Hunt Institute for Botanical Documentation
5th Floor, Hunt Library
Carnegie Mellon University
4909 Frew Street
Pittsburgh, PA 15213-3890
Telephone: 412-268-2434
Email: huntinst@andrew.cmu.edu
Web site: www.huntbotanical.org

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About the Institute
The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

The general efforts by colonials with Manihot has been in typical agric. areas of interest - fertilizer, varietal improvement, starch manufacture, export qualities + methods of production -

Very little attention to the social + anthropological aspects from point of view of natives - Asian, African or American -

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The only mention of diseases or malnutrition related to M. come from Africa or Asia - none from Latin America! Why?

FRI Library Cassava reprints

Bull. Dept. Agr. Trin + Tobago, XIV (2): 1-57. 1915

Gives uses, et al. in Trinidad.

Lists diseases - article by Rorer, J.B. pp 36-38

Leaf diseases - Cercospora - 3 sp. C. manihotis, C. cassavae, + C. henningsii -

Gloeosporium manihotis

Cercospora ⇒ leaf spots.

Gloeosporium ⇒ attacks leaf stalks (and young stems)

Stem diseases - (report from Brazil - 2 diseases)

Bacillus manihotus, more destructive 1st spots, enlarging to girdle stem - no apparent report of stem disease in Trin.

Root diseases - practically nothing known in Trin.

Insects - art. by Urich, F.W., pp. 38-40.

1. Bud maggot - Lonchoea sp. (Lonchoea chalybea)
2. Leaf mite - dwarfing + spotting of leaves.
3. Gall Midge - Lasioptera x sp. galls on leaves.

several others not considered as important pests.

Article by Carmody, reprinted here from the September 1900 issue of Lancet - on HCN - mentions presence of CN in sweet manihot.

Geography – in India – areas of cult.

Anon. – Report on the continuance of protection to the Sago (Tapioca Globules) Industry. For the Tariff Commission of Government of India – Bombay, 1954.

Gives regions of production of "Tapioca root" as: Travancore-Cochin State and in Malabar and Salem Districts and to a lesser extent in North Arcot, Tanjore and Thiruchirapalli Districts of Madras State.

Production – acreage in 1951, 52 + 53 in Travancore-Cochin State = 525,287 acres and ave. prod. as 1,497,000 tons for av. yield of 2.85 tons of roots/acre.

Moscrip, J. 1940. Possibilities for cassava growing in Florida. Fla. Dept. Agric. Bull. 104 (new series) 23 pp. – general agricultural discussions, with use as feed for cattle + hogs + chickens

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Balkuis, G.C. 1954. The Toxicity of Cassava Roots. Netherlands Jour. of Agric. Sci. Vol. II (3): 6-13.

Reproduces Koch's table of poisonous capacity –
< 50 mg. ACN/kg fresh root – innocuous.
50–100 mg " / " " " – Moderately poisonous to poisonous
> 100 mg " " " " Very " "

But see statement by Pereira that 40 mg is poisonous!

Bolhuis (cont.)

Quotes results of expt. showing soil influence of moisture in HCN conc., using a variety "Mangi" which is usually low in HCN (30 mg. HCN per kg. fresh root) and another São Pedro Preto high in HCN (150 mg on the average. Two plots of similar lateritic nature, one formerly rice paddy (good fertility) and one formerly under citronella grass, then upland rice (low fertility).

Tabulates results (TABLE 1) p 8.

Var	Age at harvest	mg HCN/kg. fresh root	
		wet field	dry field
Mangi	6 mos	32	98
	8 "	29	116
	10 "	41	137
	12 "	36	148
São Pd. Pr.	6 "	183	562
	8 "	169	537
	10 "	166	516
	12 "	152	451

Infers that "dry" soil has very great effect on HCN conc.

Bonnett 1949 - in Congress du Manioc, Marseilles, 1949, p. 30 - says N increase increases HCN

Koch, 1933 - and Nigholt, 1934-35, say N content of soil not influential on HCN.

Bolhuis (cont.) - p. 9. Does not agree that degree of toxicity and production of starch go together.

Also does not see correlation with age and toxicity - although differing varieties having differing correlations.
But size of root and HCN seem correlated - the larger the root, the less the HCN. (or in other cases vice versa)
What the above says is that age + HCN may be correlated, because a larger root might be older -

Shows no correlation with position of cutting (upside down or right side up.) except that the "poisonous" varieties tend towards higher HCN when planted upside down.

A non significant correlation (2 out of 3 varieties) showed reduced HCN when chromosome number increased by colchicine treatment.

On inheritance of HCN, an experimental hybridization indicated (p. 12) that inheritance of poisonousness is based on a fairly large number of genes.

In discussion, says that "toxicity of cassava roots can be influenced to a very large extent by a

Bohlens (cont.) p. 12 -
deficiency of K in the soil. K has substantial influence on the occurrence of alkaloids and glucosides in plants, i.e. K deficiency causes the content to increase, K surplus causes it to decrease.

Connection between N and the degree of toxicity has not yet been found.

Adriaens, E.L, + Hostermans - Medard. 1954. Remarques à propos de la Composition chimique du manioc roui, non roui ou cuit à l'eau
Bull. agricole du Congo belge. XLV(1): 1-26.

Compares results of the "retted", non-retted, and boiled manioc for content of HCN. Does not mention protein produced by the fermenting organisms, and apparently considers the "roui" process to be one of soaking, not one when the microorganisms make much of a conversion.

to remove HCN.

Tables indicate that nitrogenous substances ("Matieres azotées") in retted samples range from 0.78 to 2.57 parts per 100 parts of dry weight, and (Ammoniaque mg) from traces to 52.6.

but the content of HCN is negligible.

All samples show increase in net protein.

Bolhuis, G.G. 1939. Omgekeerd Geplante Stekken van cassave – Landbouw XV : 141-151.

Experiments with inverted planting indicates no advantage.

Govinda Rao, H.A. 1951. Cultivation of cassava and preparation of its products. The Mysore Agricultural Journ. XXXII-27 (3) : 57-69.

Storage of roots up to 4 days by steeping in mud

Graner, E.A. 1935. Contribuição para o estudo cytologico da mandioca. Universidad de São Paulo. Escola Superior de Agricultura "Luis de Queiroz". 28 pp. + 13 plates.

Describes floral morphology, micro + mega sporangenisis, somatic mitosis,

Counts $2n = 36$ in all cultivars studied.

Has English summary –

Gives methods of preparation.

Ogbunga, V.A., and Opeke, L.K. 1957. The Value of Cassava Rations for pork and bacon production. W.A. Jour. of Biolog. Chemistry Vol. 1 (1): 3-14.

The value of this paper is that it indicates that cassava, when used in a balanced ration, has no deleterious effects, indeed, was better than guinea corn, as long as it doesn't have to be considered the whole diet - thus proving that there's nothing wrong with cassava, per se, but with the diets.

This should apply to humans as well as pigs.

Jacquot, R. and Haloch, B. 1936. Le Manioc et son utilisation alimentaire. Actualités Scientifiques et Industrielles 364. 1-56. Librairie Scientific Herman et Cie. Paris.

This is the only study I've read on the nutritional aspects of the starch of manihot. Here, there is a report on saccarification with human salina, and in this, wheat flour is more readily saccharified. Saccharification with dog pancreatic enzymes, is slightly smaller than for wheat. But extrinisation of ~~potato~~ flour of manihot is easier than flour of potato!

Considering the coefficient of utilization of

Jacquot (cont)-

digestive utilization, the low content of cellulose of manihot flour makes it very high - (digestive utilization coefficient)

Comparisons of energy value of 3 types:

complete flour	336 calories / 100 g.
blanched "	324 " "
tapioca "	316 " " .

Rat feeding trials showed what others have suggested — a pure diet of manihot is extremely debilitating, and mice dead in 26 days

The above indicates that while good value for energy, a lousy balance and poor nutritional.

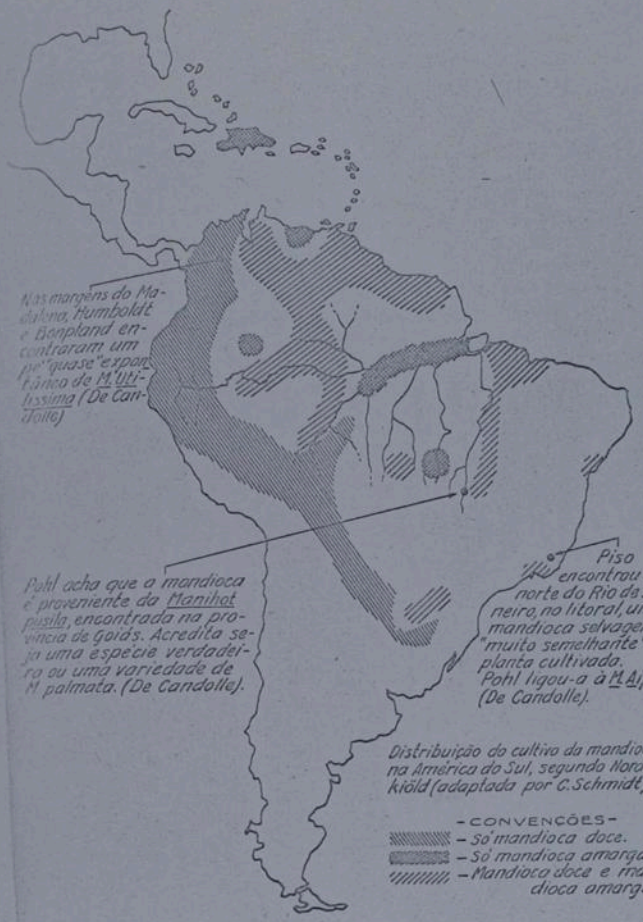
Particularly, manihot is lacking in nitrogenous substances, in phosphorus, and a probable deficiency in vitamins.

Schmidt, C. B. 1951. A Mandioca. Contribuição para o conhecimento de sua origem. Bull. de Agricultura, São Paulo, Series 52ª, No. 1, 1951 pp. 77-128.

Cites very thorough review of Indian migrations, and relates the spread of M. from Brasil northward, via Arawaks and Caribs into W. Indias, and claims that the bitter species arrived in Central America when English forced the migration of the Caribs from the W. I. to central America, in post Columbus time. He cites Sapper as source of his information on this transfer. Thought there to be two species, as usual, and ~~Sidney~~ cited M. pusilla on a map adapted from Nordenskiöld as in a region in Brazil where both sweet and bitter M. occur. He apparently believed Nordenskiöld's map of differentiation of sweet and bitter.

See xerox copy of Schmidt's map - attached

From Schmidt, P. 101



From: Tropical abstracts 26(8), August 1971

u2045. Sinha, S.K., et al. Note on the possibility of controlling increased cyanoglucoside content in cassava tubers caused by higher application of nitrogen. Indian J. Agr. Sci. 40, 6, p. 573-5. 1970.

An expt was conducted in India to study the effect of N (as ureum) on the HCN-content in tubers of a sweet and a bitter cassava (m esculenta). Compared to the soil application the foliar-spray application reduced the HCN-content 55-67%. The application half to the soil and half to the foliage gave a decrease of 23-50%. Tables. 5 refs.

u2046. Hogger, C.H. Plant-parasitic nematodes associated with cassava. Root Tuber Crops Newsletter 4, p 4-9. 1971.

Anthropology

Denevan, W.M. 1971. Campa Subsistence in the Gran Pajonal, Eastern Peru. The Geogr. Review. 61(4): 496-518.

Agricultural system of Campas, slash-burn. List of crops raised by the tribe. Yuca and maize are most important, and cropping methods are described. Gives typical daily diets of the people, with yuca 71.8% of total calories, and 10.2 % protein from the yuca (1,049 grams is weight consumed per day). The Campa are ax "nonriverine, seminomadic tribe driven to nomadism by difficult search for animal protein.

Chevaugeon, J. 1956. Les maladies cryptogamiques du manioc en Afrique Occidentale. Encyclopedie Mycologique XXVIII: X vi + 205 pp. publ. by Editions Paul LeChevalier 12, Rue de Tournon, 12--Paris-VI^{e}.

This is the most comprehensive treatment of the fungus diseases of Manihot that has been published. It is restricted to the countries of West Africa, from Senegal south to the Ivory Coast. Has very good descriptions of the symptoms, the fungus, and something about the pathogenicity of each. Has good line drawings of the organisms. Does not include the virus diseases. Includes experimental studies done at the Institute of Adiopodoumé (Adiopodoumé), Ivory Coast, which includes variations in varietal resistance to "die Back", to Cercosporas, influence of age to disease development, particularly to Glomerella cingulata (Ston.)Sp. et v. Schr. f. sp. manihotis f. nov.

Has extensive bibliography.

Mason, R.R. 1956. Cassava Varieties in Fiji. Agricultural Jour. Dept. of Agric., Fiji, 27 (3 &4): 88-93.

Summary: Lists 16 cultivars of M. now growing (1956) on island. First introduction in the 1850s, at first not widley accepted, but today 16,000 acres under cultivation. The varieties are described using characters similar to ones I use, and gives a key to them. Has two cvs variegated and used for ornamental horticulture. HCN analysis indicates all are in the "sweet" category, but with varying concns. Does not describe how food is prepared. One interesting comment is that one cv.,"manioke" a very poor yielder, seems to have been very early introduction. Young stems are dark green with a distinctive round appearance, and the stems are "angled" rather than straight. Furthermore, this cv. which is woody, is not grown now but propagates itself in the bush. This would seem to support Harlan's hypothesis that some of the wild forms are derived from the cultigen. The description fits well with number 390 from eastern Pernambuco.

Kim, J.C. and deRuiter, D. 1968. Bread from non-wheat flours. Food Technology 22: 867-878.

Abstract: Shows that mixes of cassava flour and cassava starch, along with peanut or soy bean protein extract, with a rising agent, can make satisfactory bread, and by rat-feeding trials found digestability and food value more or less equivalent to wheat bread.

Chant, S.R., Bateman, J.G. and Bates, D.C. 1971. The Effect of Cassava Mosaic Virus Infection on the Metabolism of Cassava Leaves. Trop. Agric. (Trinidad) 48(3): 263-270.

xx Summary: Respiration rate and peroxidase activity were increased in cassava leaves as a result of infection with cassava mosaic virus. No new .....Photosynthetic activity of immature and senescent leaves was not affected by cassava mosaic virus infection but was reduced by approximately 23 percent in infected mature leaves. Chloroplasts of virus-infected mesophyll cells were irregular in shape and contained numerous swollen starch grains.

Miege, J. 1959. La staminddie chez le manioc en Côte-d'Ivoire. Revue de Cytologie et de Biologie Vegetales 20: fasc. 3.161-185.

Staminodes in 4 clones of manioc were studied. Staminodes reach varying stages of development, in some cases sufficiently to produde viable pollen, and thus an hermaphrodite flower. Does not tell where the cultivars exhibiting this condition came from. Lists Senaratna, 1945 (Bisexual flowers in the manioc. Ceylon J. of Science) as first to observe this condition. Says that staminodes occur in the pistillate flower, but that pistillodes do not xxxxx occur in the staminate flower. Claims physiologic factors as responsible for the occurence, and that the season of production is important, most occurring in the dry season.

G A R I - - definition, chemical analysis, xxxuse, and manufacture.

A series of 4 mimeographed papers from the Federal Institute of Industtrial Research, Federal Ministry of Commerce and Industry, Lagos, Nigeria gives best discussion available.

Research Report No. 12, by I.A. Akinrele, A.S. Cook and R.A. Holgate, "The Manufacture of Gari from Cassava", May 1962, 8 pp. + 3 drawings of equipment.

Technical Memorandum No. 12, by L. Banks, xxx "Background information on mechanised Gari (cassava) Production as an aid to equipment manufactures in development work. April, 1962.

This paper describes gari, and estimates that in Nigeria, 20,000 tons per day are consumed.
The traditional method gari production is described: fresh tubers washed, peeled, grated by hand or home-made raspers and the grated material, after being place in bags, is subjected to pressure by piling heavy stones on tope of the bags. During this process, which takes 3 to 4 days to complete, the juice is squeezed out of the mass and at the same time a degree of fermentation takes place. The fermented pulp is removed from the bags, sieved and heated in large iron pans (surface temperature about 120° C) which are sometimes smeared with an oil (usually red palm oil). The cooking is stopped when the material makes a rustling noise. The resulting product (yield 28 to 30 percent of the tubers) is granular, white or pale straw colour, with a slightly sour aroma and a characteristic tasted. The moisture content of this gari is 12-14 percent and it keeps for only a few weeks. Drying down to 7 percent moisture content increased the keeping properties considerably, but the wetter product is apparently preferred by the average Nigerian.

The analysis of a typical sample of gari produced by F.I.I.R. (Federal Institute of Industrial Research) pilot plant is as follows:

starch content	87.0 % by weight
water content	8.2 %
fat content	0.1 %
crude protein	1.5%
crude fibre	2.3 %
ash	0.9 %
calcium	45.6 % Mg/100 gm.
phosporous	56.9 % Mg/100 gm.
H.C.N. content	10 p.p.m.

calories 325-350 per 100 g.

This paper gives a schematic for processing gari.

Library reprints.

Use + economies -

1. Scheltema, A. M. P. A. 19—?. World Production and consumption of Cassava articles. The Netherlands Indies. Vol. IV. No. 13, 14 and 15. ~~Kolff~~ Kolff + Co. Batavia - Centrum.

gives names of various products.

1. roots in fragments; cut + dried.
   Dutch - gaplek, + when ground, gaplekmeal -
   French - manioc séché, when ground farine de manioc
   American - tapioca crude (gaplek) and cassava.
2. Cassava meal (cassava starch) - differs from 1 in that fibers have been removed - used in washing starch, glucose, alcohol + textile stiffener + filler.
   Dutch - cassavemeel or cassavezetmeel
   French - fécule de manioc
   German - Maniokstärke
   Portuguese - farinha de mandioca
   English - tapioca flour + raw tapioca starch.
3. Tapioca flakes + siftings, pearls + seeds. prepared from machined flour by action of heat.
   Dutch - tapioca vlokken, paarl en seeds
   French - tapioca en perles
   German - Flockentapioka or Perltapioka.
   English - flake tapioca, tapioca siftings + pearl tapioca.

"Sago" - sometimes used for a fine-grained variety of pearl tapioca.
In trade, to make proper distinction, the real sago is designated "palm" sago, and the tapioca sago as "root sago".

4. tapioca residue - byproduct in production of cassava flour - residue of starch in the cell walls + unopened cells - made into cattle food or prod. of commercial starch -
Dutch cassavearmpas
French. déchetes de fabrication de manioc -
German - Tapioca abfälle -

Also gives production figures (pre W W II) for most producing countries - Dominican republic is a surprising large contributor for such small area.
Also exports in various forms

Clifton-Riley, B.O. 1942. Report on Manioc Starch Brazil. 20 pp. FRI Lib.
Interamerican Development Commission - (Mimeograph)
Nomenclature:
Farinha de Mandioca (manioc meal) -
peeled roots grated, squeezed, heated, sieved -
Gaplek = Raspa de Mandioca - chips or pieces of dried roots.
~~Farinha~~ Farinha de raspa de mandioca = gaplek meal
Farelho de Raspa de Mandioca (Manioc bran)
~~Sub product used for cattle feed~~

Manioc starch - 3 equivalents in Portuguese, known in English as Manioc starch or as tapioca flour - (the latter used to get around import duties on anything labelled as Starch)

Portuguese = 1) Polvilho de Mandioca } used interchangeably
2) Fecula " "
3) Amido.

but #1 is a more granular than #2, and contains more impurities
#2 is more finely ground, a better product,
#3 is an indiscriminate term for #1 + 2.
although #3 is used in reference to starch extracted from cereal grains
Fecula is starch extracted from roots, both manioc + potatoes,
so, #1 is a subdivision of #2.

Fecula is extracted from the raw, undried root
roots washed, chipped + grated - washed with H_2O -
+ the mass sieved + run into sedimentation tanks.
then sun- or oven-dried.

Tapioca is made by taking the wet extracted
starch, dropped thru a tube or sieve
on a hot metallic plate - the heat causes the
liquid to dissolve part of the starch + the
drops unite into semi-transparent tapioca grains

Making starch from dried chips less efficient than starting with fresh roots – less time + processing. Except processing plants need roots <36 hrs old, + the plants not close enough to all growers.
Starch from gapeka makes poorer quality refined product

The above suggests that two separate objectives exist for development – 1) the industrial, with a whole set of procedures defined for it – and 2) the food processing with another set of procedures –

This paper mentions as "standard" work,
auth = Juvenal Mendes de Godoy
Title = Fecularia e Amidonaria.
No source given –

Alcohol manufacture.
Auth: Juvenal Mendes de Godoy e Paulo de Aguiar Godoy –
Title. Emprego do Bagaço das Fecularias de Mandioca no Fabrico do Álcool.
Date + pp. 1946; 25 pp.
Source: Secretaria de Agricultura, Industria e Comercio. Directoria de Publicidade Agricola. São Paulo.
The work done in Bolsa de Mercadorias de São Paulo. Laboratorio de Tecnologia.

Alcohol (cont.) – Godoy points to usage of the sacarified starch from the "bagass" of mandioca for alcohol production.
"Sacarificado" = ?
Discusses the processes nec., the costs,
And concludes that mandioca bagas is prime material.

General – no menc. –
Colom, José L. 1932. Cassava: an Economic Plant Native to Latin America. Bull. Pan American Union. Sept. 1932. pp. 639–650.
4 incl. Nomencl., Botany, Chem. Analysis, History, Cult., Uses + Products.

Industrial + general | Bravo, A.F. 1950. El Cultivo de la mandioca. Misc. publ. No. 330. Ministerio de Agricultura y Ganaderia. Republica Argentina.
12 pp. + 1 diagram.
Gives production figures 1940–46 – 14,000 kilos per hectarea, sold for 10 centavos / kilo.
In 1947/48, 5,840 hectares cultivated.
Describes a mill to produce starch – diagram – from fresh roots.

Chem. Analys.

Mohr, W. 1944. Analyses Químicas de 115 variedades de Manihot utilissima, cultivada no campo experimental de mandioca, em Capela, Município de Caí. Secretaria de Estado dos Negocios da Agricultura, Industria e Comercio, Secção de Informações e propaganda Agricola. Porto Alegre, Rio Grande do Sul, Brasil.

Analysis of H_2O, ash, protein, fat + fiber -

Adrians, L. 1946. Contribution à l'etude de la Toxicité du manioc au Congo Belge. Inst. Roy. Colonial Belge. Sec. des Sci. Nat. et Med. Memoirs - Collection in-8°. Tome XIII, fase. 4.

Gives notes of toxicity (HCN + its condition in plant), toxic effects, antidotes (retarde with doses of $NaNO_2$ - because effect of HCN is removal of O_2), also use methylene blue).

Ch. II -

Preparation of manioc - talks about "roussage" - retting. Doesn't connect the fermentation process of the organisms (sparks et al) with the removal of HCN -

He makes the good point that just cooking the paste (pâte) does not get rid of HCN entirely because the liberating enzyme is destroyed,

and the heteroside remains in the product, ~~to be~~ & the HCN then can be freed in the stomach.

Arnaud's paper is a pretty good monograph & on chemistry & toxicity of M., but is updated by De Bruijn.

Speaking of exports + imports, seems to me important to differentiate the kinds of products, and discuss them separately -

Tapioca
Gaplek
Chips
etc.

Brannon (Ga, Chapt 8) does not differentiate -

761-1022

~~Sunrise~~ or Sunset Produce Co - Imports some -
or Sunrise?

Quarantine - Miss Silverman 556 4332

add to bibliography the following references from FRI library new books

1. Jameson, J.D. 1970. Agriculture in UGanda, publ for the Uganda Govt. ministry of Agriculture and Forestry by Oxford University Press. page. 247 under section "Other Crops", F. Roots. Cassava, by Jameson and D.G. Thomas.

   General discussion of cassava agriculture. Some interesting statements:
   "Many varieties flower freely, especially those that mature early."
   "Planted cuttings horizontally, slight angle, or even vertically. The variety 'Kru' from Ghana needs to be planted vertically."(No explanation of why).
   "In millet areas cassava is commonly planted as the last crop before fallow in crop rotation."

   Tabular infofmation--1963-64 acreages of cassava--total for country = 419,000

   Mosaic is only serious disease of cassava in Uganda.

2. Some Issues Emerging from Recent Breakthroughs in Food Production. K.L. Turk, ed. publ. by NY State College of Agriculture, Cornell. 1971 495 pp.
   Hill & Hardin, p. 13 "Yet generally these roots crops have suffered from scientific neglect.
   Erven Long. p. 116."Research on other standard crops--potatoes for the high lands, cassava for the dry lands.....should all contribute to opening opportunities to a larger group of farmers."