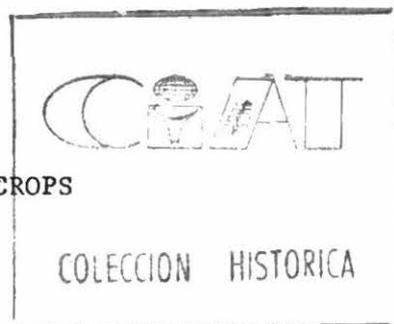


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INTERNATIONAL SOCIETY OF TROPICAL ROOT CROPS

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IV SYMPOSIUM ON TROPICAL ROOT CROPS, Cali, 1976

Programme, Abstracts and Authors

August 2-7, 1976

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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)

Cali, COLOMBIA

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The International Tropical Root Crops Society is holding its IV Symposium at CIAT as from August 2-7 inclusive. In view of the large number of papers submitted, the form of this Symposium is changed from that of the earlier ones in that only selected papers are presented.

The IV Symposium is hosted by the Centro Internacional de Agricultura Tropical and has been supported by both the International Development Research Centre and USAID. The support of these latter two agencies has made the Symposium possible and has allowed a large number of scientists from developing countries to attend. Their support is gratefully acknowledged.

James H. Cock
David A. Evans
Organizing Committee

Sunday, August 1

Arrivals and registration

Monday, August 2

Chairmen: J.H. Cock and F. Martin

08:00 - 09:00

Registration

09:00 - 10:00

Welcome: The Director General, CIAT, J.L. Nickel
The General Manager, Colombian Agricultural
Institute, J. Franco M.
The President, Int. Root Crop Society,
D.G. Coursey
The Governor of the Dept. of Valle,
Raúl Orejuela B.

10:00 - 10:30

Coffee

10:30 - 11:30

"Origin, evolution and dispersal
of root crops"

Jorge León, FAO,
Rome

11:30 - 12:30

Discussion Leaders: D. Coursey, F. Martin
D. Plucknett

12:30 - 14:00

Lunch

14:00 - 14:30

"Cyrtosperma chamissonis (Schott)
Nerr., (Giant Swamp taro), a
little-known Asian-Pacific food
crop"

Donald L. Plucknett (15)

14:30 - 15:00

"A review of sexual propagation for
yam improvement with emphasis on
Dioscorea rotundata"

Sidki Sadik (16)

15:00 - 15:30

"Selected yam varieties for the
tropics"

Franklin Martin

15:30 - 16:00

Coffee

16:00 - 16:30

"Selected and production investi-
gation on edible yams (Dioscorea
spp.) in the Western highlands
of the United Republic of
Cameroon"

S.N. Lyonga

16:30 - 17:00

"Preliminary results on the adap-
tation of cultivated potatoes to
the lowland tropics"

H.A. Mendoza (17)

17:00 - 17:30	"The use of wild relatives in sweet potato breeding"	M. Kobayashi and T. Miyazaki (18)
17:30 - 18:00	"Biology of the yam"	L. Degras
18:00 - 18:30	"Female sterility in <u>Dioscorea rotundata</u> "	E.V. Doku, E. Blay, E. Laing and A. Oppong (19)
18:30 - 19:00	"Cassava breeding in IITA"	S. Hahn
19:00	Informal cocktail party, courtesy Colombian Coffee Federation	

Tuesday, August 3

Chairmen: D.W. Wholey and D. Plucknett

08:00 - 09:00	" <u>Productivity of Root Crops</u> "	R.S. Loomis and H. Rapoport
09:00 - 10:00	Discussion Leaders: B. Okigbo, J. Cock and B.A.C. Enyi	
10:00 - 10:30	Coffee	
10:30 - 11:00	"The interrelationship between source and sink of photosynthates in sweet potato plants"	Y. Hozyo and S. Kato (20)
11:00 - 11:30	"Total dry matter production, tuber yield and yield components of six local cassava (<u>Manihot esculenta</u> Crantz) cultivars in Trinidad"	E.B. Holmes and L.A. Wilson (21)
11:30 - 12:00	"The effect of soil compaction in root and tuber zones on leaf number, leaf area and tuber yield in white lisbon yam (<u>Dioscorea alata</u> L.)"	T.U. Ferguson and F.A. Gumbs (22)
12:00 - 12:30	"Study of the Mukibat system of cassava production"	T.S. Dharmaputra and G.H. de Bruijn (23)
12:30 - 14:00	Lunch	
14:00 - 14:30	"Size of seed yams on yield of individual plants of <u>Dioscorea rotundata</u> "	F.I.O. Nwoke (24)

- 14:30 - 15:00 "Undersowing cassava (Manihot esculenta) with stylo (Stylosanthes guyanensis cv. Schofield) grown under coconut in Bali" I.M. Nitis and M. Suarna (25)
- 15:00 - 15:30 Coffee
- 15:30 - 16:00 "Effect of potassium fertilization on tuber yield and nutrient uptake of yams (Dioscorea spp.) in the rainforest zone of Nigeria" G.O. Obigbesan, A.A. Agboola and A.A. A. Fayemi (26)
- 16:00 - 16:30 "Effects of potassium sources and rates of application on growth, yield and composition of cassava (Manihot esculenta Crantz)" A.G.N. Ngongi, R. H. Howeler and H. A. MacDonald (27)
- 16:30 - 17:00 "The interaction of lime with phosphorus and minor elements in the production of cassava (Manihot esculenta) in oxisols of the Eastern plains of Colombia" R. Howeler, L.F. Cadavid and F. A. Calvo (28-29)
- 17:00 - 17:30 "Cassava and sweet potato improvement in Tanzania" P.T. Shukla and M. Msabaha (30)
- 17:30 - 18:00 "Modern sweet potato production, handling, curing, storage, and marketing in North Carolina" L. George Wilson (31)
- 18:00 - 18:30 Open

Wednesday, August 4

Chairmen: C. Lozano and E. Terry

- 08:00 - 08:30 "Phosphorus requirement of three sweet potato (Ipomoea batatas, L.) cultivars" C.J. Rendle, B.T. Kang (32)
- 08:30 - 09:00 "Effect of farmyard manure and NPK on cassava in relation to growth, yield and quality" C.R. Mohan Kumar, R.C. Mandal, G.M. Nair and N. Hrishi (33)

09:00 - 09:30	"Utilization of "bitter potatoes" in the cold tropics of Latin America"	J.A. Christiansen, N.R. Thompson
09:30 - 10:00	Coffee	
10:00 - 10:30	"Sweet potato production in Hawaii"	J.S. Tanaka and T.T. Sekioka (34)
10:30 - 11:00	"Cassava <u>Manihot esculenta</u> Crantz research in Nigeria before 1972"	E.E. Umanah (35)
11:00 - 11:30	"Production and utilization of cassava foliage"	J.J. Montilla and A. Montaldo (36-40)
11:30 - 12:00	"Cassava production on peat soils in Guyana"	Abdul Wahab
12:00 - 12:30	"Mineral nutrition of cassava with particular reference to adaptation to low fertility conditions"	D.G. Edwards, C.J. Asher and G.L. Wilson (41)
12:30 - 14:00	Lunch	
14:00 - 15:00	" <u>Pre and post-harvest losses</u> "	Dr. Shuyler, FAO, Rome
15:00 - 16:00	Discussion	Leaders: D. Thurston, R. Booth and L. Rankine
16:00 - 16:30	Coffee	
16:30 - 17:00	"Cassava diseases and their control"	J.C. Lozano and E.R. Terry
17:00 - 17:30	"Observations on field control of cassava mosaic in Coast Province, Kenya"	K. Bock, E. Guthrie and A.A. Seif
17:30 - 18:30	Round table on communications	F. Monge

Thursday, August 5

Chairman: R. Booth

08:00 - 08:30	"Investigations on <u>Mononychellus tanajoa</u> (Bondar) (Acarina: Tetranychidae) and its natural enemies in the neotropics"	M. Yaseen and F.D. Bennett
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08:30 - 09:00	"Relative susceptibility of cassava chips of different varieties to storage pest <u>Araeceras fasciculatus</u> Degeer"	K.S. Pillai (42)
09:00 - 09:30	"World distribution, identification and control of cassava pests"	A. Bellotti and A. van Schoonhoven (43)
09:30 - 10:00	Coffee	
10:00 - 10:30	"Adapted sweetpotato clones for Libyan agriculture"	Warid A. Warid
10:30 - 11:00	"Common bacterial blight of cassava in Taiwan"	L.S. Leu (44)
11:00 - 11:30	"Factors affecting the incidence of cassava bacterial blight in Africa"	E.R. Terry and G.J. Persley (45)
11:30 - 12:00	"Effect of potassium and bacterial blight on the yield and chemical composition of cassava cultivars"	G.O. Obigbesan and E.O. Matuluko (46)
12:00 - 12:30	"Lipid metabolism in cassava mosaic infested <u>Manihot esculenta</u> Crantz"	C.A. Ninan, S. Abraham, L.S. Bai, P.N.C. Nair and P. Kuriachen (47)
12:30 - 14:00	Lunch	
14:00 - 14:30	"Incidence, symptomatology and transmission of a <u>Dioscorea</u> spp. virus in Nigeria"	E.R. Terry (48)
14:30 - 15:00	"Synonymy in sweet potato virus diseases"	J. Mukiibi (49)
15:00 - 15:30	Coffee	
15:30 - 16:00	"Effect of mosaic on the yield of sweet potatoes in Uganda"	J. Mukiibi (50)
16:00 - 16:30	" <u>Phenacoccus</u> sp. in cassava in Amazonia, Brazil"	M. de Albuquerque (51)
16:30 - 17:00	"An analysis of the eco-biology in Uganda of the green cassava mite <u>Mononychellus tanajoa</u> (Bondar) (Tetranychidae) and its Predator <u>Oligota</u> (Staphylinidae)"	Z.M. Nyiira (52-53)

17:00 - 17:30	Open	
17:30 - 18:00	Special presentation on cassava flour	National Coffee Federation
<u>Friday, August 6</u>	<u>Chairmen: T. Phillips and R. Hutagalung</u>	
08:00 - 09:00	<u>"Utilization of the potato Solanum tuberosum, in the tropics"</u>	R. Wurster, Intern. Potato Center
09:00 - 10:00	Discussions Leaders: O. Oke and T. Phillips	
10:00 - 10:30	Coffee	
10:30 - 11:00	"Cassava utilization via agro-industrial systems"	D.J. McCann (54)
11:00 - 11:30	"The allocative efficiency of Fijian root crop producers: Sigatoka Valley, Fiji"	S. Chandra and A.J. de Boer (55)
11:30 - 12:00	"The importance of cassava processing in the economy of Colombia"	Hugo Valdés
12:00 - 12:30	"Agro-economic evaluation of cassava production"	T. Phillips
12:30 - 14:00	Lunch	
14:00 - 14:30	"The prophylactic action of cassava"	O.L. Oke (56)
14:30 - 15:00	"Further studies on the toxic effect of cassava on human thyroid"	F. Delange, P. Bourdoux, M. Gerard, M. Camus and A.M. Ermans
15:00 - 15:30	Coffee	
15:30 - 16:00	"Utilization of cassava as carbohydrate source for pigs in Malaysia"	V.F. Hew and R. Hutagalung (57)

- 16:00 - 16:30 "A preliminary study on the utilization of cassava products as energy source for broilers" Sarote Khajarern and J.M. Khararern (58)
- 16:30 - 17:00 "Protein enrichment of cassava by fermentation with microfungii: The role of natural nitrogenous supplements" G. Varghese, J.J. Thambirajah and F.M. Wong (59)
- 17:00 - 17:30 "Utilization of nutritionally improved cassava by nutrient supplementation and microbial enrichment in poultry and pigs" R.I. Hutagalung and P.H. Tan (60)
- 17:30 - 18:00 "Utilization of diets based on cassava flour, without methianine supplement, during the life cycle periods of pigs" G. Gómez, C. Camacho and J.H. Maner
- 19:30 Cocktails and dinner

Saturday, August 7

Chairman: R.I. Hutagalung

- 08:00 - 10:00 Field tour
- 10:00 - 10:30 Coffee
- 10:30 - 11:00 "Establishment of a pilot plan for the production of fungal protein from cassava" K. Gregory, A. Meiereng, F. Azi, J. Sedgwick, J. Cunningham, S. MacLean, J. Santos and G. Gómez
- 11:00 - 11:30 "Studies on the utilization of cassava (Manihot utilissima Pohl) by the ruminant" C. Devendra (61-62)
- 11:30 - 12:00 "Lipase activity and the conversion of fat to carbohydrate in cassava" F. Nartey (63)
- 12:00 - 12:30 "A system of food delivery from root crops" T.O. Nakayama, J.H. Moy and J. da Fonseca (64)

12:30 - 13:00

"Mechanization of yam and sweet
potato production in Barbados"

J.P. Jeffers (65)

13:00 - 15:00

Lunch

15:00

Elections and other Society
business.

Cyrtosperma chamissonis (Schott) Merr., (giant swamp taro), a Little-known Asian - Pacific Food Crop. Donald L. Plucknett, Office of Agriculture, Technical Assistance Bureau, Agency for International Development, Washington, D.C.

Cyrtosperma chamissonis (Schott) Merr., a member of the Araceae and probably native to Indonesia; has now spread eastward to become a minor crop in the Philippines, Papua New Guinea and some Pacific Islands, but a major crop on coral atolls and low islands of the Pacific. A hydrophyte, it grows in coastal marshes, natural swamps, and man-made swamp pits in conditions unsuitable for other staple crops. An extremely hardy perennial, Cyrtosperma produces large edible corms which may be harvested for daily subsistence, for local markets, or emergency use. It has some salinity tolerance, but the levels of tolerance are unknown. Mulches and organic manures are used to fertilize the crop, especially in the man-made pits constructed for its production on coral atolls. Crop duration can be long, as much as 6 years or more, but some islands have cultivars which can be harvested in less than one year. Average crop duration is probably 2 to 4 years. Yields vary, but 10 to 15 metric tons of corms per ha per year have been produced. Highest yields are on Yap, where plant spacings are close and the crop is most important. There is great need to collect and evaluate cultivars now in use for salinity and flooding limits, short crop duration, superior food value and acceptance and other factors, before they are lost through neglect.

A review of sexual propagation for yam improvement with emphasis on *Dioscorea rotundata*. Sidki Sadik, International Institute of Tropical Agriculture, Ibadan - Nigeria.

The development of methods to germinate seeds now make it possible to improve white yam, *Dioscorea rotundata* through sexual propagation.

Previous difficulties in seed germination resulted from the failure to recognize a 3 to 4 month dormancy period and because many seeds lack well developed embryo and endosperm. At the end of dormancy, seeds germinate in 3 weeks. Since 1973, about 40.000 genotypes have been produced through sexual propagation. This provides a wide range of genetical diversity to improve yam by selection for desirable characteristics.

Preliminary results on the adaptation of the cultivated potato to the lowland tropics. Humberto A. Mendoza, Breeding & Genetics Dept., International Potato Center, Lima- Perú.

An initial group of 6000 potato clones from various taxonomic groups was screened for adaptation to high temperatures and humidity at a high jungle site (800 meters). Of these, 34 tetraploid clones were selected for further testing under three tropical environments in Peru (La Molina (240 m), San Ramón (800 m), and Yurimaguas (175 m)). These sites represented a hot, irrigated location; a high wet jungle; and a low, wet jungle, respectively. The length of the growing period was 90 days at San Ramón, 75 days at La Molina, and 60 days at Yurimaguas. Temperaturewise Yurimaguas placed the most stress; minimum night temperatures were never below 19°C.

The performance of some of the clones, in particular, hybrids of Tuberosum x Neo-tuberosum and Tuberosum x Phureja was remarkable given the short growing season and the stress imposed not only by the weather but also by weeds, insects, and diseases. It appears that the greater genetic diversity of the inter-group hybrids gave the genotypes a greater ability to adapt to conditions of stress than the intra-group hybrids. This suggests that mating genetically divergent parents, previously selected for adaptation would produce a greater degree of heterozygosity and thus maximize the performance of the hybrids. Yields up to 15 ton/ha were obtained at Yurimaguas in 60 days. These results show that there is genetic potential to adapt potatoes to high temperatures. A growing season of 60 to 70 days combined with resistance to late blight and bacterial wilt may make it possible for the first time to grow economically potatoes in the lowland tropics.

The use of wild relatives in sweet potato breeding. Masashi Kobayashi and Tsukasa Miyazaki, Kyushu National Agricultural, Experiment Station, Kagoshima - Ken, Japan.

A sweet potato variety and various breeding materials which include germplasm of wild Ipomoea suggest that the wild relatives have much to offer sweet potato breeders.

The wild relatives which can be crossed with cultivated sweet potato include diploids, triploids, tetraploids and hexaploids. All of them resemble the sweet potato in two respects:

They have similar floral morphologies and incompatibility systems. These characters may be useful in future searches for wild plants.

Our experience in the practical use of wild species in sweet potato breeding, a flower induction technique, self - and cross - compatibility test and species hybridization with sweet potato suggest that useful genes can be expected from the wild species. Some principles necessary for an effective gene introduction system have been identified. A critical understanding of wild Ipomoeas could lead to greater advances in sweet potato improvement.

Female sterility in Dioscorea rotundata. Emmanuel V. Doku, E. Blay, E. Laing and A. Opong. Crop Science Dept., University of Ghana, Legon - Ghana.

Degress of female flower abortion in Dioscorea rotundat are outlined, as well as seed abortions within the capsule.

Probable causes of this female sterility are also discussed.

The Interrelationship between Source and Sink of Photosynthates in Sweet Potato Plants. Y. Hozyo and S. Kato. Plant Physiologist, respectively, National Institute of Agricultural Sciences, Kitamoto, Saitama, Japan.

The evidence which suggest that the source or sink of photosynthates may be more limiting in crop plant were analyzed using the grafts of sweet potato plant.

In the grafts among cultivars or cultivars and wild type plants, the presence of close interrelationship between source and sink were found and the effect of sink on plant production process was so apparently.

Total Dry Matter Production, Tuber Yield and Yield Components of Six Local Cassava (*Manihot esculenta* Crantz) Cultivars in Trinidad. E.B. Holmes and L.A. Wilson, Graduate Student and Professor, respectively, Dept. of Crop Science, U.W.I., St. Augustine, Trinidad, W.I.

Dry matter production and quantitative shoot morphology, dry matter distribution as well as tuber yield and yield components of six representative cassava cultivars in Trinidad are presented and results discussed in relation to the yield performance of elite cassava cultivars and the yield potential of the cassava species. A cassava type on which improvement of the yield potential of the species might be based is identified.

The effect of soil compaction in root and tuber zones on leaf number, leaf area and tuber yield in White Lisbon yam (*Dioscorea alata* L.). Theodore U. Ferguson and Frank A. Gumbs, Caribbean Development Bank, St. Michael - Barbados.

The effect of soil compaction in root and tuber zones on the growth and yield of White Lisbon yams (*Dioscorea alata* L.) were examined using specially designed boxes. Each box consisted of a central tuber compartment in which the tuber developed and two outer root compartments in which the main fibrous roots developed. Soil compaction in both the root and tuber compartments reduced leaf number, leaf area and yield. A close positive linear relationship was observed between leaf number and yield. It is suggested that the growing tuber contributes substantially to the development of the plant by assisting in the absorption of moisture and essential nutrients. Compaction in the tuber zone had no effect on tuber number, tuber length and tuber width. However tubers growing in compacted soil penetrated the soil to a lesser depth, tended to develop above the original level of the soil to a greater extent and had a larger number of growing points (or toes).

Study on the Mukibat System of cassava production. T.S. Dharmaputra.
Brawijaya University, Malang- Indonesia.

Research on the Mukibat system of cassava production has given some interesting preliminary results. There is a strong indication that the Mukibat system is outyielding the normal cassava production system when Mukibat cassava is planted at the right time and with proper plant spacing. It was found that individual varieties do not react in the same way to the Mukibat system. This findings offers the possibility of selecting for high yield within varieties which have good eating quality but only produce moderately under the normal system.

It was also found that making planting holes for the Mukibat system is not necessary.

The results of the study on the growth period indicate that the highest accumulation of dry matter in the root of the Mukibat cassava occurs between 12 and 15 months with all three varieties tested - Faroka, Pandesi and Mentega - and at the two locations.

Scion material taken from the Mukibat plants was found to be as good as that taken from the original M. glaziovii tree.

Two different types of scion material were tested for their influence on the productivity of the Mukibat system. The results show that the so called "black" type is superior to the "white" type at one location, but not at the other.

It can be concluded from a N-P-K fertilizer experiment that nitrogen is the limiting plant nutrient for Mukibat cassava production at Tulungagung.

A discussion of the results is presented in the paper.

Yield of *Dioscorea rotundata* Poir as affected by periodic removal of mother tuber¹. F.I.O Nwoke and S.N.C. Okonkwo, Department of Botany University of Nigeria, Nsukka, Nigeria.

The effect of the removal ('milking') of mother tuber from *Dioscorea rotundata* stands after 4, 7, 10 and 13 weeks of growth on the yield of individual plants were investigated. In addition, some of the 'milked' tubers were replanted at another location and the cumulative yields of the 'milked' setts compared with yields of control plants (unmilked).

Our results show that irrespective of the size of seed yam used, removal of mother tuber from yam stands after 4 weeks of growth drastically reduced yields; removal after 7 weeks had little or no effect and removal after 10 weeks did not affect the yield of individual plants of *D. rotundata*.

If yam stands are 'milked' after 4 weeks and the 'milked' tuber replanted, the cumulative yield of both 'milked' stands and the replanted stands was significantly lower than the yield of control plants. However, 'milking' and replanting of mother tuber after 7 weeks or more gave cumulative yields which did not differ from the control.

¹This study is dedicated to the memory of the late Professor Eni Njoku

Undersowing cassava (Manihot esculenta var valenca) with stylo (Stylosanthes guyanensis cv Schofield) grown under coconut in Bali. I.M. Nitis and M.Suarna. Fac. of Veterinary Science and Animal Husbandry Udayana University, Denpasar, Bali, Indonesia.

Three field experiments on undersowing cassava with stylo were carried out for 26 to 41 weeks on a loamy, fine sand under coconuts, 2 km from the Kuta beach, Bali.

Stylo drilled under the cassava at diagonal crossing produced tuber D.M. similar to that of the cassava sown without stylo. The other methods of sowing stylo (broadcast, windrow, criss-cross and drill midway between the 2 cassava) significantly ($P < 0.05$) decreased the tuber D.M. yield by 32 to 51%. Windrow sowing exerted the most and criss-cross sowing the least effect. Windrow sowing the stylo under the cassava by replacing cassava with stylo so that the spacing increased from 40 x 40 cm (without stylo) to 40 x 80 cm (with stylo) and from 60 x 60 cm (without stylo) to 60 x 120 cm (with stylo) increased the tuber productions by 20 and 22% respectively. At the wider cassava spacing the replacement significantly decreased tuber D.M. yield by 28%. In the other experiment, windrow sowing stylo under the cassava decreased tuber D.M. yield by 14% ($P < 0.05$). PK or PKT fertilizers could alleviate such yield depression. The cassava + stylo combination produced shoot D.M. about 69% more than that of the cassava sown without stylo.

The importance of undersowing cassava with stylo in the mixed farming systems were discussed.

Effect of Potassium Fertilization on Tuber Yield and Nutrient Uptake of Yams (*Dioscorea* spp) in the Rainforest Zone of Nigeria. G.O. Obigbesan, A.A. Agboola and A.A.A. Fayemi. Dept. of Agronomy, University of Ibadan - Nigeria.

Results of experiments on K fertilization of yam varieties (*Dioscorea* spp.) indicated that highest tuber yields could be produced by *D. cayenensis* and *D. rotundata* (var ARO) when fertilized at 30kgK₂O/ha while *D. alata* and *D. rotundata* (var. Efuru) gave optimum performance with 60kgK₂O/ha. Yield differences due to the varieties were significant in the two years of the experiment (1974, P= 0.05; 1975, P= 0.01) but significant responses to K application were obtained only in the 1975 experiment at the farm site where the exchangeable soil K was 0.151 me/100g.

K fertilizations raised the percentage of marketable (ware) tubers of the species except *D. rotundata* (var. ARO). There were also varietal differences in the crude protein (5.20 - 8.26%) and mineral nutrient content of the species with the highest values in *D. alata* and lowest in *D. cayenensis*. Nitrogen and potassium constitute the major nutrients removed in large amounts. The average nutrient removal via the tuber ranged between 128 - 155kgN, 16.9 - 19.4kgP and 155 - 184kgK per ha with the highest figures at about 175kgN, 21kgP and 200kgK per ha.

Effects of potassium sources and rates of application on growth, yield and composition of cassava (*Manihot esculenta crantz*). A.G.N. Ngongi, R. Howeler and H.A. Mac Donald, Soil Research Institute, Kwadaso, Kumasi, Ghana.

Three field experiments were conducted in Colombia to investigate the differential effects of KCl and K_2SO_4 on cassava root yields. At Pance, where soil $SO_4^{=}$ -S content was 9.0 ppm, there were no differences in yields between KCl and K_2SO_4 plots, but at Carimagua and Tranquero where soil $SO_4^{=}$ -S content was 4.0 - 4.5 ppm, K_2SO_4 produced significantly higher root yields than KCl . A $KCl + S$ 'source' produced yields equal to those produced by K_2SO_4 at equivalent rates of potassium.

Cassava root yields increased with potassium fertilization. Potassium applied at a rate of 120 Kg K_2O per hectare appeared to be adequate. Maximum root yields obtained were 40 and 20 tons per hectare at Pance and Tranquero respectively. There was a high positive correlation between cassava root yields and total plant fresh weight produced per hectare.

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La interacción de cal con fósforo y elementos menores en la producción de yuca (Manihot esculenta) en oxisoles de los Llanos Orientales de Colombia.

Reinhardt Howeler, F. Cadavid y Fabio Calvo. Centro Internacional de Agricultura Tropical, CIAT, Cali - Colombia.

La yuca como especie promisoría en oxisoles de los Llanos Orientales de Colombia ha servido como cultivo indicador en algunos ensayos de fertilización.

Siendo estos suelos extremadamente ácidos y con una fertilidad baja, la yuca responde muy bien tanto a los elementos mayores y secundarios como también a algunos elementos menores.

Se ha hecho especial énfasis con estudios de cal y fósforo, debido, en gran parte, a que el calcio y el fósforo son dos de los elementos más limitantes y con los cuales se han encontrado mayor respuesta en otros cultivos como arroz, maíz, sorgo, etc.

Se observó la tolerancia de 134 cultivares de yuca a la acidez, usando niveles de cal 0, 0.5, 2 y 6 ton/ha, encontrándose un efecto positivo en los rendimientos al nivel 0.5 ton/ha. Algunos cultivares respondieron hasta 2 ton/ha de cal, pero por encima de este valor, el efecto fué negativo, más que nada por la deficiencia de Zn.

En un estudio de cal por fósforo, los mayores rendimientos se obtuvieron con 0.4 ton/ha de cal y aplicaciones de 50 a 100 kg P_2O_5 /ha como superfosfato triple. Con aplicaciones mayores de cal, el efecto sobre el rendimiento fué negativo, probablemente por deficiencia de algunos elementos menores. Con 0.5 ton/ha de cal y aplicaciones basales de fósforo hasta 200 kg P_2O_5 /ha, se encontró una respuesta positiva, no habiendo diferencia entre aplicaciones en banda, al voleo, ó en corona al momento de la siembra.

En un estudio de cal por elementos menores, se observó una respuesta positiva hasta el nivel de 2 ton/ha de cal disminuyendo los rendimientos con

aplicaciones mayores. Cuando se aplicó elementos menores la respuesta fué positiva a las aplicaciones de zinc en el orden de 20 kg/ha como Sulfato de Zinc. Con el cobre, manganeso, boro y molbdeno, el efecto sobre el rendimiento fué menor.

Cassava and sweet potato improvement in Tanzania. P.T. Shukla and M.A.M. Msabaha, Agricultural Research Institute Ukiriguru, Mwanza-Tanzania.

The location and climate of Tanzania along with the problems concerning root and tuber crops cultivation in the country are described. The past work conducted on cassava and sweet potato is summarized. The paper describes the present policy, objectives and projects in progress in the country. The yield potential of the elite cassava varieties along with the promising mite resistant varieties is presented. Details are given about the sweet potato germ plasm evaluated at Ukiriguru. It is emphasized that there are very few diseases and pests on cassava and sweet potato in the country; and the variability present in the local material is enormous which could be used for future breeding program without much dependence on exotic material.

Modern Sweet Potato Production, Handling, Curing, Storage and Marketing in North Carolina. Wilson, L.G., Dept. of Horticultural Science, North Carolina State University, Raleigh, North Carolina 27607, USA.

North Carolina's climate and sandy loam Coastal Plain soils are ideal for producing high yields of sweet potatoes. High yielding, high quality "yam type" varieties (i.e. Jewel) which store well for long periods have originated from this state, as have effective, modern curing and storage techniques. The combined efforts of a dedicated team of extension and research scientists have minimized the effects of diseases and insects and introduced improved production and harvesting techniques. North Carolina is the leading sweet potato producing state, growing one-third of the U.S. crop on approximately 32,000 acres in 1975. Growers/shippers promote their product nation-wide and sell in every major marketing area east of the Rocky Mountains. Sweet potatoes are the leading horticultural commodity in North Carolina. Problems, current investigations and future trends will be discussed.

Phosphorus requirement of three sweet potato (*Ipomoea batatas* L.) cultivars.
C.J. Rendle and B.T. Kang, International Institute of Tropical Agriculture,
Ibadan-Nigeria.

Sweet potato cultivars Tib 3, Tib 4 and Tis 2534 were grown in a Shante soil series in a pot experiment, at 7 levels of phosphorus concentrations in the soil solution ranging from 0.01 to 1.6 ppm P.

Differential response and external P requirement were apparent between the cultivars. At soil solution concentration of 0.01 ppm P, over 70% of the maximum yield was obtained with the three cultivars. 95% Yields occurred at soil solution concentrations of 0.05, 0.10 and 0.15 ppm P respectively for the cultivars Tib 3, Tib 4 and Tis 2534.

Tissue phosphorus concentrations of 0.22% in the blade and 0.08% in the petiole of the index leaf at 9 WAP appeared to be sufficient for 95% yield for the three cultivars.

Effect of farm yard manure and NPK on Cassava in relation to growth, yield and quality. C.R. Mohan Kumar, R.C. Mandal, G.M. Nair and N. Hrishikesh, Central Tuber Crops Research Institute, Trivandrum - India.

Exploitation of hybrid vigour in cassava at the Central Tuber Crops Research Institute showed the genetic potential for nutrient utilization and canalisation of the total biological yield.

Significant tuber yield increase were noticed by the application of farm yard manure in combination with nitrogen, phosphorus and potash. Farm yard manure with nitrogen alone or combination of nitrogen with phosphorus and potash were the next best treatments. However, the lowest tuber yields were recorded in the phosphorus or potash treated plots.

The bitterness of tuber was found to be increased by the application of farm yard manure and nitrogen whereas potash reduced it.

Sweet potato production in Hawaii. Jack S. Tanaka and T.T. Sekioka, Dept. of Horticulture, University of Hawaii, Honolulu-Hawaii.

This paper describes the general cultural practices of sweet potato production in Hawaii. Presented are cultivars grown, method of planting, fertilized application, pest control, harvesting, and factors contributing to increased yield.

Cassava *Manihot esculenta* Crantz research in Nigeria before 1972. E.E. Umanah. Federal Department of Agricultural Research, Ibadan - Nigeria.

A review of cassava research achievements in Nigeria for a period of 20 years is made. Particular attention is given to Plant Breeding, Agronomy, Chemical analysis, Physiology, Pests and diseases and cytogenetics. A brief note is made of the various uses into which cassava is put in the country. Breeding objectives and recommended varieties to the various ecological areas of the country are discussed.

A package of management practices as recommended from research results are indicated. On basic research, the karyotypes of some *Manihot* species including cassava were determined and it was suggested that cassava is an allopolyploid with chromosome number of $2n = 36$ and a basic chromosome number of $X = 9$.

Producción y utilización del follaje de yuca. I.- Producción de follaje de yuca. Alvaro Montaldo y J.J. Montilla, Profesores de Raíces y Tubérculos Tropicales y de Nutrición Animal respectivamente, Facultades de Agronomía y Ciencias Veterinarias, Universidad Central Maracay, Venezuela.

Los más altos rendimientos en producción de follaje seco en la plantación de Estación Seca, Cuadro No. 1, ocurren con densidades de 31.250 y 15.625 pl/Ha con producciones de:

I (31.250)	II (15.625)
1.- 21,9	1.- 22,2
2.- 20,9	2.- 19,8
3.- 11,6	3.- 15,8

Esto tendería a indicar que un valor de densidad entre 31.250 y 15.625 sería el óptimo para la producción de follaje, bajo las condiciones ecológicas en que se realizó el experimento.

Se nota además que los valores máximos de producción de follajes ocurrieron cuando se realizaron tres cosechas.

El Cuadro No. 2, muestra valores de porcentajes de proteína: 22,3, 20,1 y 20,6 para la primera cosecha (4 meses) de follaje del Experimento de Estación Seca, con densidades de 31.250, 15.625 y 10.412 pl/Ha.

En la tercera cosecha (12 meses) los valores de proteína son más bajos, pero se nota aquí que el follaje de reciente producción, rebrotes de 4 meses, es superior al material de 12 meses, gran parte de cuyo material aéreo está constituido por tallos gruesos.

Esto mostraría que para la producción de follaje sería conveniente densidades medias de plantación con cosechas sucesivas.

El Cuadro No. 3, calculado a base del valor del análisis de la proteína en la tercera cosecha, muestra valores más altos de proteína en Tn/Ha de

3,9, 4,2 y de 3,8 y 3,9 en las densidades de 31.250 y 15.625 pl/Ha en cosechas a los 4, 8 y 12 meses (subtratamientos No. 1) y 8 y 12 meses (subtratamiento No. 2) respectivamente.

El Cuadro No. 4 representa un segundo experimento planteado al inicio de la Estación Húmeda.

A los 12 meses los máximos rendimientos ocurren con 31.250 pl/Ha. Este experimento se siguió cosechando hasta los 17 meses, lográndose producciones de follaje de 44,7 Tn/Ha de peso seco con la densidad de 31.250 pl/Ha con cosechas cada 3 meses. (2)

El Cuadro No. 5, indica la comparación de cosechas a los 12 meses entre las plantaciones efectuadas en la Estación Seca y en la Estación Húmeda.

Se ve un mayor rendimiento con la densidad de 31.250 pl/Ha de la Estación Húmeda comparada con la seca.

Los datos en las otras densidades en ambas Estaciones son bastante irregulares.

Respecto a la producción de raíces reservantes, que sólo se ha medido en el experimento de Estación Seca, se nota, Cuadro No. 1, una manifiesta mayor producción en las densidades de 31.250 y 15.625 pl/Ha, cuando el cultivo se mantuvo con follaje (subtratamiento No. 3) hasta la cosecha de las raíces.

Lo anterior indicaría que no es recomendable planificar una explotación mixta de follaje y de raíces ya que la proteína disminuye en el follaje por la mayor proporción de madera sobre hojas.

(^o) El experimento de Estación Húmeda se abonó a los 17 meses en toda la superficie del ensayo con la fórmula, 10: 15: 15, 500 Kg/Ha y se continuó cosechando cada dos meses en conjunto habiendo alcanzado 21 mes de vegetación con producciones totales de 4-5- Tn/Ha de follaje seco en cada corte.

La poda con machete en el cuello de las plantas de yuca provoca una activa brotación de yemas, presentando las plantas sometidas a este tratamiento mayor número de ramas que las no podadas.

Producción y utilización del follaje de yuca. II. Efecto de varios niveles de harina de follaje de yuca en raciones para pollos de engorde. J.J. Montilla, R. Vargas y A. Montaldo, Profesores de Producción Avícola y de Raíces y Tubérculos de las Facultades de Ciencias Veterinarias y de Agronomía, Universidad Central de Venezuela, Maracay, Venezuela.

Con el objeto de iniciar el estudio de las posibilidades de utilizar la harina de follajes de yuca como fuente protéica en raciones para aves, se realizaron dos (2) experimentos de 10 semanas de duración cada uno, según diseño completamente aleatorizado. Se utilizaron 480 pollitos Vantress x White Rock de un (1) día de nacidos, los cuales fueron alojados en baterías metálicas de 4 pisos, dotadas de fuentes eléctricas de calor. La unidad experimental estuvo constituida por grupos de 10 aves, asignándose en ambos experimentos, 4 grupos a cada tratamiento.

En el experimento I se estudiaron la sustitución de harina de follaje de yuca de 10%, 20% y 30% de harina de oleaginosas (ajonjolí y algodón) y de maíz, en proporciones de 75% y 25%, respectivamente, para cada nivel de sustitución.

El alimento se preparó en forma harinosa. En el experimento II se estudiaron los mismos niveles de incorporación de harina de follaje de yuca, comparándose su preparación en forma harinosa y en forma de tacos.

Los resultados indican que cuando las raciones se suministraron en forma harinosa, el incremento de peso y la eficiencia alimenticia se deterioran para todos los niveles de incorporación de follaje, hasta la 6a. semana. Este deterioro se hace notable en las últimas 4 semanas sólo con el mayor nivel de sustitución. La preparación del alimento de forma de tacos corrige, en gran

parte, los efectos adversos que se presentaron cuando el alimento se ofreció en forma harinosa.

Se requieren investigaciones adicionales para definir las posibilidades reales de utilización de la harina de follaje de yuca, en raciones para pollos de engorde.

Mineral nutrition of cassava with particular reference to adaptation to low fertility conditions. D.J. Edwards, C.J. Asher and G.L. Wilson., Dept. of Agriculture, University of Queensland, Australia.

Results of solution culture experiments conducted under closely controlled and constant conditions of temperature, pH and nutrient ion concentrations suggest that cassava is better able to withstand the effects of very low external nutrient ion concentrations than a number of other crop species. However, for maximum growth rates the concentrations needed at root surfaces of cassava are either comparable with or in some cases higher than those needed by other crops. The results suggest also that cassava may have considerable tolerance to acid soil infertility factors (H^+ , Mn^{++} , Al^{+++}). Experiments with phosphorus suggest a substantial ability to adjust growth rates to match rates of nutrient uptake without the development of deficiency symptoms or the prevention of appreciable root bulking.

Relative susceptibility of cassava chips of different varieties to storage pest *Araeceras Fasciculatus* DeGeer . K.S. Pillai, Central Tuber Crops Research Institute, Trivandrum - India.

Studies were made to ascertain the relative susceptibility of cassava chips of different varieties to storage pest *A. fasciculatus*. The test insect was collected at first from the storage house and then cultured in the laboratory on cassava chips. Ten cassava varieties viz. H-226, H-1687, H-2304, H-38, H-3641, H-312, H-97, H-2059 and H-1310 were taken as treatments to study their relative susceptibility. Results of the experiment revealed that the hybrids H-226 and H-2304 were significantly superior to all other varieties tested for their lower susceptibility.

WORLD DISTRIBUTION, IDENTIFICATION AND CONTROL OF CASSAVA PESTS

A.C. BELLOTTI AND A. VAN SCHOONHOVEN

Numerous insect and mite pests have been identified as attacking cassava. These pests represent a wide range of insect fauna; more than 100 species have been recorded. Many of these are minor pests and cause little or no economic losses. However recent research has shown that several pests can cause crop losses and must be classified as major pests. These include mites, thrips, stemborers, whiteflies, hornworms, scale insects and whitegrubs. Many pests, such as mites, whiteflies, scales, whitegrubs, stemborers, ants, termites, are distributed world wide. Others are local pests or limited to one or two continents. Chemical control of cassava pests is uneconomical in many areas where it is a low value crop. Pesticides are expensive and their continual use is impractical for a long season crop such as cassava. Emphasis should be directed toward the use of resistant varieties, biological control and improved cultural practices. Strict quarantine practices should be enforced to prevent the spread of cassava pests into areas where they are not present.

Common Bacterial Blight of Cassava in Taiwan. L.S.Leu, Senior specialist, Plant Pathology Division, Plant Protection Center, Taiwan, Republic of China.

Common bacterial blight, the most important cassava disease in Taiwan has been probably present before 1945. The disease is systemic in nature and transmitted primarily by cuttings contaminated with bacteria and secondarily by windborn water. Angular leaf spots, wilting, defoliation, gum exudates on leaf lobe, stipule, stem, especially on the latter two, and death of plants are caused by vascular-invading bacterium, Xanthomonas manihotis (Arthaud-Berthet) Starr.

Morphological and most physiological studies of the bacterium agreed with other investigations presented in the literatures. The bacterium confines its host on genus Manihotis and shows poor survival ability in the soil.

By using bacterial suspension; dipping of healthy cuttings, injecting into young stems, spraying of whole plants, cutting leaves of young plants with contaminated scissors, and pouring into injured roots of young plants all induced the disease.

Factors affecting the incidence of cassava bacterial blight in Africa. E.R. Terry. International Institute of Tropical Agriculture, Ibadan - Nigeria.

Cassava bacterial blight (Xanthomonas manihotis) is a widespread and damaging disease in South America, Africa and Asia. Its severity in Africa varies with locality and climatic conditions. Possible factors affecting its severity are soil type, climate, cultural practices and varieties. The paper presents observations on the distribution and economic importance of CBB in Africa and experimental results obtained from epidemiological studies.

Effect of Potassium and Bacterial Blight on the Yield and Chemical Composition of Cassava Cultivars. G.O. Obigbesan and E.O. Matuluko, Dept. of Agronomy, University of Ibadan - Nigeria.

Studies on cassava cultivars of different susceptibility to bacterial blight caused by Xanthomonas manihots, Buckholder, revealed that the infection exerted differential influence on the mineral nutrient and starch contents of the cultivars. The disease caused a reduction in the macronutrient content, led to a higher accumulation of micronutrients in the diseased leaves and adversely affected the tuber quality by lowering the percentage starch content of the tubers. Despite the relatively greater tolerance of the 60506 cultivar, bacterial blight significantly reduced its tuber and starch yields.

Lipid metabolism in cassava mosaic infected *Manihot esculenta* Crantz.

C.A. Ninan, Susan Abraham, L. Sandhyavathi Bai, P.N. Chandrasekharan Nair and Philomena Kuriachen. Department of Botany, University of Kerala, Trivandrum - India.

This paper reports results of studies conducted on the lipid metabolism in Cassava mosaic - infected cassava plants. Two varieties of cassava, namely M₄ and H.165 with accession numbers M.67-01 and M.72-10 respectively were selected for the studies. Total lipids, phospholipids and triglycerides were determined in the leaves and petioles of the infected plants. The results showed a decrease in total lipids, phospholipids and triglycerides in the leaves and petioles of both the varieties.

Incidence, symptomatology and transmission of a *Dioscorea* spp. virus in Nigeria. E.R. Terry, International Institute of Tropical Agriculture, Ibadan - Nigeria.

A *Dioscorea* spp. virus disease incidence was highest in field planting in Ibadan on *Dioscorea rotundata* variety Ihobia. Field symptoms included green vein-banding, shoestring and distortion. The virus was transmitted mechanically and by nymphs and winged adults of the cotton aphid, *Aphis gossypii* to seedlings of *Dioscorea rotundata* . Test plants in mechanical and vector transmission studies exhibited mainly green vein-banding.

The role of *A. gossypii* in field spread of this disease is discussed.

Synonymy in sweet potato virus diseases. J. Mukiibi. Dept. of Crop Science, Makerere University, Kampala - Uganda.

Literature pertaining to virus or virus-like diseases of sweet potatoes has been reviewed. It is concluded that there are only two diseases proved conclusively to be caused by viruses; Sweet Potato Mosaic, with many synonyms and Sweet Potato Internal Cork. The other virus-like diseases are either caused by mycoplasma, mites, or are physiological.

Effect of mosaic on the yield of sweet potatoes in Uganda. J. Mukiibi.
Dept. of Crop Science, Makerere University, Kampala-Uganda.

The sweet potato mosaic virus disease caused a reduction in yield, of approximately 57 percent, both in terms of the weight and the number of root tubers produced by the variety Kyebandula, when it was grown at Makerere University Farm in Uganda.

Cochonilha em mandioca na Amazônia. Milton De Albuquerque, Eng.^o Agr.^o
Pesquisador da EMBRAPA/CPATU, Belém - Brasil.

Um severo ataque de Cochonilha ocorrido no 2^o semestre de 1975, na coleção de mandioca na sede do Centro de Pesquisa Agropecuária do Trópico Úmido, em Belém determinou, pela sua gravidade, a erradicação pela queima, de todo o material existente, incluindo espécies silvestres não resistentes. O agente foi determinado como Phenacoccus sp (Homoptera-Pseudococcidae), sendo a primeira vez em que é assinalado na Amazônia. Nenhum inseticida dos utilizados no seu combate mostrou-se 100% eficiente. Os estudos com a praga continuam.

An Analysis of the Eco-biology in Uganda of the Green Cassava Mite, *Mononychellus tanajoa* (Bondar) (Tetranychidae) and its predator *Oligota* (Staphylinidae). Z. M. Nyiira, Entomologist/Insect Ecologist at Kawanda Research Station, Kampala and part-time Lecturer in Agricultural Entomology at Makerere University, Kampala - Uganda.

The green cassava mite, *Mononychellus tanajoa* (Bondar) (Acarina: Tetranychidae), also known as the cassava leaf mite, is a fairly new pest on the continent of Africa. Its potential threat to cassava production in Africa has attracted serious investigations into its biology, ecology and possible control. Initial infestations of this mite start in sheltered places, along the midribs and veins of cassava leaves.

Results of ecological studies suggest that denser populations are recorded during dry spells and more in the basal than in the apical halves of cassava leaves. The ratios of active mites, their eggs and males and females categories in the apical half of the leaves to that of similar components in the basal half are discussed.

In the varieties investigated, cassava plants between 3 months and 10 months old were more densely infested by *M. tanajoa* than the younger and older plants. Aging of cassava leaves on a plant up to 5 weeks allowed mite population build up after which had the population density of green cassava mites was reduced. It was also found that some varieties of cassava supported fewer mites than others over a season suggesting an element of resistance to the mite in these varieties. Reduction in the population of mites was more associated with absence of leaves on cassava plants than meteorological factors although rain and possibly relative humidity had negative effect on population build up of the mite.

The Staphylinidae, *Oligota*, was the dominant and widespread predator. It appeared in sufficient numbers and in synchrony with the green cassava mite populations. Its population, however, fell sharply when the host population

started diminishing.

The results reported point out the potential of varietal resistance in cassava and biological control as possible effective considerations in integrated control of M. tanajoa on Manihot esculenta.

Cassava Utilisation Via Agro-Industrial Systems. D.J. McCann, Dept. of Chemical Engineering (and Energy Research Centre), University of Sydney-Sidney - Australia.

Cassava is an ideal crop for use in agro-industrial systems, where agriculture and industry combine to achieve the greatest efficiency in utilisation. The basic concepts for a correctly designed agro-industrial system based on cassava are explained, and those industrial processes with the greatest potential are discussed. If research and development on both the "agro" and "industrial" front can proceed together then cassava could be a major provider of food, chemicals and energy within a decade.

The allocative efficiency of Fijian root crop producers: Sigatoka Valley, Fiji. S. Chandra and A. J. De Boer, Dept. of Agriculture, University of Queensland, St. Lucia, Brisbane-Australia.

The allocative efficiency of the Fijian root crop producers in the Sigatoka Valley, Fiji, is measured using estimated elasticities of production and marginal value products of the four production factors-land, labour, capital and current expense. A two-year farm management data, from an original sample of 26 farms, covering the period November 1970 to October 1972, was used in this study. The root crop production model is based on the Cobb-Douglas type of production function in which zero-one dummy variables were also incorporated to measure the environmental effects of region and soils and time effects on farm gross output. It was found that the most efficient root crop producers are those farming the light-textured soils in the lower Sigatoka Valley and the most important production factors are labour and capital. Recommendations are made on the optimum levels of resource use under various conditions of limited capital and fixed availability of land or labour. It is suggested that in the future, root crops offer the best possibility to meet the demands for low-priced food crops to the urban poor and for this reason the problem of efficient resource allocation on root crop farms is of prime importance to both the farmer and agricultural administrators.

The prophylactic action of cassava. O.L. Oke, University of Ife, Ile-Ife, Nigeria.

Cyanogenic glycosides are toxic in large doses, but the body can cope with small doses which are converted to compounds of high physiological activities eg. glucose, cyanate and thiocyanate (used for sickle cell crisis and certain hypertension), salicylic acid and isomers (an anti-pyretic & analgaesic) and hydrocyanic acid (a potent cytotoxin). Under certain conditions such as development of neoplasm or schistosomiasis, the cells affected contain high amounts of glucosidases or glucuronidases which are capable of hydrolysing the glycosides but are devoid of the enzyme rhodanese for converting the highly toxic hydrocyanic acid to the much less toxic thiocyanate. This therefore results in selective toxicity in which the cells are destroyed but the somatic cells with high amounts of rhodanese survive. Since the diets of people in developing countries contain a lot of cassava high in cyanogenic glycosides, this might account for the prophylactic property which results in rarity of sickle cell anaemia and bowel cancer.

Utilization of cassava as carbohydrate source for pigs in Malaysia. V.F. Hew and R.I. Hutagalung, Animal Improvement Div., Malaysian Agricultural Research and Development Institute, Serdang, Selangor-Malaysia.

Cassava is shown to serve as an inexpensive source of valuable energy for pigs. The correct choice of cassava with low cyanogenic glucosides and the use of high quality proteins to make up for nutrient deficiencies such as amino acids and vitamins makes the replacement of grains by cassava possible. The use of cassava would substantially reduce the cost of feed.

When 30 Landrace pigs were assigned to diets containing 0, 15, 30, 45 and 60% cassava as the energy source in their diets, no significant difference in performance nor carcass characteristics was observed. The increase in cassava levels was accompanied by an increase in fishmeal, a high quality and locally available protein source. The inclusion of higher fishmeal rather than other proteins of plant origin in high cassava diets is comparable to the supplementation in the cassava diets of methionine or other synthetic amino acids.

A preliminary study on the utilization of Cassava products as Energy Source for broilers. Sarote Khajarn and Jowaman M. Khajarn, Animal Science Dept., Fac. of Agriculture, Khon Kaen University, Thailand.

Two experiments were conducted in order to determine the substitutional value of cassava for corn in broiler rations. One-day-old Arbor Acres broiler chicks were used in these two experiments. In the first experiment, no significant differences in body weight gain and feed conversion were noted for chicks receiving 0, 7.5, 15, 22.5 and 30% substituted cassava pellets. However, in Experiment 2, significantly poorer body weight gain and feed conversion ($P < .05$) were noted during 1-5 weeks of age when the rations contained 0, 10, 20, 30, 40 and 50% cassava root meal.

It was also noted that body weight gain was not depressed until the rations contained above 30% of cassava root meal. The ability of chicks to utilize cassava root meal increased with age. Results from this experiment indicated that, during 5 to 9 weeks of age and 1 to 9 weeks of age, there were no significant differences observed on body weight gain and feed conversion when the concentration of cassava root meal increased in the rations. Limiting factors in maximum replacement and economic feasibility cassava product for corn were fiber and protein contents, the prices of these two feed-stuffs (cassava and corn) and protein supplements such as fish meal and soybean meal.

Protein enrichment of cassava by fermentation with microfungi: the role of natural nitrogenous supplements. G. Varghese, J.J. Thambirajah and F. M. Wong, Associate Professor, Graduate Associate and Research Assistant (IDRC) respectively. Faculty of Agriculture, University of Malaya, Kuala Lumpur, Malaysia.

In our recent studies on protein enrichment of cassava by fermentation using selected strains of Rhizopus Aspergillus and Neurospora, it was found that protein levels of fermented cassava do not exceed 3%. Since this is far below the recommended level for animal feed, we tested the role of natural nitrogenous supplements to augment fermentation efficiency. Solid fermentation of cassava chips with 35% supplementation of chicken dung increased protein levels to 8 - 10.5%. Since these values are still lower than required, we tested other supplements such as ground-nut, pineapple bran and soybean, alone and in combination with chicken dung. The results showed that appreciable increase in protein level (40%) of the fermented product could be attained.

A procedure for solid fermentation of cassava incorporated with natural nitrogenous supplements has been developed as a first stage towards the designing of a pilot plant for continuous production of the fermented product.

Utilization of nutritionally improved cassava by nutrient supplementation and microbial enrichment in poultry and pigs. R.I. Hutagalung and P.H. Tan, Faculty of Agriculture, University of Malaysia, Kuala Lumpur-Malaysia.

Studies related to the improvement of cassava through nutrient supplementation and fermentation were discussed. In a first series of nutritional evaluation of moist-solids fermented cassava on poultry and pigs, an experiment was carried out to investigate the effect of substituting maize with increments of fermented cassava on performance of broiler chickens. In addition, the preliminary results of iodine metabolism in pigs fed cassava diet were also given.

Substitution of maize with fermented cassava up to 50% level resulted in performance, animals which compared more favourably to that of the control. Total substitution of maize component of the chickens diet by fermented cassava did not appreciably depress the performance.

Further improvement in the protein quality of the fermented cassava and proper supplementation with other nutrients will make it a significant contribution both as energy and medium protein source to poultry and pigs, where there is a surplus of carbohydrates available.

Studies on the utilization of cassava (*Manihot utilissima* Pohl) by the ruminant. C. Devendra, Malaysian Agricultural Research and Development Inst., University Pertanian, Serdang, Selangor, Malaysia.

Results are reported from a research programme on the value and utilisation of cassava (*Manihot utilissima* Pohl) by the ruminant. Six trials were altogether completed, five balance studies with sheep, and the sixth, a feeding trial on cattle.

In trial 1 the addition of cassava to rice straw-molasses diets, significantly increased dry matter and crude protein digestibility and also N retention ($P/0.05$). In trials 2, 3 and 4, involving increasing levels of cassava (20, 40, 60 and 80 per cent) with varying levels or similar levels of dietary nitrogen, the highest digestibility of dry matter (93.2 to 94.5 per cent) and crude protein (62.4 to 92.6 per cent) were found for the 20 per cent level of inclusion; the differences were significant ($P/0.05$). The dry matter digestibility with 80 per cent level of cassava was 79.9 to 83.1 per cent.

Supplementing methionine (0.2, 0.4 and 0.6 per cent) significantly ($P/0.05$) only affected crude fibre digestibility, which increased with increasing levels of cassava (40, 60 and 80 per cent). Methionine may therefore be important in the activity of cellulolytic bacteria in the rumen. Maximum nitrogen retention occurred when urea supplied 62 to 63 per cent of the total crude protein requirements.

Feeding cassava (30, 40, 60 and 80 per cent) in the concentrate diet to Kedah-Kelantan cattle with Napier grass (*Pennisetum purpureum*) in the ratio of 1:3 in the total dry matter intake, indicated that the best daily

live weight gain (318.7g.) and efficiency of feed conversion (12.49) were recorded for the 30 per cent level. The value of cassava in increasing the overall supply of energy and N utilisation in the diet, consistent with maximum performance and productivity in ruminants is emphasised.

Lipase activity and the conversion of fat to carbohydrate in cassava, *Manihot esculenta* Crantz. Frederick Nartey, Inst. of Plant Physiology, University of Copenhagen-Denmark.

The activities of Lipase, Isocitrate lyase and Malate synthetase were investigated in Cassava, *Manihot esculenta* Crantz. The enzymes were present in mature dry seeds. Their activities increased gradually during the initial phase of germination. In the post-germination period of growth in the dark, however, the activities of these enzymes increased rapidly, and reached their peaks at the period of maximum carbohydrate synthesis and storage, which nearly coincided with the period of maximum lipid degradation. This indicated that the fat-carbohydrate mechanism in Cassava involves the key enzymes of the glyoxylate cycle.

A system of food delivery from root crops. Tommy Nakayama, James Moy and José H. da Fonseca, Dept. Food Science, University of Hawaii, Honolulu - Hawaii.

The production of stable convenient foods from root crops involves several steps which may be taken in diverse orders. For taro (Colocasia esculentum), it is possible to separate out the acidity factors by gravitational means, stabilize the material by dehydration, and utilize it as the main component in a noodle like food which can be prepared for consumption by simple cooking.

These steps are part of a larger study aimed at the entire system of delivering food calories from root crops.

Mechanization of yam and sweet potato production in Barbados. J.P.W. Jeffers,
Ministry of Agriculture, Science and Technology, St. Michael - Barbados.

A locally constructed planter and an imported transplanter were used to plant Yams and Sweet Potatoes respectively on a field scale.

Harvesting was carried out using a locally constructed Harvesting-Aid and an imported Digger-elevator. The Digger-elevator was successful in Sweet Potatoes, but will have to be modified to work on Yams.

Salinity effects on plant growth and tuberization in Cassava. P. Indira and N. Hrishi, Central Tuber Crops Research Intitute, Trivandrum-India.

The effects of salinity on plant growth and tuberization in cassava were studied. Salinization was effected by the addition of sodium chloride to the soil and the concentrations used were 0 ppm, 500, 1000, 1500, 2000, 2500, 3000, 3500 and 4000 ppm. The criterion of judging the tuber initials was the deposition of starch in the secondary xylem region of the transections of the roots observed under the microscope. The results suggest that the plants are subjected to toxicity from 2000 ppm onwards resulting in retardation of plant growth and tuber initiation. The anatomical investigations in the roots indicate that the decaying of the cortical parenchyma and formation of tyloses in the vessels were the associated anomalies derived from the toxic effect of salinization.

Autotetraploidy in *Vigna Capensis* Walp.- A leguminous root crop of India.

K. Vijaya Bai and N. Hrishi, Central Tuber Crops Research Institute, Trivandrum-India.

Tetraploidy was induced in *Vigna Capensis*, a leguminous tuber bearing species. The morphology and cytology of these tetraploids and the tetraploid plants raised from the open pollinated seeds in comparison with their diploids were studied and reported. Irregular meiosis resulting in the formation of tetrads with micronuclei and reduced fertility were recorded in the tetraploids. The number and size of tubers were more in these tetraploid plants as compared to their diploids which indicated the scope for economic exploitation of these tetraploids as a valuable tuber crop.

Producción de Arracacha (*Arracacia xanthorrhiza*) en el Trópico frío.
F. Higueta M., Ingeniero Agrónomo. Director Regional Programa Hortalizas y Frutales. Tibaitatá. Bogotá - Colombia S.A.

La arracacha, (*Arracacia xanthorrhiza*) Banch, es una raíz comestible propia del trópico frío. Los campesinos de Los Andes, tienen especial predilección por esta planta, la cual en muchos casos se consume tanto como la papa o la yuca.

HISTORIA. La primera descripción conocida sobre la arracacha data de 1533. El Cronista Fernández de Oviedo, relata las características de la planta cultivada en las Indias Occidentales.

The cultivation and uses of Curcuma spp. in Indonesia. Made Sri Prana,
The National Biological Institute, Bogor-Indonesia.

Of the 20 species of the genus Curcuma reported to occur in Indonesia some are of economic importance, utilized for many different purposes, namely: as medicinal plants, sources of starch and vegetables, spices, dyes and as important materials in domestic rites. Their cultivation, however, has not been given very much attention.

Serious genetic erosions have been noted in several places, particularly in Java and Sumatra.

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