Cassava Research in Nigeria Before 1972

E. E. Umanah[1]

This review of cassava research achievements in Nigeria over a period of 20 years pays particular attention to plant breeding, agronomy, chemical analysis, physiology, pests and diseases, and cytogenetics. Breeding objectives and varieties recommended for the various ecological areas of the country are discussed.

A package of management practices as recommended from research results is given. 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 $X = 9$.

Cassava is of great importance in the national economy of Nigeria, and is second only to yams in total root crop production. However, cassava produces more calories per acre than yams and is easier to cultivate. In addition to its food uses, cassava is also used in industrial processes. By 1985, Nigeria hopes to produce 13.9 million tons annually.

The objective of this paper is to document the research achievements on this crop over a period of 20 years.

History of Cassava Research

Selected high-yielding disease-resistant varieties of cassava were introduced to Nigeria about 1940. Following trials in the eastern part of the country GCH 7 or 37065 was recommended for cultivation about 1942 because it was higher yielding than local varieties and was tolerant to mosaic disease. About 1953, variety 53101 was recommended to the Western Region and the southern part of the Northern Region.

Although some collections, introductions, and work on mosaic disease had been done as far back as 1932, serious and systematic cassava research for improvement by breeding and cultural practices was only initiated in 1955 when a plant breeder was assigned to the cassava improvement program.

The objectives of this improvement program included: (1) high yield of tubers; (2) high starch content; (3) high dry matter content; (4) high protein content; (5) low hydrocyanide content; (6) good quality; (7) cassava mosaic disease resistance; and (8) improved cultural practices.

To achieve these objectives, cassava collections of varieties grown in different ecological zones in Nigeria and from foreign countries were initiated, and a selection of the highest yielding types was made. These introductions included *Manihot glaziovii* from Puerto Rico, *Manihot melanobasis* and *M. saxicola* from Surinam, and interspecific hybrids such as 58308, 58198, and 58212 from Amani in East Africa, which were resistant to mosaic disease. Variety 58308 was low in prussic (hydrocyanic) acid, however it was also low in tuber yield.

The country can be divided into two broadly based ecological zones on the basis of consumer preference. In areas north of Minna, consumers prefer "sweet" cassava, which is eaten raw or boiled and made into "tuo." In areas south of Minna down to the coast, the emphasis is on gari production from "bitter" cassava.

Samaru was selected on this basis as the centre for collections and trials for the Northern States. The area south of Minna was divided into four ecological and administrative zones for collections and variety trials.

Hybridizations within the species *M. esculenta* were carried out to obtain high-yielding mosaic tolerant/resistant types with desirable agronomic characters. Crosses involving the varieties 53101 and 42074 as parents and 53101 and 32031 as parents gave consistently high yielding hybrids. Seedlings of these hybrids were raised in nurseries, and subsequent multiplication stages were tested in progeny trials replicated at various centres and finally in zonal centres. No one variety was consistently high yielding at all locations. This led to independent selections of cassava hybrids in the different climatic zones of the country. Combined analysis of the trials showed that varieties 60444, 60506, 60447, and 53101 were the highest yielding selections and were recommended for cultivations in the various ecological zones, Table 1.

---

[1]Federal Department of Agricultural Research, P.B.M. 5042, Ibadan, Nigeria.

Table 1. Recommended mosaic-disease resistant cassava varieties and their qualities.

Variety	Yield (t/acre)	Mean increase over local variety (%)	Recommended to be planted in (States)	Starch content at 15–18 months (%)	HCN (mg/100 g)
37065 (GCH7)	8.9	28.0	Eastern Nigeria	23.0	182.0
44086 (Congo) (Sweet)	5.6	8.2	Eastern Nigeria	22.0	135.0
53101	13.6	64.5	Western, Kwara, B/Plateau, Southern parts of N/West State	30+	185.0
Dan Wari (Sweet)	8.5	32.0	Cassava growing areas north of 10 °N latitude	30	145.0
60444	16.3	95.3	Mid-West, East Central, South-East, Rivers, Lagos	25–30	162.0
60506	15.4	78.0	Western, Kwara, B/Plateau, Southern parts of N/West, Mid-West, East Central, South-Eastern	30	162.0
60447	15.0	55.1	Mid-West, East Central, South-East, Rivers, Lagos	25–30	189.0

Interspecific hybridization of clones, selected as described above, with other species of *Manihot*, such as *M. glaziovii*, *M. saxicola*, and *M. melanobasis*, was designed to introduce characteristics for mosaic disease resistance and high protein content in cassava. Hybrids from crosses made between selected cassava varieties and *M. glaziovii* usually broke down in resistance to mosaic disease within a few generations.

Cassava varieties with high protein content are of importance where tubers are consumed raw by humans or fed to livestock. *M. esculenta* has only about 1.6% crude protein in fresh tubers, but tubers of *M. melanobasis* and *M. sexicola* have crude protein contents of over 10%. This necessitated the production of interspecific hybrids from *M. esculenta* crossed to *M. melanobasis*. Cassava variety 50100 was crossed with *M. melanobasis* (58186). Back crosses were made to *M. melanobasis*, but although the protein contents of the back cross progeny were improved, the total tuber yield was low. Further crosses to the high yielding varieties are to be carried out.

Chemical Analysis of Tubers

Tuber analyses for starch content, dry matter content, and hydrocyanide content were carried out for all promising varieties to assess the qualities of these varieties. It was generally found that bitter cassava contained more starch than sweet varieties. The starch content of tubers also varied with age — the highest starch content being found at the age of 15–18 months. Depending on varieties, the range was 20–30% of fresh tubers. The dry matter content of cassava tubers varies with the starch content. The range is between 30 and 40% of fresh tuber weight harvested at 12 months (figures as high as 40–50% are common for tubers harvested at 15–18 months).

The hydrocyanic acid content of tubers is a very variable characteristic, which is subject to environmental influence (Jones 1959). With cyanide titrations it has been found to vary within the tuber and within the variety. Drier soils appear to favour high concentrations of the acid. The relationship between the acid content and taste of the tuber (sweet/bitter) has not been assessed.

Physiology and Seed Germination

Experiments on effects of different ranges of temperature and scarification on the germination of cassava seeds were carried out. Outcrossed seeds of cassava varieties 60444, 58308, and 53101 were subjected to temperatures from 35 to 50 °C for 24 hours and then soaked in water at ambient temperature for 24

Table 2. Effect of time of planting on yield of different varieties.[a]

Time (months)	Yield of different varieties (lb/plot)				Mean (t/acre)
	53101	60444	60447	60506	
June	775	789	844	716	15.8
July	694	761	678	657	14.1
August	306	484	328	297	7.2
September	257	296	391	325	6.4
October	212	78	209	181	3.4
Mean (t/acre)	9.1	9.8	9.9	8.8	9.4

[a]LSD ($p = 0.05$) = 18.1 lb/plot or 1.5 t/acre.

hours. Germination in the greenhouse occurred between 15 and 25 days and varied with varieties.

Seeds of other varieties were immersed in water and subjected to periods of heat pretreatment (35 °C) in an attempt to speed up germination. All varieties gave 80% germination between 15 and 20 days after 48 hours of this wet heat pretreatment.

This period of maximum germination was the same as that obtained for scarified seed, which usually completed germination within 15–20 days. Because scarification is time consuming, and results in heavy losses, the 35 °C heat pretreatment for 48 hours was recommended for large scale cassava seed germination (Umanah 1970).

Agronomy Practices

The experiments on agronomic practices included planting dates, planting method, length of cuttings, number of cuttings, spacing and hence plant population, time of harvesting, and fertilizer practices.

Planting Date

In the southern parts of the country the period between April and July was found to be the best time for planting, whereas June–August was best in the north. At Ibadan it was shown that planting in June significantly outyielded July, August, September, or October planting (Table 2). In wetter areas, such as Umudike, April and May plantings were shown to be as good as June.

Harvesting Date

Yield data and starch content of tubers at different times of harvesting were studied. Significant differences were demonstrated for the different times of harvesting (Table 3). Yield at 18 months was highly significantly superior to that at 12 months and those beyond 18 months. But there was no significant difference between harvesting at 18 months and 15 months. The same trend is shown in the starch content of the tubers (Table 4). There were significant differences in varieties × harvesting times interactions although between varieties, the differences were not significant. The highest starch content was found in variety 53101 at 18 months and this was not superior to 15 months harvesting time.

Planting Method

Investigations on planting methods revealed that multiple cuttings were either buried horizontally or were stuck right side up singly per stand. Erect or slanting orientation of single cuttings two-thirds buried was found to give superior yield to horizontal orientation, because in the latter case numerous main stems formed and the resulting overcrowding reduced yield.

Length of Cuttings

Experiments with cuttings of different lengths showed that the most efficient length was between 9 and 12 in. Cuttings 9 in. long were recommended to economize on planting material (1 in. = 2.54 cm).

Spacing and Plant Population

Spacing combinations of 2 × 4, 3 × 3, 3 × 4, 4 × 4, and 6 × 4 ft were tried. The spacing adopted varied with variety used. For instance, it was found that varieties that were tall and had a scanty canopy with little branching did well with 3 × 3 ft spacing, whereas those that had little branching and a thick canopy, e.g. 60444, required a spacing of 3 × 4 ft. An

Table 3. Effect of time of harvest on yield of different varieties.[a]

Variety	Time of harvest (months) 12	15	18	21	24	Mean (t/acre)
60447	687	987	1061	1001	946	15.8
53101	756	883	1087	994	724	15.3
37065	625	665	871	625	669	11.7
44086	444	680	588	463	452	8.6
Mean (t/acre)	10.6	13.8	14.9	13.2	11.8	12.9

[a]LSD ($p = 0.05$) = 29.5 lb/plot or 1.2 t/acre.

average spacing of 3 × 4 ft (12 ft^2) of feeding area gave a good average yield for all varieties. The recommended spacing is 3 ft apart on ridges separated by 4 ft, giving a plant population of 3630 stands/acre for a sole cassava crop (1 acre = 0.4 ha).

Fertilizers

Initially, great controversy existed about the application of fertilizers to cassava, due probably to the low yield returns from the unimproved varieties, which were cultivated. However, with the recommendations for improved varieties, fertilizer practices were also recommended. Experiments, which were carried out mainly in the Eastern Region between 1960 and 1967, revealed that the new cassava varieties were responsive to fertilization (Phillips 1973). It was therefore recommended that on acid soils (pH < 5.0) lime should be applied at a rate of 1500 lb/acre before planting. Then nitrogen as sulfate of ammonia and phosphorus as single superphosphate should be applied together with sulfate of potash as a 10:10:20 mixture at the rate of 240–300 lb/acre for a sole cassava crop. Nitrogen and potash are more important for cassava than phosphorus. Time of application was given as 3 months after planting provided there was enough moisture available. When cassava is repeatedly grown as a sole crop on the same land, such as in a plantation, or in a rotation system, fertilizer must be applied to obtain a good crop.

Pests

Several pests of the cassava plant exist, but most of them are not serious and some are seasonal.

Bemisia nigeriensis (*tabaci*) or the white fly is the vector of the cassava mosaic disease. Golding (1936) showed that this insect transmitted the virus from one cassava plant to another. The grasshopper, *Zonocerus variegatus*, causes seasonal damage to the leaves of cassava during the dry season. They move in swarms and devour the plants. They can be controlled by spraying with gammalin 20. The cricket, *Gryllotalpa africana*, causes damage to young seedlings in the nursery. These crickets can be controlled by digging and killing since they are active mostly at nights and hide in holes during the day. Termites can destroy a whole plot of newly planted cassava cuttings, especially if the weather is also dry. Sometimes they also attack mature cassava plants. They can be controlled by dusting the planting materials with 2.5% aldrin dust. Red spider mites are more common during the dry season. They are very small and cannot be easily seen with the naked eye. They feed on leaf blades and cause symptoms that can be mistaken for cassava mosaic disease. However, they can be controlled by spraying with gammalin 20. Rodents, bush fowl, and even goats can be menaces to a cassava plot. Both rodents and bush fowls dig up and eat the cassava roots, whereas goats eat the leaves and break the stems.

Diseases

Cassava mosaic disease manifests itself in different degrees depending on the cassava variety. In general, a high degree of mottling, curling of leaves, distortion, and in some cases reduction in size of leaves and stunting of plants occur. The vector of the disease is *Bemisia nigeriensis* (*tabaci*) or white fly. Golding (1936) showed that this disease caused up to a 30% reduction in yield. In East Africa, Tidbury (1937) demonstrated a reduction of up to 95% in yield. In Ibadan, Beck and Chant (1958) showed for variety 56160 that primary infection caused a reduction of 29% in yield. The only solution appeared to be resistant

Table 4. Effect of time of harvest on percentage starch yield.[a]

Time of harvest (months)	Variety				Mean
	53101	44086	60447	37065	
18	26.6	22.0	23.2	18.7	21.9
15	24.2	21.3	18.2	18.8	20.2
12	19.4	17.8	16.0	15.5	17.9
24	19.6	16.2	15.1	17.5	17.1
21	15.0	19.0	16.1	12.2	16.0
Mean	21.0	19.3	17.7	16.5	18.6

[a]LSD ($p = 0.05$) = 5.2 (variety).

varieties. Treatment of the cuttings by heating at temperature of 37–39 °C inactivates the virus and prevents primary field infection, however this does not prevent the secondary infection.

Brown leaf spot, caused by *Cercospora henningsii*, results in mature leaves becoming senescent faster than unaffected leaves. The effect of this disease on yield has not been assessed. White leaf spots, caused by *Cercospora caribeae*, occurs along with brown leaf spot, but the lesions are smaller than the brown leaf spots.

Die back is caused by *Glomerella cingulata* in some plants. The disease is not wide-spread.

Yellow rot is caused by the fungus *Polyporus bandoni*, and is common in damp or water-logged soils. The infected lower stem and roots are covered with orange-yellow mycelium and orange coloured sporophores are produced.

Bacteria wilt, first reported in 1972 by Williams et al. (1973), causes wilting of leaves and stems. The disease is very serious and requires intensified effort to eradicate it.

Basic Cassava Research

Cytogenetic studies of cassava *M. esculenta* and *M. glaziovii* were carried out (Umanah and Hartmann 1973). The chromosome numbers of these two species were found to be $2n = 36$. The karyotypes of the two species were similar. Two pair of satellite chromosomes were reported for the first time for both species. Meiosis was normal in pollen mother cells; the 18 bivalents at M1 disjoined regularly at A1. It is suggested that these *Manihot* species are allopolyploids with a basic chromosome number of $X = 9$. This conclusion confirms that of Perry (1943).

Beck, B. D. A., and Chant, S. R. *A preliminary investigation on the effect of cassava mosaic virus on M. utilissima Pohl in Nigeria.* Trop. Agric. Trin. 35(1), 1958, 59–64.

Golding, F. D. *Bemisia nigeriensis Corb; a vector of cassava mosaic in Southern Nigeria.* Trop. Agric. Trin. 13(7), 1936, 182–186.

Golding, F. D. *Cassava mosaic in southern Nigeria.* Nigeria Dept. of Agric. Ann. Bull. 11(1), 1936.

Jones, W. O. *Maniocin Africa.* Stanford University Press, Stanford, USA, 1959.

Perry, A. B. *Chromosome number and phylogenetic relationships in the Euphorbiaceae.* Amer. J. Bot. 30, 1943, 527–543.

Phillips, T. A. *An agricultural notebook.* Longmans of Nigeria, Ikeja, Nigeria, 1973.

Tidbury, G. E. *Effect of cassava mosaic disease on yield of cassava.* E. African Agric. J. 3, 1937, 119.

Umanah, E. E. *The germination of cassava seeds: The effect of temperature and scarification.* Proc. Agric. Soc. Nigeria, 7, 1970, 54.

Umanah, E. E., and Hartmann, R. W. *Chromosome numbers and karyo types of some Manihot species.* J. Amer. Soc. Hort. Sci. 98(3), 1973, 272–274.

Williams, R. J., Agboola, S. D., and Schneider, R. W. *Bacterial wilt of cassava in Nigeria.* Plant Dis. Rep. 57(10), 1973, 824–827.