before their release to national institutions. Results obtained from the 1st trial on the N. Coast of Colombia are discussed. The Program's international cooperation activities in L A. and SE Asia are designed to link research generation and technology application between CIAT and national agencies. Within-country and training activities are discussed. (*Summary by T.B.*) J00

0425-11274 ALBUQUERQUE, M. DE Cassava program review conference. Belém do Pará-PA, Brasil, Instituto de Pesquisa Agropecuária do Norte, 1972. 3p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Brazil.

The Instituto de Pesquisa Agropecuária do Norte is responsible for cassava research activities in the E. Amazonian region (Pará, Amapá, Maranhão), where cassava has been traditionally grown for native consumption (85% for table flour made from bitter var.). Because of the construction of 2 highways (Transamazonic and Santarém-Cuibá), this area is being integrated into the nation's economy and the demand for cassava for industrial purposes has increased. Important limiting factors are the soil (Latosols), limited availability of inputs, and low cultural and socioeconomic levels. Emphasis in research is on management of large plantations, mechanization, possible variations in starch quality due to regional climatic variations, fermentation and genetic improvement. (*Summary by F.G. Trans. by T.B.*) J00

0426-11261 ALVAREZ-LUNA, E. Cassava (*Manihot esculenta* Crantz) a tropical root crop. Cali, Colombia, Centro Internacional de Agricultura Tropical, 1972. 3p Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Plant geography. Uses. Production. Productivity. Nutritive value. Cassava programs. Colombia.

Brief data are given on the origin and geographic distribution of cassava, uses and nutritional value. The importance of research efforts is pointed out. (*Summary by F.G. Trans by T.B*) J00

0427-11286 ARRAUDEAU, M. **Memorandum on cassava in Malagasy Republic.** Tananarive, Malagasy Republic, Institute of Agronomic Research of Madagascar, 1972. 3p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Malagasy Republic.

In 1971 about 300,000 ha were planted to cassava; av yield was ca 3 t/ha but varied a great deal ($\leq$ 2 t when intercropped with legumes or grasses in dry S. areas and $>$ 35 t in modern plantations). Cassava is grown for direct consumption, starch and tapioca. Factors limiting to production are quantitative (drought, poor soils, inadequate cultural practices) and qualitative (low DM and protein and high HCN contents). There are also problems of marketing and multiplication of var. The Institut de Recherches Agronomiques de Madagascar is doing research on high-yielding var. with resistance to AMD, and fertilization. (*Summary by F.G. Trans. by T.B*) J00

0428-11269 BOLHUIS, G.G. **Notes on CIAT Cassava Program review conference.** Wageningen, The Netherlands, 1972. 3p. Engl

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972

Cassava. Cassava programs. Production.

Although the area planted to cassava increased 50% from 1948-68, yield/ha increased only 14%. Possible reasons for this are discussed. The importance of developing improved cultural practices and high-yielding cv. is pointed out. (*Summary by T.B.*) J00

0429-11278 CORREA, H. **Conference on cassava.** Sete Lagoas-MG, Brasil, Comissão Nacional de Mandioca, 1972 4p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Production. Socio-economic aspects. Brazil.

Data (1969) are given on area cultivated, production and productivity in the principal cassava-growing states of Brazil. Factors limiting production and utilization include the use of too many var., farmers' lack of knowledge on disease problems, poor soils, high cost of inputs in improved technology, lack of stable domestic market, and region-specific cultural practices. At the Instituto de Pesquisas e Experimentação Agropecuárias Centro-Oeste, work is being done on genetic improvement and cultural practices for the region. (*Summary by F.G. Trans. by T.B.*) J00

0430-11275 COURSEY, D.G. **Memorandum on cassava program review conference.** London, England, Tropical Products Institute, 1972. 8p. Engl, 10 Refs.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Production.

Production data (1967-69) are presented for the 9 most important cassava-producing countries, which account for 74.2% of the total world production. Factors limiting to production and utilization are discussed. Ongoing research on cassava at the Tropical Products Institute is outlined. Appendices give data on total production, % increase in production and highest per capita production in the main cassava-producing countries. (*Summary by T.B.*) J00

0431-11268 ESTRADA R., N. **Cassava program review conference.** Bogotá, Instituto Colombiano Agropecuario. Programa de Tuberosas, 1972 2p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972

Cassava. Cassava programs. Colombia.

Cassava yields in Colombia are very low (3 2 t/ha), most of the production is consumed as fresh food. There are a few small-scale starch processors Factors limiting to production and utilization include difficult and costly transportation, poor agronomic practices, short storage life, lack of processing factories, unstable prices, limited local markets Favorable factors are good potential land areas, few limiting diseases, potentially good high-yielding native var. The Instituto Colombiano Agropecuario is evaluating var for different ecological areas Insecticides and herbicides are also being tested. With increased inputs, 400% increases in yield are possible on commercial plots. (*Summary by F.G. Trans by T.B*) J00

0432-11271 GODFREY-SAM-AGGREY, W. **The status of cassava production, utilization and research in Sierra Leone.** Njala, University of Sierra Leone, Njala University College, 1972. 4p Engl , 2 Refs.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cultivation systems. Uses. Production. Cassava programs. Sierra Leone.

Cassava is the 2nd most important crop in Sierra Leone as can be seen from the areas under cultivation (161,028 ha vs 11,745 for yams and 9,598 for sweet potatoes). Both sweet and bitter var are used for food, either cooked or processed into foofoo, gari and starch. Data are available on age and length of cuttings, spacing, planting depth, period and method Two problems are the fertilizer requirements of cassava on the upland soils and AMD, which is widespread. (*Summary by F.G. Trans. by T.B.*) J00

0433-11273 HAHN, S K **A proposed cassava improvement program.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1972 2p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Africa.

Africa produces ca 30 million t of cassava annually (35% of world production) on approx 5 million ha (50% of the world area); 80% of the production and 70% of the acreage is in tropical W. Africa, where cassava is an important staple, mainly in the form of gari and foofoo. The main factors limiting to production are technical and socioeconomic: deficient cultural practices,

difficulty of transportation, marketing and processing systems, lack of agricultural education, research and extension. Research was begun at IITA in 1971, with emphasis on collecting germplasm and screening for resistance to AMD and pests, more efficient, high-yielding, early-maturing, widely adapted plants with better quality roots for food and industrial processes. Methods to be used in the breeding program are outlined. (*Summary by F.G. Trans. by T.B.*) J00

0434-11281 HERNANDEZ X., E. **Cassava program review conference, general program scheme.** Chapingo, México, Escuela Nacional de Agricultura, 1972. 3p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Mexico.

Cassava cultivation occurs in a large region of the hot humid tropics in Mexico in 3 main patterns: small plantings in individual gardens, commercial stands (total < 200 ha) in Morelos to supply the fresh market for human consumption in Mexico City, and commercial plantings (> 1000 ha) in the SE part of Chiapas for industrial processing. The principal factor limiting cassava production for human consumption is cultural, for industrial purposes, genetic improvement and better cultural practices are required. A general research program (botanical studies, production factors, forms of use of the different products) is proposed for the Graduate School of the Escuela Nacional de Agricultura at Chapingo. (*Summary by F.G. Trans. by T B*) J00

0435-11285 JONES, W.O. **Some views of a program of research on *Manihot esculenta*.** Stanford, California, University of Stanford, 1972. 2p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Research. Cassava programs.

Some of the characteristics that make cassava an advantageous tropical crop are its high potential yield of food calories/ha, economic yields under relatively poor soil and erratic rainfall conditions, possibility of low planting and cultivating costs, high resistance to pests and diseases (except AMD), and vegetative propagation The following should be strived for in a development program: high yields without inputs, greater understanding of the physiology and ecology of the root system, farming systems that permit the return of a max of nutrients to the soil, a plant that can be harvested at lower cost, early-maturing var. Other aspects of importance are AMD and HCN content in food products. (*Summary by F.G. Trans. by T.B.*) J00

0436-11260 MAGOON, M.L **Memorandum on cassava production and utilization in India.** Jhansi, Indian Grassland and Fodder Research, 1972. 7p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. India.

Cassava has become an important crop in India, being cultivated mainly in Kerala State (80% of the area) and Tamil Nadu. Its different uses in food, industry and feedstuffs are described. The main factors limiting to production are lack of early-maturing, high-yielding var. resistant to AMD and drought, and poor agronomic practices As for utilization, problems that need to be dealt with are HCN content, limited storage life, insufficient supply for feedstuffs, high

production and processing costs, fluctuations in prices, inadequate equipment and competition with other crops (e.g , maize). The Central Tuber Crops Research Institute, established in 1963, is conducting research on screening germplasm, var. improvement, basic genetic studies, cultural practices, fertilization, pathology and entomology. (*Summary by F.G. Trans. by T.B.*) J00

0437-11265 NORMANHA, E. **Production and utilization of cassava in Brazil.** Campinas-SP, Brasil, Instituto Agronômico, 1972. 11p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Production. Uses. Cassava products. Prices. Trade. Tuber productivity. Brazil.

Statistics are given on area, production and yield of cassava in Brazil (1950-68) and export of its different products (1965-70). The different uses in nutrition and industry are discussed. Factors limiting to production include economic (fluctuating prices, lack of credit, high production costs) and agronomic aspects (poor soils, adverse climate, CBB and the shoot fly *Silba pendula*). Factors limiting the greater utilization of cassava in nutrition and industry are also outlined In each state there is at least one state or federal entity engaged in cassava research. Some of the ongoing projects and areas requiring further study are listed. (*Summary by F.G. Trans. by T B.*) J00

0438-11267 OKIGBO, B.N. **Report on cassava work in Nigeria.** Nsukka, University of Nigeria. Department of Plant Soil Science, 1972 3p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Nigeria.

Of the 29 million t of cassava produced in Africa in 1967, 9 million were from Nigeria. In the N. states sweet var. are consumed raw as vegetables; in the S where mostly bitter var. are grown, foofoo, gari and kpokpo gari are made. The leaves are sometimes used as vegetables, and animals are fed cassava as a major source of carbohydrates. Factors limiting to production are AMD, low soil fertility, lack of adapted var. and limited mechanization. Research at the U. of Nigeria is being done on the effect of cutting length, diameter, age and planting position on yield, fertilization and mulching, planting dates and var. selection on the basis of yield and resistance to AMD. The Federal Institute of Industrial Research at Oshodi is working on processing, fermentation and fortification of cassava products; PRODA, on batch and mechanized processing. (*Summary by F.G. Trans. by T.B.*) J00

0439-11266 PINSTRUP-ANDERSEN, P. **The role of CIAT in the international improvement of cassava: the agricultural economics input.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1972. 2p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Colombia.

Suggested objectives of the agricultural economics program at CIAT are to collaborate in the allocation of research resources, improve the economic efficiency of cassava production and

marketing, estimate the overall socioeconomic consequences of the adoption of improved technology in production and marketing, and guide private and public investment and public policy with respect to cassava. Specific areas of research needed include the identification of major bottlenecks in production, marketing and consumption and estimation of the relative economic importance of each, the estimation of production costs under various management systems; the estimation of economic losses during transportation and storage under different marketing systems; and the analysis of present and future demand for cassava as well as the implications of expanded production. (*Summary by F.G Trans. by T.B.*) J00

0440-11277 SILVA, J.R. DA **Some aspects of cassava (*Manihot esculenta* Crantz) in the state of São Paulo, Brazil.** Campinas-SP, Brasil, Instituto Agronômico, 1972. 4p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Production. Economics. Cassava programs. Brazil.

São Paulo is one of the main producers of cassava in Brazil (1.7 million t in 1971; av yield 17 t/ha), of which > 90% was used for making chips, flour and starch Although agronomic problems exist, present commercial, industrial and administrative structures are obsolete and inefficient. High production costs impede exports and development of new product lines The Instituto Agronômico in Campinas has been doing research for > 30 yr, ongoing projects include genetic improvement, fertilization, botanical characterization of var., and identification of var. resistant to the shoot fly *Silba pendula*. (*Summary by F G. Trans by T.B*) J00

0441-11272 SILVESTRE, M. **Cassava in French-speaking African and Malagasy countries.** Paris, Institut de Recherches Agronomiques Tropicales et des Cultures Vivriéres, 1972. 6p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Production. Uses. Cultivation systems. Cultivation. Africa.

Cassava production in Africa is ca 34 million t (39% of world production); in French-speaking Africa (including Madagascar and excluding Zaire), it is 6.5 million t (an increase of 40% in 20 yr, the same as the growth in population). If distinguishing between the Guinean zone (Ivory Coast, Togo, Dahomey, Cameroon), where cassava is a staple food, and the Sudanian zone (Senegal, Mali, Niger, Upper Volta, Tchad), where the people mainly consume cereals, it can be seen that production increased more vigorously in the savanna countries than in the humid ones. In Madagascar the amount of starch processed is decreasing sharply (12,000 t in 1971 vs 40,000 t in 1950); it is the only country where cassava is used for animal feed, but on a small scale. Cassava is generally cultivated manually on family farms in a shifting cultivation system; yields av 5-12 t/ha. Factors limiting production are economic: limited foreign markets and rather high domestic prices. Increased productivity (from 15 to 25 t/ha) can be obtained easily using known cultural practices and improved var The research being done in the different countries by the Institut de Recherches Agronomiques Tropicales et des Cultures Vivriéres is discussed. (*Summary by F.G. Trans by T.B.*) J00

0442-11279 THOMPSON, R.L. **Agronomy program in cassava.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1972. 3p. Engl.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972

Cassava. Cassava programs. Colombia.

The objectives of the agronomy program at CIAT are to increase production/unit cost, increase and stabilize the supply of cassava available for the market, and reduce consumer prices. Three projects — development of standards for efficient exptl procedures, international and national cooperative work, cassava cropping systems — are outlined. (*Summary by F.G. Trans. by T.B*) J00

0443-11283 WILSON, L.A. **The status of cassava (*Manihot esculenta*) and cassava research in the Commonwealth Caribbean.** St. Augustine, University of the West Indies, 1972 8p. Engl., 8 Refs.

Paper presented at Cassava Program Review Conference, Cali, Colombia, 1972.

Cassava. Cassava programs. Production. Uses. Caribbean.

Cassava is not an important crop in the Caribbean Commonwealth countries, grown for the most part on small plots (0.40-2.02 ha) for family consumption. Jamaica is the only country for which national production figures are readily available (10,000-18,000 t on 1215-1620 ha). The principal factors limiting production and utilization are lack of efficient processing for industrial utilization, relatively high production costs, relatively small acreages of available arable land. Limited research has been done at the U. of the West Indies-St. Augustine. Research needs for the area are discussed (*Summary by F.G. Trans by T.B.*) J00

0444-4211 FISH, P. **Tapioca mountain worries Thailand.** Farm Eastern Economic Review 1978 (Sept.):91-92. 1978. Engl., Illus.

Cassava. Pellets. Cassava flour. Trade. Prices. Thailand.

Cassava exports have increased steadily during the past decade (781,357 t in 1967 vs. 3.97 million t in 1977); in export value, it was 2nd to rice in 1977. Total exports for 1978 are expected to be > 5 million t. Heavy sales of pellets have accelerated a decline in prices in the EEC, where pressure is being applied to lower sales by instituting quantitative restrictions or increasing current tariffs (6% of the CIF value). Thai govt policies, profit losses for farmers, product adulteration and other problems are discussed. (*Summary by I.B. Trans. by T.B.*) J00

0445-10420 NOJIMA, K. and HIROSE, S. **An outline of bibliographical studies on cassava — a guide to cultivation of cassava.** Lampung, Thailand, Lampung Agricultural Development Project. Japan International Cooperation Agency. 1977. 83p. Engl., 336 Refs., Illus.

Cassava. Cultivation. Cassava programs. Injurious insects. Diseases and pathogens. Human nutrition. Animal nutrition. Processing. Economics. Plant physiology. Plant breeding.

This is an extended, revised edition of "Cassava, a starch crop — a study of upland farming in Southeast Asia" (1975). Chapters deal with production data (1974) and origin, general characteristics as a foodstuff, botanical characteristics, var. (emphasis on Indonesia and Malaysia), HCN content and detoxification, growth patterns and yield, cultural practices, breeding, damage by pests and insects, harvesting and processing, storage problems, uses (food

preparations including special detoxification techniques and detoxification by fermentation, nutritional enrichment, starch, flour and tapioca, manufacture of pellets), marketing of products with emphasis on Japan, and international research institutes working on cassava. (*Summary by T.B.*) J00

0446-10935 NESTEL, B.L. **Cassava-some recent research findings.** Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. 5p. Engl., 4 Refs.

Cassava. Cassava programs. Plant breeding. Resistance. Germplasm. Proteins. Colombia. Nigeria.

Cassava research programs at the Centro Internacional de Agricultura Tropical (CIAT) in Colombia and at the International Institute of Tropical Agriculture (IITA) in Nigeria are reviewed A desirable plant ideotype is being selected with greater leaf longevity, a HI of 0.5-0.6 and a large root storage capacity. Emphasis is on finding sources of resistance to diseases, classification of the characteristics of the large germplasm collection and the production of microbial protein from a cassava substrate. (*Summary by Abstracts on Tropical Agriculture*) J00

0447-4147 SILVESTRE, P. **Réunion relative au programme de recherches sur le manioc du CIAT.** (*CIAT cassava research program review*). Cali (Colombie) 10-12 janvier 1972. Agronomie Tropicale 27:639-640. 1972. Fr.

Cassava. Cassava programs. Colombia.

A report is given of the Cassava Program Review Conference held at CIAT in 1972. Information is given on the initial germplasm collection, the list of CIAT cassava researchers and ongoing research projects.(*Summary by T.B*) J00

0448-3565 **PRODUTOR DE mandioca debate em seminário o futuro da lavoura.** (*Cassava growers debate the future of the crop*). Agricultura e Abastecimento 3(6):22. 1977. Port.

Cassava. Cassava programs. Socio-economic aspects. Brazil.

The perspectives of cassava cultivation are being analyzed for the region of São João da Barra (state of Rio de Janeiro), where 2350 farmers have 8000 ha (av production 132 t/ha) planted to cassava. Considerations arising from this workshop will be submitted to the Empresa de Assistência Técnica e Extensão Rural-Rio for the 1977-78 Work Plan. Formation of a cooperative is recommended in order to take advantage of govt credit and technical assistance programs; current minimum prices are given (*Summary by I.B Trans. by T.B.*) J00

0449-11221 HAYNES, P.H. **Root crop production and use in Fiji.** *In* Regional Meeting on the Production of the Root Crops Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. 1977. pp.44-50. Engl., 7 Refs.

Cassava. Production. Fiji.

The root crops grown in Fiji, including taro (*Colocasia esculenta*), yams (*Dioscorea alata*), cassava and sweet potatoes are discussed in terms of their adaptation to some of the prevailing

ecological conditions Their systems of production, distribution, yields, crop duration, plot size and cropping mixtures are reviewed. A comparison is made between some root crops of prices of edible DM. (*Summary by Abstracts on Tropical Agriculture*) J00

0450-9853 TORO M., J.C. **Sistemas de producción de yuca.** (*Cassava production systems*). *In* Seminario Internacional de Ganadería Tropical, Acapulco, México, 1976. Memoria. México, Secretaría de Agricultura y Ganadería, 1976. pp.211-213. Span.

Cassava. Cassava programs. Plant breeding. Cultivation. Colombia.

A brief outline is given of the technology being developed by CIAT to improve yields with low levels of inputs. The Cassava Program has developed simple cultural practices and sanitary measures to be used with improved efficient var. with resistance to diseases and pests. Mention is made of an agro-economic study being done in Colombia, where data are also being gathered from 9 regional trials. (*Summary by T.B.*) J00

0451-9734 MENDOZA R., R.E. **Diagnóstico y lineamiento del proyecto de yuca para la Comunidad de Sabaneta, Municipio San Simón, Distrito Maturín, Estado Monagas.** (*Analysis and guidelines for a cassava project for the community of Sabaneta in the state of Monagas, Venezuela*). Tesis Ing. Agr. Jusepín, Venezuela, Universidad de Oriente. Escuela de Ingeniería Agronómica. Núcleo de Monagas, 1975. 80p. Span , 33 Refs , Illus

Cassava. Cassava programs. Production. Cultivation. Socio-economic aspects. Costs. Income. Marketing. Casave. Processing. Venezuela.

This project designed for small farmers was proposed to improve cassava production in this community. An analysis is made of literature, visits to institutions and surveys of the farmers, as well as of the situation in the region (agroecological, socioeconomic and agronomic aspects); soils, agricultural potential, selection and preparation of planting material, planting distances, fertilization, processing, marketing and social aspects. Potrerito and Sabaneta have the best lands with regard to extension and agricultural potential. Cuttings should be used immediately after the harvest; density should be increased; harvesting should be done at 15-20 mo; different var. should be planted and mixed to obtain a better product (casave). A cooperative processing and marketing system should be established. (*Summary by F.G. Trans. by T.B.*) J00

0452-3484 NORMANHA, E.S. **Suggested guidelines for FAO's role in increasing and improving productivity of tropical root crops.** Rome, Italy, Food and Agriculture Organization of the United Nations. AGPC: MISC/40 Unedited version. 1975. 41p. Engl.

Cassava. Cassava programs. Research.

General aspects of the products, main production problems, diseases and pests of cassava, sweet potatoes, yams and edible aroids (taro, *Colocasia esculenta;* tania or cocoyam, *Xanthosoma* spp.) are discussed. Existent research centers in L.A , Africa and Oceania that could coordinate regional research work through technical support are listed. Suggestions (economic, nutritional and agricultural aspects) are given for utilization of this production in developing countries. An annex lists research networks for introducing improved var. The justification and background, objectives, activities and methods of 3 network projects are discussed. (1) increasing production in Central and E. Africa through testing of superior var., (2) better cassava yields in Central

America through testing of superior var., and (3) superior Brazilian var. as a means of increasing production in Paraguay, the Caribbean, Indonesia and Pacific Islands. (*Summary by T.B.*) J00

0453-10431 WASSA, N.M. **Contribution à l'étude agro-économique de la culture du manioc au Zaïre.** (*Contribution to the agro-economic study of cassava cultivation in Zaire*). Thèse Ing. Agr. Yangambi, Congo, Université Nationale du Zaïre. Faculté des Sciences Agronomiques, 1974 160p. Fr., Sum Fr., 48 Refs., Illus.

Cassava History. Plant geography. Cultivation. Production. Cultivars. Socio-economic aspects. *Xanthomonas manihotis.* **Economics. Marketing.** Yield components. **Adaptation. Zaire.**

Cassava is the most important staple in Zaire since it can be grown throughout the year; in addition its by-products generate employment. The historical development of cassava production is presented, together with aspects of climatic and edaphic requirements, geographic distribution, pathology and agronomic practices. Although national demand has increased in the last 10 yr, it has been affected by rural migration and displacement of labor to nonagricultural activities due to low economic incentives and fluctuations in prices. Other limiting factors are inadequate cultural practices, CBB, degeneration of clones, exploitation by middlemen and scarcity of labor. The following recommendations are made: to reorganize existing cooperatives, create new markets and improve the efficiency of the system of commercialization so that the farmers' income is increased and protected. Production should be increased through the use of improved, early-maturing var. with a high starch content, well adapted to different soils and more resistant to diseases and pests. (*Summary by M.R.T. Trans. by T.B.*) J00

0454-11742 MONTALDO, A. **La yuca o mandioca; cultivo, industrialización, aspectos económicos, empleo en la alimentación animal, mejoramiento.** (*Cassava: cultivation, industrialization, economic aspects, use in feedstuffs, improvement*). San José, Costa Rica, Instituto Interamericano de Ciencias Agrícolas de la OEA, 1979. 386p. Span., 611 Refs., Illus.

Cassava. Taxonomy. Production. Plant geography. Plant anatomy. **Composition. Cultivation systems. Plant breeding. Diseases and pathogens. Injurious insects. Injurious mites. Storage. Uses. Industrialization. Socio-economic aspects. Cassava products. Processing. Human nutrition. Animal nutrition.**

An overview is presented with regard to the production of cassava (most of the references are prior to 1974). An analysis is made of the problems that need to be investigated in each area; in some cases the Venezuelan situation is emphasized. Chapter 1 deals with synonymy and common names; 2 - History, origin and present geographic distribution; 3 - Botany (taxonomy, morphology, anatomy, growth cycle); 4 - Chemical composition, nutritive value and toxicity; 5 - Environmental factors (light, photosynthesis, photoperiod, rainfall, temp, wind); 6 - Ecology; 7 - Soils and fertilizers; 8 - Cultivation (production systems, cultural practices, mechanization, selection and multiplication of propagation material, control of weeds, diseases and pests, planting and harvesting dates); 9 - Genetics and improvement (flowering, cytology, sterility and fertility, mutations, objectives of breeding programs and methods used); 10 - Viral, bacterial and fungal diseases, insect and mite pests, nematodes and other pests; 11 - Storage with emphasis on postharvest losses; 12 - Cassava products for domestic and industrial use, as well as feedstuffs; 13 - Processing of flour, meal, pellets and starch including factory installation requirements; 14 - Cassava-based feedstuffs (meal, leaf meal, silage, fresh roots) for poultry, swine and ruminants; 15 - Economic aspects. A glossary of terms is also included. (*Summary by T.B.*) J00

0455-4042 FUKUDA, C. **Anteprojeto de implantação do Centro Nacional de Mandioca.** (*Preliminary proposal for establishing the National Cassava Program in Brazil*). Brasilia, Empresa Brasileira de Pesquisa Agropecuária, 1975. 57p. Port., 34 Refs.

Cassava. Cassava programs. Developmental research. Production. Maps. Brazil.

Because of the importance of cassava for food, forage and industrial purposes, as well as its socioeconomic value, a study was made of regions that would be ideal for its cultivation. Based on climatic conditions, topography, location, transportation facilities, inventory of human and material resources and utilization of the roots, the commission selected the 3 most appropriate sites for research and training: Sete Lagoas (MG), Campinas (SP) and Cruz das Almas (BA). A detailed analysis is presented of each. Satellite operations would be carried out at Belém (PA), Pacajús (CE), Glória do Goitá (PE), Itabuna (BA), Linhares (ES), Indaial (SC) and Taquarí (RS). Crops to be studied in association or rotation with cassava are maize, soybeans, peanuts, sweet potatoes and yams. Personnel requirements and research divisions are given in accordance with an organization model similar to that used by EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária) for its other divisions. (*Summary by T.B.*) J00

0456-11231 SILVA, J.R. DA **Some aspects of cassava production in Brazil.** Brasilia, Brasil, Empresa Brasileira de Assistência Técnica e Extensão Rural, 1979. 25p. Engl., Illus.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979.

Cassava. Cassava programs. Cultivation. Production. Marketing. Tuber productivity. Economics. Brazil.

In 1978 Brazil produced 25 million t cassava roots, 53.5% of which came from the NE region. Av productivity is 12.8 t/ha (8.3-21.1 t). A comparative analysis is made of the traditional (no technical assistance) and recommended (used by farmers receiving assistance) production systems in the NE. Aspects dealt with include soil (conservation, physicochemical characteristics), cultural practices (preparation of the land, planting depth, selection and preparation of cuttings, planting position, fertilization, weed control), planting date and systems, control of ants (*Atta* sp. and *Acromyrmex* sp.) and the hornworm (*Erinnyis ello*). Diseases are not of importance in this region. In the Cerrado region of Minas Gerais, characterized by unfertile Latosols, cassava is being planted by large companies for supplying a local alcohol distillery. Important limiting factors are CBB, *E. ello*, the use of unadapted cv., poor-quality planting material and the lack of experience in completely mechanized operations. Technical assistance is just beginning to be provided in this region. Aspects of rural credit discussed include govt. minimum price policies (US$19.40/t roots in 1978; flour prices depend on quality, av $0.12/kg), public and private financing available for purchasing machinery and equipment and crop costs (formula given for calculating amount available/ha). Commercialization is characterized by fluctuating prices, the active participation of middlemen between the farmer and the wholesaler, and little advantage taken by the farmer of the minimum price policy. Socioeconomic strategies of action are regional; an example is given of that used by EMBRATER-Santa Catarina. (*Summary by F.G. Trans. by T.B.*) J00

0457-11236 DIAZ D., R.O. **Experiences in La Colorada.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1979. 8p. Engl.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979.

Cassava. Socio-economic aspects. Cassava programs. Colombia.

An analysis is made of the sociocultural, technical and economic implications in the transfer of technology, based on experiences acquired with cassava farmers from the community of Media Luna, located on the Atlantic Coast of Colombia. It is concluded that the technician must assimilate the life style of the community in order to transmit the technology under the same conditions. Of the sociocultural aspects, the religious, political and folkloric ones are the most important. New technology should be in line with traditional practices, which should be evaluated initially. All technology that represents an increase in income for the same cost will have immediate acceptance; thus a promising high-yielding var. should be introduced. Cultural practices should be demonstrated and taught in the form of suggestions. (*Summary by T.B.*) J00

0458-11234 COCK, J.H. **Criteria for design of a new technology.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1979. 10p. Engl.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979.

Cassava. Cassava programs. Developmental research. Colombia.

The criteria for technology design are as follows: suitable for areas presently marginal for agricultural production, low inputs; give a nonperishable product for transportation; simple to transfer and easy to manage, requiring minimal changes in the traditional system. Some problems that are being dealt with include low yield and yield potential, control of diseases, pests and weeds, inadequate agronomic practices, HCN content, rapid postharvest deterioration and nutritional quality. (*Summary by F.G. Trans. by T.B.*) J00

0459-11237 DIAZ D., R.O. **El cultivo de la yuca en La Colorada, Media Luna.** (*Growing cassava in La Colorada, Media Luna*). Cali, Colombia, Centro Internacional de Agricultura Tropical, 1979. 26p. Engl., Illus.

Paper presented at Workshop on Pre-release Testing of Agricultural Technology, Cali, Colombia, 1979

Cassava. Cultivation. Production. Socio-economic aspects. Cultivars. Tuber productivity. Soil analysis. Inter-cropping. Rotational crops. Costs. Income. Labour. Marketing. Colombia.

A detailed socio-economic description is given of this rustic farm community on the Atlantic Coast of Colombia; where cassava is the main source of income. Av temp is 28°C, annual rainfall 1556 mm; the sandy soils (pH 5.5-6) have $<$ 1% OM, $<$ 15 ppm P and $<$ 0.15 meq K/g. Since 1960 the farmers have had contact with several agricultural institutions including the Instituto Colombiano Agropecuario and CIAT, which 1st held regional trials there in 1974. In 1977 the validation of technology was begun based on the results of these trials. The preferred var. is Venezolana (av yield 7 t). Cassava is usually planted in association with maize, cowpeas or sesame, according to the time of year; when planted alone, a ground cover (*Citrullus vulgaris*) is usually used. The most profitable association is cassava-maize-sesame. Some farmers practice crop rotation with sesame every 2-4 yr or leave the land planted to guinea grass (*Panicum maximum*) 1½-3 yr. Pests of importance are termites, mites and the whitefly *Aleurotrachelus* sp.; diseases are white and brown leaf spots, CBB and superelongation. Cassava is used for on-farm consumption including animal feed and is sold on a nearby market for starch. Prices fluctuate, being higher in the rainy season when the farmer is planting and lower when he is harvesting. (*Summary by T.B.*) J00

0460-10911 DAHNIYA, M.T. **Root and tubers in lowland humid tropics farming systems.** Ibadan, Nigeria, International Institute of Tropical Agriculture, 1978. 7p. Engl., 6 Refs.

Paper presented at the Regional Root and Tuber Crop Improvement Workshop, Freetown, Sierra Leone, 1978.

Cassava. Yams. Sweet potatoes. Cocoyams. Production. Productivity. Inter-cropping. Shifting cultivation. Cassava programs. Nigeria.

The importance of cassava, yams, sweet potatoes and cocoyams is analyzed, with emphasis on cassava which is of particular use in the lowland humid tropics because of its adaptability to these conditions Of the 11 million ha planted to cassava in the world, 52.2% are in Africa, but only 40% of the production (41 million t) comes from there. Av production in Africa is 6.9 t/ha (vs. 12.3 t/ha in S. América). Most of the crops in these regions are grown at the subsistence level in very complex farming systems with a combination of root crops, tree crops, cereals and vegetables, and others under mixed intercropping in shifting cultivation systems. The role of root and tuber crops and research guidelines are discussed briefly. (*Summary by F.G. Trans. by T.B.*) J00

See also *0056* *0073* *0087* *0121* *0125* *0320* *0341* *0370* *0377* *0380* *0467*

K01 Rotational Schemes and Intercropping

0461-4876 ODURUKWE, S.O. **Cropping systems research at the National Root Crops Research Institute.** *In* Ene, L.S.O. *et al.*, eds. National Seminar on Root and Tuber Crops, 1st., Umudike, Nigeria, 1977. Proceedings. Umudike, National Root Crops Research Institute, 1978. pp.102-112. Engl., 10 Refs.

Cassava. Shifting cultivation. Inter-cropping. Fallowing. Soil fertility. Tuber productivity. *Dolichos.* **Maize. Yams. Dung. Calcium. Nigeria.**

Research on cropping systems done at the Umudike Research Station (Moor Plantation) from 1923 to date is summarized. Current projects have 2 phases: continuous and mixed cropping The former tests the minikits of the single crop program under a system of intensive cropping in which yams, cassava and maize are each grown continuously for 3 yr on the same plot, which is then tested in a 3-yr rotation scheme. This will be compared with the basic rotation of yams followed by maize and then cassava. Another aspect being studied is NPK fertilization vs. compost for continuous cropping of cassava. In the 2nd group of expt, spacing arrangements and levels of fertilizer requirements for optimum yield are being determined. At present maize is intercropped with yams, cassava or cocoyams Aspects of farmer acceptance and the multidisciplinary approach to these problems are also discussed. (*Summary by T.B.*) K01 D03

0462-9938 MOHAN KUMAR, C.R. **Intercropping in cassava.** *In* Hrishi, N. and Gopinathan Nair, R., eds. Cassava production technology. Trivandrum, India, Central Tuber Crops Research Institute, 1978. pp.25-30. Engl., Illus

Cassava. Intercropping. Maize. Tuber productivity. Economics. Field experiments. India.

Factors to be taken into account when considering intercropping with a long-duration crop are outlined. Most cassava in Kerala is grown in monoculture. Cultural and fertilizer requirements are given for cassava when intercropped with peanuts, mung beans, maize, soybeans and sunflowers. Best results were obtained with peanuts, giving ca 25% more returns than the control (cassava monoculture) (*Summary by T.B*) K01

0463-4213 MALAYA RUBBER RESEARCH INSTITUTE. **Banana and tapioca as intercrops in immature rubber.** Planter's Bulletin of the Rubber Research Institute of Malaya no. 123·202-212. 1972. Engl.

Cassava. Intercropping. Cultivars. Cultivation. Economics. Weeding. Insect control. Disease control. Productivity. Costs. Statistical analysis.

The following aspects of intercropping cassava with rubber are discussed: var. used (bitter types - Black, Yellow and Green Twig; sweet types - Medan and Jurai), selection of stem cuttings, land preparation, spacing, postplanting care, topping, yield (9-19 t/ac) and returns. It is concluded that in the short run, intercropping cassava is profitable, but has a slight effect on rubber tree

growth when spaced 4-5 ft from the rubber. Nevertheless, this practice is not generally recommended since the long-term effects on soil depletion and rubber tree growth need to be determined. (*Summary by T.B.*) K01

0464-6250 HART, R.D. **A bean, corn and manioc polyculture cropping system. I. The effect of interspecific competition on crop yield.** Turrialba 25(3):294-301. 1975. Engl, Sum. Engl., Span., 4 Refs., Illus.

Cassava. Intercropping. Cultivation systems. Maize. Beans. N. P. K. Weeding. Timing. Productivity. Field experiments. Costa Rica.

Beans, maize and cassava were planted in monoculture and 3 polyculture cropping systems, which consisted of (1) a succession polyculture in which the 3 crops were all planted at the same time and harvested after 9, 18 and 36 wk, respectively; (2) a reverse polyculture in which cassava was planted alone and then interplanted with maize after 18 wk and beans after 27 wk and all crops harvested after 36 wk; and (3) an intensive polyculture in which 4 bean crops, 2 maize crops and 1 cassava crop were all interplanted during a 36-wk period Four treatments consisting of the factorial product of 2 fertilizer treatments (no fertilizer and an initial application of 222, 169 and 40 kg NPK/ha, respectively) and 2 weeding treatments (no weeding and weeding every 6 wk) were applied to the 3 mono- and 3 polycultures, as well as to a natural vegetation cropping system that consisted of the invading weeds The effect of the fertilizer and weeding treatments on yield was not the same in the mono- and polyculture cropping systems. Interspecific competition in the succession polyculture resulted in a dynamic interaction between bean and maize yield. When fertilizer was applied to the polyculture, maize yield increased and bean yield decreased. (*Author's summary*) K01 D03

0465-7220 HART, R.D A bean, corn and manioc polyculture cropping system. II. A comparison between the yield and economic return from monoculture and polyculture cropping systems. Turrialba 23(4) 377-384. 1975. Engl, Sum. Engl., Span, 21 Refs., Illus

Cassava. Beans. Maize. Intercropping. Field experiments. Productivity. Weeds. Prices. Economics. Fertilizers. Costa Rica.

An expt in which beans, maize and cassava were planted in monoculture and polyculture systems in described in Part I Results were used to compare the yield and economic returns, which were significantly higher from the poly- than from the monocultures. The net economic return from the succession polyculture, which had been designed as an analog to leaf, stem and root biomass compartmentalization during natural succession was higher than from the 2 other polycultures The succession polyculture was evaluated by comparing it with a hypothetical monoculture rotation cropping system using the same 3 crops. Yield and net economic return were 37 and 54% higher, respectively, than from the monoculture rotation cropping system (*Author's summary*) K01

0466-10458 EKPETE, D.M. **Fertilizer responses under mixed cropping in Nsukka, Nigeria.** East African Agricultural and Forestry Journal 42(1) 18-59. 1976 Engl, Sum Engl., 8 Refs

Cassava. Intercropping. Fertilizers. Productivity. Maize. N. P. K. Nigeria.

In field trials, yam and cassava were each grown on an Oxisol, singly or in a mixed cropping

system with maize and maize + okra. The fertilizer formulae 15:15:15 and 10:10:20 were used in addition to the recommended ones of 10:23:3 for yams and its intercrops and 9.28:9 for cassava and its intercrops The fertilizers were added at 0, 250, 500, 750 or 1000 kg/ha. Effects of the treatments on yields of the individual crops and the economics of the treatments are discussed, as well as the residual effects of fertilizers on a sole maize crop following the main crops. Results indicated that fertilizers recommended for sole crops would be more profitable when applied to those sole crops than when applied to mixed crops. (*Summary by Abstracts on Tropical Agriculture*) K01 D01

0467-1208 LAGEMANN, J. **Intensitäten der Bodennutzung in Ölpalmen-Maniok-Betrieben Ostnigerias — das Prinzip der innerbetrieblichen Differenzierung.** (*Intensity of soil utilization on oil palm/cassava farms in Eastern Nigeria — the principle of within-farm differentiation*). Schriften der Gesellschaft für Wirtschafts und Sozialwissenschaften des Landbaues 14:311-322. 1977. Germ., Sum. Germ., 26 Refs.

Cassava. Cultivation systems. Socio-economic aspects. Fallowing. Nigeria.

Due to increasing population, different intensities of land use have developed in oil palm/cassava farms in E. Nigeria. Decreasing soil fertility has led to more intensive cultivation on fields located near farmers' homes. Extensive agriculture in the outlying areas led to decreased soil fertility and crop yields, which were dependent on the length of the fallow period. It is suggested that this process of impoverishment in the rural areas can be improved by adopting the landlord method of combining perennial and annual crops and the intensive use of fertilization. (*Author's summary. Trans. by D.E.L.*) K01 J00

0468-11208 FA'ANUNU, H.O. **Traditional aspects of root crop production in the Kingdom of Tonga.** *In* Regional Meeting on the Production of Root Crops. Nouméa, New Caledonia. South Pacific Commission. Technical Paper no. 174. pp.191-199. Engl., 12 Refs

Cassava. Starch crops. Cultivation systems. Tonga.

The traditional cropping system — planting yams (*Dioscorea* spp.) + giant taro (*Alocasia macrorrhiza*), sweet potatoes, taro (*Colocasia esculenta*), cassava and bush fallow — is reviewed. The different var. or types used, cultural practices, pests and disease problems are discussed. Cassava is commonly planted in pairs (6-12 in cuttings) at an angle $\leq 45°$ at 36-40 in. intervals on ridges 40-50 in. apart. Surplus roots are chipped and sun dried for making a native bread. The starch of a bitter var. is used as an adhesive for gluing pieces of tapa cloth together. Large quantities of cassava are being used for feed, particularly for pigs. Mites (*Tetranychus* spp.), scales (*Saissetia nigra*) and brown leaf spot (*Cercosporidium henningsii*) are present but of minor importance. (*Summary by T.B.*) K01

0469-11649 ESCOBAR, C.R. **Análisis del crecimiento y rendimiento del camote en monocultivo y en asociación con fríjol, maíz y yuca.** (*Analysis of sweet potato growth and yield in monoculture and in association with beans, maize and cassava*). Tesis Mag. Sc. Turrialba, Universidad de Costa Rica. Centro Agronómico Tropical de Investigación y Enseñanza, 1975. 81p. Span., Sum. Span., Engl., 48 Refs., Illus.

Cassava. Sweet potatoes. Beans. Maize. Intercropping. Productivity. Field experiments. Growth. Timing. Costa Rica.

Growth and yield of sweet potato var. C-15 were studied in monoculture and in association with beans, maize and cassava; and the associations were classified according to their influence on SP at the Centro Agronómico Tropical de Investigación y Enseñanza in Turrialba, Costa Rica. A randomized block design was used with the following treatments: SP in monoculture, SP + beans (B), + maize (M), + cassava (C) and a triple association (SP + M + B). Periodic samplings were taken of a great no. of plants grown in 90 m² plots. Comparisons between variables were made by t-test. Physiological and morphological variables were determined every 30 days while the SP plants were in the field. Yield analysis included the no. and wt of tubers/plant and tuber yield/ha. It was concluded that the association of SP plants with the other species retarded its growth and tuberization. The associations SP + B and SP + C permitted a growth of the SP plants similar to that of the monoculture in terms of periodic increase in biomass in the organs whereas maize produced detrimental effects on SP plant growth SP yields were correlated with the growth pattern of the plants; nevertheless, it was found that the growth tendencies were similar in all associations, but periodic increases in biomass tended to diminish when the plants were grown in association. The length of the main stem cannot be used as a parameter to represent SP plant growth since it was the same for all treatments at 60 and 90 days. (*Author's summary*) K01

0470-10449 OKIGBO, B.N. **Cropping systems and related research in Africa.** Ibadan, Nigeria, Association for the Advancement of Agricultural Sciences in Africa. Occasional Publications Series-OT-1. 1978. 81p. Engl., 106 Refs., Illus

Cassava. Cultivation systems. Inter-cropping. Rotational crops. Nutritional requirements. Soil requirements. Soil fertility. Ecology. Productivity. Africa.

An ample review is presented of the traditional cropping systems in Africa including general characteristics of each region (W., Central and S., E. and N. Africa, Egypt) It was found that (1) multiple cropping (2-3 or more crops/yr) exists in traditional farming systems in Africa but is an exception, not being as prevalent as in SE Asia. (2) The most widespread system consists of mixed cropping in which several species of annuals and perennials are developed on compound farms to form a complex, fairly stable agroecosystem. (3) Intercropping involves small areas of a few pure stands of crops in addition to relay cropping Research results indicate that these factors should be taken into account in intercropping research: plant populations of the component crops, length of the growing season, plant structure, relative duration of the life cycles of the component crops, nutrient requirements, planting pattern and soil fertility. The overall advantages and disadvantages of intercropping are analyzed. (*Summary by I.B. Trans. by T.B.*) K01

0471-11786 LIRA, M. DE A. *et al.* **Consórcio de milheto com mandioca.** (*Cassava/pearl millet associations*). Pesquisa Agropecuária Pernambucana 2(2).137-146. 1978. Port., Sum. Engl, Port., 10 Refs.

Cassava. *Pennisetum typhoides*. Inter-cropping. Field experiments. Spacing. Planting. Timing. Soil analysis. Tuber productivity. Brazil.

A 2-yr intercropping expt with cassava and pearl millet (*Pennisetum typhoides*) was conducted on a laterite soil of a semiarid zone of the state of Pernambuco, Brazil, using a randomized block design with subdivided plots. Four systems were studied on the main plots: cassava alone, 2/3 cassava + 1/3 pearl millet, 1/3 cassava + 2/3 millet, and millet alone; 3 populations were used in the subplots The cassava was harvested at 18 mo and the millet intercropped during the 2 yr. Intercropping is not recommended for the 2nd cassava yr; further studies need to be done for the 1st yr. (*Author's summary*) K01 D03

See also 0087 0147 0241

Z00 GENERAL

0472-10471 THAMPAN, P.K. **Cassava.** Trichur, Kerala Agricultural University, 1979. 242p Engl., 303 Refs., Illus.

Cassava. History. Plant geography. Economics. Human nutrition. Leaves. Proteins. HCN content. Toxicity. Cultivars. Plant breeding. Hybridizing. Cultivation. Intercropping. Nutritional requirements. Injurious insects. Insect control. Diseases and pathogens. Disease control. Uses. Harvesting. Productivity. Food products. Feeds and feeding.

The author has compiled the results of research on cassava, with emphasis on India. The 1st chapter includes general subjects such as origin, distribution, economic importance, the role of cassava in human nutrition, the leaves as a source of protein and as a non-mulberry silkworm feed, and HCN content and toxicity. Chapter 2 deals with adaptation including climatic and soil requirements, growth characteristics of the different plant parts and the influence of growth regulators on plant development. Chapter 3 deals with var., var. improvement through intervar. and interspecific hybridization as well as through polyploidy, and improvement of productivity through grafting. Agronomic practices, intercropping, mineral nutrition and fertilization, harvesting of roots and forage, storage and yields are dealt with in chapters 4-6. Pests and control measures described include the whitefly, mites, scale insects, hornworms, thrips, grasshoppers, white grubs, stemborers, termites, rats and stored products pests. A description of the field symptoms, method of dissemination, preventive measures and selection of tolerant var. are discussed for the following diseases: CBB, brown leaf spot, white leaf spot, Alternaria leaf spot, concentric-ring leaf spot, Phomopsis blight, anthracnose, superelongation, root rot (*Phytophthora* spp) and AMD. The uses of cassava in food products, as well as for commercial purposes, are dealt with in the last 2 chapters (*Summary by T.B.*) Z00

0473-4027 CURIEL N., F. and VELASQUEZ R., E.J. **Técnicas para la producción de yuca.** (*Techniques for cassava production*) Caracas, Venezuela, Ministerio de Agricultura y Cría. Centro Nacional de Investigaciones Agropecuarias, Región Nor-Oriental, 1977. 52p. Span , 21 Refs., Illus.

Cassava. Taxonomy. *Manihot*. Plant anatomy. Climatic requirements. Bitter cassava. Cultivars. Sweet cassava. Soil requirements. Land preparation. Cuttings. Storage. Planting. Injurious insects. Diseases and pathogens. Trade. Production. Costs. Industrialization. Venezuela.

This manual on cassava production for the state of Monagas deals with climatic requirements, characteristics of sweet and bitter cassava var., soils, soil preparation, plant material, planting, manuring, weeds, pests and diseases, harvesting, commercialization and industrialization, and production costs. (*Summary by Abstracts on Tropical Agriculture*) Z00

0474-4418 PAERELS, J.J. **Cassave; cultuur en industrie in Nederlandsch-Indië.** (*Cassava: cultivation and industrialization in Indonesia*). Nederlandsch-Indië Oud & Nieuw 4(12):355-372. 1920 Dutch , Illus.

Cassava. Cultivation. Processing. Cassava products. Indonesia.

A detailed report is given on the history, cultivation and processing of cassava in Indonesia. Starch (tapioca) and meal (gaplek) are the most important products, the processing of which is outlined. Data are also given on the export of these products. (*Summary by J.V.*) Z00

0475-4729 BLOKZEIJL, K.R.F. **De cassave.** (*Our colonial agriculture. IX. Cassava*). Haarlem, Holland, H.D. Tjeenk Willink & Zoon, 1916. 76p. (Onze Koloniale Landbouw no. 9). Dutch, Illus.

Cassava. Cultivation. Injurious insects. Processing. Cassava products. Marketing. Indonesia.

In this handbook many different aspects of cassava in Indonesia are described, including its history, cv., selection, soils, climates, land preparation, planting, planting material, cultural practices, important pests and diseases (*Lytta, Monolepta quadripunctata, Acosmeryx ancea, Lecanium, Pinnaspis, Aleurodes, Leucopholis rorida, Lepidiota stigma, Tetranychus bimaculatus*), harvesting, yields and chemical composition of the roots The preparation of several cassava products (gaplek, tapioca flakes and pearls, and wastes) is described in detail. Data are given on production and trade for 1911-15. (*Summary by J.V.*) Z00

0476-4752 LEATHERDALE, D. **Cassava thesaurus.** Cali, Colombia, Centro Internacional de Agricultura Tropical, 1977. 145p. Engl.

Cassava. *Manihot esculenta.* **Thesauri. Reference materials.**

This structured vocabulary of terms related to cassava is divided into 2 sections: a categorized listing, giving the main relationships among the terms; and an alphabetical listing, giving the full array of relationships among the descriptors. The thesaurus was developed in order to assist the Cassava Information Center at CIAT in indexing and retrieving the large mass of cassava literature. (*Summary by Abstracts on Tropical Agriculture*) Z00

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0011 0311 0314 0315

CLIMATIC REQUIREMENTS
0011 0057 0058 0063 0098 0139 0386
0422 0473
GROWTH
0068 0089 0133 0144
PRODUCTIVITY
0054 0070 0102 0127 0131 0133 0141
0144 0165 0424 0464

CLONES
0302

COCOYAMS
0124 0126 0460

COELOSTERNUS GRANICOLLIS
0063

COLOMBIA
0015 0017 0032 0051 0061 0110 0115
0129 0135 0137 0139 0153 0159 0212
0264 0265 0266 0267 0270 0279 0283
0292 0338 0351 0354 0355 0359 0380
0386 0412 0416 0423 0424 0426 0431
0439 0442 0447 0450 0457 0458 0459

COMPOSITE FLOURS
0319 0376 0395

COMPOSITION
0026 0027 0034 0048 0056 0063 0071
0075 0081 0096 0111 0113 0116 0135
0139 0166 0170 0209 0281 0295 0303
0318 0352 0358 0396 0454
CASSAVA FLOUR
0040 0389 0394 0395 0398
CASSAVA MEAL
0320 0335 0340 0349 0354 0359
CASSAVA STARCH
0174 0331 0362 0394
LEAVES
0021 0022 0033 0037 0040 0046 0088
0097 0105 0169 0233 0246 0247 0258
0317 0335 0340 0341 0353 0368 0472
STEMS
0022 0023 0033 0046 0169 0368
TUBERS
0021 0023 0033 0037 0039 0040 0041
0042 0044 0045 0046 0076 0079 0088
0169 0288 0331 0339 0354 0362 0367
0368 0378

CONCENTRATES
0338

CONGO
0202 0219 0237 0242 0261

COOKING
0317 0362 0383

COPPER
0084 0087 0096 0333

COPTOTERMES
0260 0423

CORTEX

COMPOSITION
0368
HCN CONTENT
0368
USES
0337

CORYNEBACTERIUM
0399

COSTA RICA
0059 0071 0241 0464 0465 0469

CRETINISM
CLINICAL MANIFESTATIONS
0329

CROSSBREEDING
0299 0306

CUBA
0062 0340

CULTIVARS
0010 0022 0031 0039 0041 0046 0049
0055 0056 0057 0058 0059 0061 0068
0071 0083 0126 0135 0136 0163 0185
0199 0201 0210 0220 0232 0233 0244
0247 0248 0249 0257 0288 0289 0299
0315 0352 0369 0463 0473
ADAPTATION
0453
GERMPLASM
0171 0211 0266 0290 0294 0304 0313
IDENTIFICATION
0009 0062 0088 0169 0294 0448
SELECTION
0037 0184 0198 0211 0266 0293 0297
0298 0302 0303 0307 0308 0310
STARCH PRODUCTIVITY
0087 0116 0165 0166 0174 0423
TUBER PRODUCTIVITY
0021 0023 0027 0032 0067 0073 0076
0078 0079 0080 0086 0087 0088 0090
0115 0121 0122 0131 0146 0148 0152
0164 0165 0166 0169 0171 0172 0174
0177 0298 0308 0310 0423 0459
TOXICITY
0063 0472

CULTURE MEDIA
0011 0012 0013 0031 0033 0206 0235
0399 0400 0401

CUTTINGS
0057 0058 0059 0062 0275
GERMINATION
0129 0139 0144 0151 0424
TIMING
0139 0151
PROPAGATION
0119 0125 0134 0139 0153 0157 0158
0423 0424
ROOTING
0030 0135 0139
SPACING
0056 0061 0113 0117 0118 0120 0123
0138 0139 0140 0157
STORAGE
0052 0115 0129 0151 0423 0424 0473
TUBER PRODUCTIVITY
0024 0113 0117 0118 0119 0120 0128
0131 0144 0423 0424

CYANIDES
0034 0035 0037
THIOCYANATES

0318 0329 0368
TOXICITY
0329 0368
TOXICOLOGY
0368

CYANOGEN
0369

CYANOGENIC GLYCOSIDES
0034 0035 0043 0281 0325 0329 0368

CYTOGENETICS
0297 0315

DETERIORATION
0281
TUBERS
0019 0076 0178 0368

DETOXIFICATION
0367 0394

DEVELOPMENTAL STAGES
0130
BRANCHING
0015 0023 0025 0028 0078 0157 0424
FLOWERING
0025 0028
GERMINATION
0129 0139 0144 0151 0308 0424
ROOTING
0030 0135 0139
TUBER DEVELOPMENT
0020 0024 0113 0295

DIETS

DIETARY VALUE
0334 0343 0355 0368

NUTRITIVE VALUE
0322 0331 0343

DIGESTIBILITY
0335 0339 0348 0358 0368
CASSAVA MEAL
0333 0334
CASSAVA STARCH
0362

DISEASE CONTROL
0054 0061 0123 0163 0192 0463 0472
BACTERIOSES
0181 0183 0185 0188 0189 0191 0195
0198 0212 0213 0216 0217 0218 0219
0225 0228 0229 0231
MYCOPLASMOSES
0188
MYCOSES
0181 0185 0188 0189 0191 0238 0258
VIROSES
0012 0181 0183 0185 0188 0189 0231
0245 0251 0253

DISEASE TRANSMISSION
0206 0250 0252
VECTORS
0245

DOMINICAN REPUBLIC
0061 0280 0348 0353 0360

DRIED TUBERS
0040 0335 0346 0351 0375 0384 0385
0386 0396

DRYING
0424
CASSAVA CHIPS
0346 0384 0385 0386 0396
CASSAVA FLOUR
0384 0394
CASSAVA STARCH
0384 0394
PELLETS
0384
WATER CONTENT
0396

ECOLOGY
0208 0221 0408 0451 0464 0470

ECUADOR
0358 0369

EGGS
0363

ENDEMIC GOITRE

CLINICAL MANIFESTATIONS
0327
ETIOLOGY
0327

ERINNYIS ELLO
0059 0063 0163 0270
BIOLOGICAL CONTROL
0264 0265 0279 0280 0283 0423 0424
BACILLUS THURINGIENSIS
0264 0265
POLISTES
0264
TRICHOGRAMMA MINUTUM
0264 0265
INSECT AGENTS
0264 0265 0274 0279 0280 0283 0423
INSECT CONTROL
0181 0187 0264 0265 0279 0283 0423
0424

ERWINIA CAROTOVORA
0196 0202 0212

ERWINIA CASSAVAE
0189 0215 0423

ETHANOL
0163 0370 0372 0381 0388 0393 0415
0419 0420 0421

EUDIPLOSIS BRASILIENSIS
0274
INSECT CONTROL
0187

FACTORIES
0370

FATTENING

SWINE
0344 0349 0351 0358 0359

FEED CONSTITUENTS
0337 0344 0345 0346 0347 0349 0353
0355 0357 0359 0360 0361 0363 0365
0366 0368

FEED MIXTURES
0342 0350

FERMENTATION
0368 0370 0371 0400

FERMENTED PRODUCTS
0176 0320 0326 0337 0370 0371 0372
0381 0388 0390 0393 0394 0399 0404
0415 0419 0420 0421

FLOWERING
0025 0028

FLOWERS
0008 0289 0315

FOLIAGE
0110 0352

FOOD PRODUCTS
0319 0325 0326 0329 0369 0376 0378
0379 0382 0383 0391 0404 0472

FORAGE
0338 0341 0348 0351 0353 0356

FUSARIUM

DISEASE CONTROL
0189

GARI
0382 0404
COMPOSITION
0378
HCN CONTENT
0325 0378
INDUSTRIAL MACHINERY
0391
MECHANIZATION
0415
PROCESSING
0378 0415

GELATINIZATION
0174

GERMINATION
0308
CUTTINGS
0129 0139 0144 0151 0424
TIMING
0139 0151

GERMPLASM
0007 0093 0171 0211 0219 0266 0290
0294 0295 0300 0301 0304 0309 0313

GHANA
0228

GLOMERELLA CINGULATA
0181 0190 0237 0242 0244

GLOMERELLA MANIHOTIS
0193 0194

GLUCOSE
0381

GROWTH
0015 0018 0022 0027 0029 0031 0032
0046 0068 0075 0081 0084 0089 0133
0144 0157 0162 0469

HARVESTING
0027 0057 0061 0063 0065 0121 0126
0128 0140 0178 0180 0415 0424 0472
AGRICULTURAL EQUIPMENT
0133 0136 0137 0152 0154 0159
TIMING
0048 0072 0087 0088 0103 0123 0135
0152 0155 0162 0171 0464

HCN CONTENT
0043 0048 0063 0075 0081 0082 0170
0295 0325 0352
CASSAVA CHIPS
0040
CASSAVA FLOUR
0040
CASSAVA MEAL
0354
CORTEX
0368
LEAVES
0040 0088 0169 0233 0247 0258 0368
0472
STEMS
0169 0368
TUBERS
0040 0041 0042 0079 0088 0169 0288
0354 0367 0368 0378 0383

HERBICIDES
0059 0088 0124 0133

HYBRIDS
0289 0294
PRODUCTIVITY
0297 0305
RESISTANCE
0248 0297
SELECTION
0297 0305
TUBER PRODUCTIVITY
0305

HYDROLYSIS
0389
CASSAVA STARCH
0381

INCOME
0073 0087 0403 0451 0459

INDIA
0026 0068 0073 0081 0082 0140 0150
0170 0178 0185 0238 0243 0246 0247
0251 0255 0258 0260 0276 0287 0294
0315 0402 0462

INDONESIA
0009 0067 0117 0118 0119 0120 0121
0166 0167 0207 0474 0475

INDUSTRIAL MACHINERY
0373 0387 0391

INDUSTRIAL STARCHES
0063 0320 0382

INJURIOUS INSECTS
0049 0057 0058 0062 0065 0115 0182
0259 0268 0271 0278 0286 0445 0454
0472 0473 0475
ANASTREPHA MANIHOTI
0181

ANASTREPHA PICKELL
0059 0212 0267 0270 0423 0424
AONIDOMYTILLUS ALBUS
0038 0181 0260 0285 0423
BEMISIA
0059 0180 0184 0251 0257 0260 0270
COELOSTERNUS GRANICOLLIS
0063
COPTOTERMES
0260 0423
ERINNYIS ELLO
0059 0063 0181 0187 0264 0265 0270
0274 0279 0280 0283 0423 0424
EUDIPLOSIS BRASILIENSIS
0187 0274
LEUCOPHOLIS RORIDA
0260
PHENACOCCUS GOSSYPII
0423
PHENACOCCUS MANIHOTI
0261 0263 0269 0275 0276 0277 0281
0282 0424

ZONOCERUS VARIEGATUS
0257 0272

INJURIOUS MITES
0059 0257 0258 0262 0270 0274 0454
MONONYCHELLUS TANAJOA
0266 0273 0424 0451
TETRANYCHUS TELARIUS
0184 0260 0266 0279 0423 0424

INSECTICIDES
0038 0187 0267 0285

INTERCROPPING
0147 0163 0213 0241 0459 0460 0461
0462 0463 0464 0465 0466 0469 0470
0471 0472

IODINE
0329 0330

IRON
0084 0401

IRRIGATION
0049 0085

ISOLATION

DISEASES AND PATHOGENS
0207 0212 0219 0220 0221 0227 0230
0235

KENYA
0227 0250 0252

LABOUR
0121 0123 0391 0459

LAND PREPARATION
0057 0058 0059 0123 0140 0473

MECHANIZATION
0087
TUBER PRODUCTIVITY
0086 0087 0121

LEAF AREA
0015 0018 0029 0032 0162 0313 0424

LEAVES
0009 0010 0015 0016 0029 0031 0032
0037 0078 0123 0162 0185 0197 0205
0210 0215 0234 0251 0252 0263 0265
0275 0290 0323
AMINO ACIDS
0040 0047
ANALYSIS
0040 0046 0047 0223 0233 0258 0368
ANIMAL NUTRITION
0335 0340 0353 0368
HCN CONTENT
0040 0088 0169 0233 0247 0258 0368
0472
MINERAL CONTENT
0021 0022 0033 0040 0096 0105
NUTRITIVE VALUE
0047 0335 0340 0341
PRODUCTION
0341
PROTEIN CONTENT
0040 0088 0340 0341 0353 0368
VITAMIN CONTENT
0040 0246 0317

LEGAL ASPECTS
0375 0405

LEUCOPHOLIS RORIDA
0260

LINAMARASE
0034 0035 0043

LINAMARIN
0034 0035 0043 0368

LOTAUSTRALIN
0368

LYSINE
0350

MAGNESIUM
0046 0071
ABSORPTION
0033

MALAGASY REPUBLIC
0171 0427

MALAYSIA
0086 0341 0346 0363

MANGANESE
0084

MANIHOT GLAZIOVII
0248 0268

MARKETING
0055 0377 0405 0451 0453 0456 0459
0473 0475
CASSAVA CHIPS
0406
CASSAVA FLOUR
0369 0404 0406 0444
GARI
0404
PELLETS
0406 0444
TUBERS
0180 0369

MATURATION
0027

MECHANIZATION
0087 0126 0133 0135 0136 0137 0138
0154 0159 0318 0373 0415

METHIONINE
0350

MEXICO
0058 0316 0357 0434

MITE CONTROL

ACARICIDES
0262
MONONYCHELLUS TANAJOA
0451
TETRANYCHUS TELARIUS
0279

MOLYBDENUM
0082 0084

MONONYCHELLUS TANAJOA
0266 0273 0424 0451

MOULDS
0178

MUTATION
0297

NIGERIA
0066 0070 0091 0099 0124 0125 0126
0138 0183 0184 0192 0208 0209 0210
0211 0213 0216 0225 0230 0231 0256
0257 0259 0272 0291 0292 0301 0304
0309 0312 0318 0322 0325 0326 0335
0337 0377 0378 0438 0460 0461 0466
0467

NITROGEN
0041 0044 0046 0049 0056 0065 0069
0070 0072 0073 0074 0077 0082 0083
0085 0086 0087 0088 0089 0090 0091
0092 0093 0095 0099 0102 0103 0104
0105 0106 0108 0109 0110 0111 0112
0139 0143 0146 0209 0213 0225 0233
0368 0423 0424 0464 0466

NEMATODES
0181 0182 0256

NUTRIENT UPTAKE
0022 0031 0046 0070 0071 0084 0105
0109 0143

OIDIUM
0190 0241

ORGANOLEPTIC EXAMINATION

CASSAVA FLOUR
0319 0321
COMPOSITE FLOURS
0319

PACKAGING
0405

PEELING
0371 0373

PELLETS
0323 0335 0362 0406 0444
INDUSTRIAL MACHINERY
0387
PROCESSING
0368 0384

PERU
0056 0061 0083 0132

PEST DAMAGE
0185 0187 0255 0258 0270 0274 0280
0287

PETIOLES
0009 0215

PH
0034 0043 0071 0080 0097 0110
CASSAVA STARCH
0401

PHENACOCCUS GOSSYPII
0423

PHENACOCCUS MANIHOTIS
0261 0263 0269 0275 0276 0277 0281
0282 0424

PHILIPPINES
0074 0191 0344 0345

PHOMA
0181 0189 0190

PHOSPHORUS
0046 0049 0056 0069 0071 0072 0074
0077 0080 0082 0083 0085 0086 0087
0088 0089 0090 0093 0095 0099 0102
0103 0104 0105 0106 0108 0110 0111
0112 0139 0143 0146 0209 0213 0225
0246 0423 0424 0464 0466

PHOTOPERIOD
0020 0025 0133

PHOTOSYNTHESIS
0032

PHYLLOSTICTA
0181

PHYTOPHTHORA DRECHSLERI
0190

PLANT ASSIMILATION
0018

PLANT GROWTH SUBSTANCES
0011 0012 0013 0020 0026 0028 0030
0139

PLANT HEIGHT
0021 0023 0025 0026 0076 0111

PLANT PHYSIOLOGICAL PROCESSES
0010 0014 0015 0018 0022 0031 0032
0033 0046 0070 0084 0105 0423

PLANT TISSUES
0012 0019 0033 0201 0209 0223 0224
0230 0247

PLANTING
0057 0058 0059 0062 0063 0098 0129
0134 0135 0141 0142
AGRICULTURAL EQUIPMENT
0133 0138 0154
COSTS
0052 0087 0121 0146 0473
LABOUR
0121
MECHANIZATION
0087 0126 0133 0138 0154
SPACING
0018 0054 0055 0056 0061 0072 0092
0106 0113 0116 0117 0118 0120 0133
0138 0139 0140 0145 0146 0148 0149
0157 0160 0241 0471
TUBER PRODUCTIVITY
0072 0086 0087 0088 0113 0116 0117
0118 0119 0120 0121 0122 0127 0128
0131 0146 0148 0149 0150 0160 0175
0424 0471

POLISTES
0264

POLLEN
0008

POLLINATION
0299

POLYPLOIDY
0297 0315

POSTHARVEST LOSSES
0019 0178 0179 0180

POTASH
0086

PRICES
0380 0405 0406 0418 0437 0444 0465

PROCESSING
0055 0063 0180 0281 0369 0377 0378
0379 0383 0392 0415 0445 0451 0454
0474 0475
DRYING
0346 0384 0385 0386 0394 0424

FERMENTATION
0368 0370 0371
PEELING
0371 0373
WASHING
0371

PROPAGATION
0013 0119 0125 0134 0139 0153 0157
0158 0170 0253 0423 0424

PROTEIN CONTENT
0034 0056 0075 0081 0295 0320 0352
0358
LEAVES
0040 0088 0340 0341 0353 0368
STEMS
0368
TUBERS
0040 0041 0044 0088 0368

PROTEIN DEFICIENCIES

DIETS
0322

PROTEIN ENRICHMENT
0321 0354 0401 0402
AMINO ACIDS
0324
FERMENTATION
0400

PROTEINS
0323 0472
AMINO ACIDS
0047 0324 0351
ANALYSIS
0047

DIETARY VALUE
0338 0366
INDUSTRIAL MICROBIOLOGY
0400 0401
PROTEIN ENRICHMENT
0324 0400 0401

PRUNING
0042 0063 0118 0130 0162 0423

PSEUDOMONAS
0185 0214

PULP
0335

PULPING
0342

RESISTANCE
0010 0070 0266 0297 0323
DISEASES AND PATHOGENS
0183 0184 0185 0192 0198 0199 0201
0210 0211 0216 0218 0219 0228 0233
0244 0248 0249 0257 0293 0300 0306
0307 0309 0424 0448
INJURIOUS INSECTS
0184 0257 0263 0269 0423 0424

ROOTING
0030 0135 0139

ROOTS
0126
GROWTH
0015 0022
PRODUCTION
0139

ROSELLINIA
0181 0190

ROTATIONAL CROPS
0055 0147 0163 0459 0470

SULPHUR
0046 0423

SCLEROTIUM ROLFSII
0181

SEED
0232
COMPOSITION
0044

SHIFTING CULTIVATION
0460 0461

SHOOTS
0012 0022 0033 0139 0157 0252

SIERRA LEONE
0113 0404 0432

SILAGE
0351 0354

SILBA PENDULA
0181 0270

SMALL SCALE EQUIPMENT
0385 0386 0391

SMALL SCALE PROCESSING
0385 0386

SOCIO ECONOMIC ASPECTS
0125 0408 0424 0429 0448 0451 0453
0454 0457 0459 0467

SOIL ANALYSIS
0023 0070 0071 0076 0077 0084 0086
0087 0093 0095 0096 0105 0106 0459
0464 0471

SOIL FERTILITY
0077 0082 0083 0093 0100 0103 0104
0112 0253 0386 0461 0470

SOIL IMPOVERISHMENT
0102

SOIL REQUIREMENTS
0054 0055 0057 0063 0071 0076 0077
0082 0083 0084 0086 0087 0095 0097
0102 0103 0110 0143 0163 0422 0470
0473

SOLAR DRYING
0346 0384 0385 0396

SPACING
0018 0054 0056 0061 0072 0092 0106
0113 0116 0117 0118 0120 0123 0133
0138 0139 0140 0145 0146 0148 0149
0157 0160 0241 0471

STAMENS
0011

STARCH CONTENT
0020 0021 0023 0026 0039 0040 0041
0045 0048 0056 0075 0079 0088 0135
0165 0169 0170 0258 0303 0368 0378

STARCH PRODUCTIVITY
0084 0167
CLIMATIC REQUIREMENTS
0165
CULTIVARS
0087 0116 0165 0166 0423
FERTILIZERS
0065 0085 0087
HARVESTING
0087
IRRIGATION
0085

TIMING
0066 0087 0116 0165

STEEPING
0299 0367

STEMS
0009 0022 0031 0033 0129 0197 0212
0215 0224 0252 0285
ANALYSIS
0046 0223 0368
HCN CONTENT
0169 0368
PLANT DEVELOPMENT
0023 0046

STORAGE
0052 0055 0076 0115 0129 0151 0178
0179 0180 0259 0281 0285 0346 0354
0368 0374 0377 0380 0405 0416 0423
0424 0454 0473

SUGARS
0026 0389

SUPERELONGATION
0424

SWINE
0333 0336
FATTENING
0344 0349 0351 0358 0359
FINISHING
0342 0344 0351 0359
LEAVES
0335
PELLETS
0335
TUBERS
0339 0351 0354

TAPIOCA MACARONI
0382

TAPIOCAS

LEGAL ASPECTS
0375
USES
0382

TETRANYCHUS TELARIUS
0184 0260 0266 0279 0423 0424

TEXTILES
0384

THAILAND
0048 0089 0091 0092 0093 0094 0095
0099 0100 0101 0102 0103 0104 0106
0107 0109 0111 0141 0142 0144 0145
0146 0149 0151 0155 0160 0161 0162
0302 0303 0304 0308 0310 0323 0343
0385 0387 0396 0406 0444

THIOCYANATES
0318 0327 0329 0330 0368

TISSUE CULTURE
0013

TOXICITY
0040 0043 0063 0328 0329 0356 0368
0472

TOXICOLOGY
0325 0327 0368

TRADE
0405 0413 0437 0473
CASSAVA CHIPS
0406
CASSAVA FLOUR
0406 0444
PELLETS
0406 0444

TRICHOGRAMMA MINUTUM
0264 0265

TUBER DEVELOPMENT
0020 0024 0113 0295

TUBER PRODUCTIVITY
0021 0023 0024 0026 0027 0032 0048
0066 0067 0069 0070 0072 0073 0074
0075 0076 0078 0079 0080 0081 0084
0085 0086 0087 0088 0089 0090 0091
0093 0094 0096 0097 0101 0103 0105
0107 0108 0110 0111 0113 0116 0117
0118 0119 0120 0121 0122 0127 0128
0130 0131 0132 0143 0144 0146 0148
0149 0150 0152 0155 0160 0162 0164
0165 0166 0167 0169 0170 0171 0172
0174 0175 0177 0255 0298 0305 0308
0310 0377 0423 0424 0437 0456 0459
0461 0462 0471

TUBERS
0009 0014 0023 0031 0032 0033 0037
0068 0144 0159 0373
ANALYSIS
0019 0040 0041 0044 0045 0046 0079
0331 0339 0362 0368 0369 0383
BIOCHEMISTRY
0368
DETERIORATION
0019 0076 0178 0368
DIETARY VALUE
0339 0362 0368
DRYING
0424
HCN CONTENT
0040 0041 0042 0079 0088 0169 0288
0354 0367 0368 0378 0383
NUTRITIVE VALUE
0331 0354
SILAGE
0351 0354

STARCH CONTENT.
0020 0021 0039 0040 0041 0045 0079
0088 0169 0368 0378
STORAGE
0052 0076 0178 0180 0354 0368 0374
0424

UGANDA
0189 0451

UREA
0108

UROMYCES MANIHOTIS
0059 0181 0190 0241

VERTICILLIUM DAHLIAE
0239 0240

VENEZUELA
0154 0262 0274 0298 0349 0352 0414
0451 0473

VIRUS INHIBITION
0250 0253

VISCOSITY

CASSAVA STARCH
0174 0381

VITAMIN CONTENT
0040 0246 0317

WASTE UTILIZATION
0392 0397 0402

WATER REQUIREMENTS(PLANT)
0085 0098

WATER CONTENT

CASSAVA CHIPS
0396
CASSAVA MEAL
0340
LEAVES
0340
STEMS
0129
TUBERS
0044

WEEDING
0054 0055 0059 0061 0063 0087 0088
0121 0124 0132 0133 0149 0424 0463
0464.

WEEDS
0132 0133 0465

XANTHOMONAS CASSAVAE
0196 0197 0200

XANTHOMONAS MANIHOTIS
0180 0184 0186 0193 0194 0196 0199
0201 0204 0206 0207 0208 0209 0211
0215 0220 0221 0222 0223 0224 0225
0227 0230 0293 0300 0307 0364 0423
0424 0453
DISEASE CONTROL
0163 0181 0183 0189 0191 0195 0198
0213 0215 0217 0218 0219 0225 0228
0229
ETIOLOGY
0190 0195 0200 0202 0203 0219

YEAST PRODUCTION
0135 0402

ZAIRE
0195 0229 0245 0256 0263 0269 0275
0277 0327 0330 0411 0453

ZINC
0082 0084 0401 0423

ZONOCERUS VARIEGATUS
0257 0272

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
BAP	6-Benzylaminopurine
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
CF	Cassava flour
CGR	Crop growth rate
CLV	Cassava latent virus
CM	Cassava meal
cm	Centimeter(s)
concd	Concentrated
concn	Concentration
CSL	Calcium stearyl lactylate
C.V.	Coefficient of variation
cv.	Cultivar(s)
2,4-D	2,4-dichlorophenoxyacetic
DM	Dry matter
DNA	Deoxyribonucleic acid
EC	Emulsifiable concentrate
EDTA	Ethylenediaminetetraacetic acid
e.g.	For example
expt	Experiment
exptl	Experimental
°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
IBA	Indolebutyric acid
i.e.	That is
IU	International unit
kat	Katal (amount of enzymatic activity that converts 1 mole of substrate/s)
kcal	Kilogram-calorie(s)
kg	Kilogram(s)
km	Kilometer(s)
KNap	Potassium naphthenate
kR	Kiloroentgen(s)
l	Liter(s) (only in combination with no.)
LAD	Leaf area duration
LAI	Leaf area index
lat.	Latitude
lb	Pound(s)
LD_{50}	Mean lethal dose
LER	Land efficiency ratio
LPC	Leaf protein concentrate
lx	Lux
M	Molar

m	Meter(s)
max	Maximum
ME	Metabolizable energy
meq	Milliequivalent(s)
met	Methionine
mg	Milligram(s)
mho	Reciprocal ohm
min	Minimum, minute(s)
ml	Milliliter(s)
mm	Millimeter(s)
mol wt	Molecular weight
NAA	α-Napthalene acetic acid
NAD	Nicotinamide adenine dinucleotide
NADH	Nicotinamide adenine dinucleotide, reduced form
NAR	Net assimilation rate
NCE	Net CO_2 exchange
nm	Nanometer(s) (10^{-9}m)
no.	Number(s)
NPR	Net protein ratio
NPU	Net protein utilization
OM	Organic matter
oz	Ounce(s)
P	Probability
Pa	Pascal(s)
PCNB	Pentachloronitrobenzene
PDA	Potato dextrose agar
PER	Protein efficiency ratio
pH	Hydrogen ion concentration
pphm	Parts per hundred million
ppm	Parts per million
PSA	Potato sucrose agar
pv.	Pathovar.
resp	Respective(ly)
Rf	Retardation factor - chromatography
RGR	Relative Growth Rate
RH	Relative humidity
RNA	Ribonucleic acid
s	Second
$S_{20,w}$	Sedimentation coefficient corrected to water at 20°C
SBM	Soybean meal
SCN	Thiocyanate
SCP	Single cell protein
SDS	Sodium dodecyl sulfate
sp.	Specie
spp.	Species
SSL	Sodium Stearyl-2-lactylate
t	Ton(s)
TDN	Total digestible nutrients
temp	Temperature
TIBA	2,3,5-Triiodobenzoic acid compound with *N*-methylmethanamine
TLC	Thin-layer chromatography
TMV	Tobacco mosaic virus
TSH	Thyroid-stimulating hormone
UMS	Unmodified cassava starch
UV	Ultraviolet
var.	Variety(ies), varietal
vol	Volume
VPD	Vapor pressure deficit
vpm	Volume per million
wk	Week
WP	Wettable powder
wt	Weight
yr	Year(s)
α	*alpha*
β	*beta*
γ	*gamma*
δ	*delta*
ε	*epsilon*
λ	*lambda*
π	*pi*
ψ	*psi*
/	Per
μ	Micro
%	Percent(age)
>	More than, greater than
<	Less than
≤	Equal to or less than
≥	Equal to or greater than
±	Plus or minus
ϕ	Diameter
≪	Much less than
≫	Much greater than

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CALI – COLOMBIA

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