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A REVIEW OF CASSAVA DEVELOPMENT IN NIGERIA FROM 1940-2010

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ABSTRACT

This paper summarizes the past and present trends in cassava development in Nigeria from 1940 to 2010. Time series data from many sources in Nigeria form the basis of this paper. The various stages or periods such as the incipient cassava development period (1940 - 1953), medieval cassava development period (1954 -1967), National and International Coalition cassava development period (1970 - 2010), pre-emptive - CMD period, Nationally coordinated cassava project and cassava improvement through breeding in Nigeria. Salient factors that contributed to cassava development in Nigeria government and government policies, financial agencies, research collaboration and other factors that contributed to cassava development in Nigeria were highlighted. The progress in cassava varietal development, coupled with the current government policy on cassava development will soon or later make Nigeria discover an ideal cassava for the 21st century to enable her feed her growing population and has reserves for export and security. The paper also examines the improvement made over the years that brought about the release of 29 improved (high yielding, early maturing and pests and diseases resistances) cassava varieties in Nigeria in 2009. Additional 4 new varieties were released in 2010 with the collaboration of International Institute of Tropical Agriculture (IITA) and cassava researchers in Nigeria but coordinated by National Root crops Research Institute (NRCRI). Data were also obtained from research findings and regular documentations in research and University libraries in Nigeria.

Keywords: cassava, improvement, germplasm, history, Nigeria.

INTRODUCTION

Efforts to x-ray cassava development in Nigeria cannot be justified without mentioning the origin of cassava, its introduction and spread in Nigeria. Early sites and farms of cassava existed in Northern Brazil and Central America but its greatest staple status is in tropical Africa (CIAT 1993 and Leon, 1977). It is from these sites that cassava was introduced into other parts of the World including Africa, during the early trade movements and explorations by the Portuguese.

Cassava was introduced into Nigeria by the Portuguese traders and explorers from Fernando-Po to Warri in the then Mid-Western Nigeria in the late 18th Century (Muoneke and Njoku, 2008). It later spread to Lagos, Badagry, Abeokuta and Ijebu in the early 19th Century by slaves returning from West Indies and Sierre Leone who settled in these towns (Agboola, 1979). These returnees processed cassava into gari, lafun and iwa-panya (roast and eat) for food. Cassava and cassava products were later introduced into Eastern Nigeria along the Coast towns of Calabar and Yenagoa by traders from Western Nigeria. Thus, cassava may have been introduced in Nigeria to different regions about 330 years ago (Agboola, 1979).

The importance of cassava cannot be over-emphasized. Although the site of its origin is far away from Africa and Nigeria in particular, its greatest staple utility rests in Africa. It is a basic staple food to more than 70% of Nigerian population and consume at least once every day (Njoku and Muoneke, 2008). About 90% of cassava produced in Nigeria is used locally for food, animal feed, industrial and pharmaceutical uses and unquantified quantities for export. As human food, cassava is processed into over 50 food forms - gari, lafun, bread, flakes, flour etc. (Denton *et al*., 2004). The utility attributes of cassava is inexhaustible especially with the increasing processing technologies. The aim of this work was to x-ray the many developmental stages of cassava with regards to progress made and challenges before and after Nigeria independence.

Cassava development in Nigeria

Cassava development in Nigeria consists of multi-dimensional set of activities fashioned by Research Institutes, Government and its policies, Agricultural Development Agencies, Funding Agencies, Farmers and Non-Governmental Organizations (NGOs.) Cassava development in Nigeria is basically embarked upon by both national and international bodies, ministries and agencies.

Basically, there are four stages or periods of cassava development in Nigeria namely: the incipient cassava development period stretching from 1940 to 1953; medieval cassava development period stretching from 1970 to 1990 and the pre-emptive - CMD cassava development period stretching from 1995 to date. These developmental stages or periods in Nigeria are fully discussed below.

The incipient cassava development period (1940-1953)

Cassava improvement and development started in 1940 with collection and introduction of superior germplasm for improved yields and resistance against cassava mosaic virus (Umunah, 1977). Based on a two year selection of the collected germplasm, the first cassava hybrid called Gold Coast Hybrid (GCH 7) or 37065

emerged in 1942. This variety had an average yield of 9t/ha with an improvement of 28% in yield over local varieties (Umanah, 1977 and Okeke, 1988).

Further selection of locally available cassava germplasm in 1953 gave rise to another superior cassava hybrid popularly called Oloronto or 53101. This was recommended to farmers in Southwestern Nigeria.

Medieval cassava development period (1954-1967)

The medieval cassava development period is a period of modern cassava research and development in Nigeria. In 1954/55, modern cassava research and development started at the Federal Department of Agricultural Research (FDAR), Moor Plantation, Ibadan, when a Plant Breeder was assigned to the cassava improvement programme. With the provision of a Breeder, more collections were made locally and from foreign countries. Some of the germplasm acquired from foreign countries include *Manihot glaziovii* from Puento Rico; *Manihot melonohasis* and *Manihot saxicola* from Surinam; 58308; 58; 98 and 58212 from Amani in East Africa. Crosses of these cassava varieties 53101 and 42074 etc led to the development and release of cassava hybrids such as 60444, 60:06 and 60447 in 1967. The attributes of these varieties are shown in Table-1.

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

Variety	**Yield/acre**	**Mean increase over local variety** (%)	**Starch Content at 15-18 months** (%)	**HCN content** (mg/100g)
Gold Coast (GCH 7)	8.9	28.0	23.0	182.0
53101	13.6	64.5	30.0	185.0
60444	16.3	95.3	25.30	162.0
60506	15.4	78.0	30	162.0
60447	15.0	55.1	25.30	189.0

Source: Umanah 1977.

National and international collaborative cassava development period (1970- 2010)

The national and international collaborative cassava development period is a period when National and International Research Institutions became actively involved in cassava improvement and development in Nigeria. This era coincided with a period when a violent cassava disease called cassava bacterial blight (CBB) was a scourge on cassava in Nigeria. This was in 1972 and only cassava variety, 60506 and few other varieties withstood this virulent cassava disease. Breeding work at International Institute of Tropical agriculture (IITA), Ibadan, later in 1976 released the first two cassava hybrids - TMS 30211 and TMS 30395 that assisted in controlling the virulent cassava bacterial blight disease. Shortly, IITA flooded the Nigerian cassava industry with more cassava hybrids TMS 30572, TMS 30001, TMS 300017, TMS 30110, TMS 30337, TMS 30555, and TMS 4(2)1425 (IITA 1984). These cassava hybrids were high yielding and resistant to cassava mosaic virus disease (CMD), cassava bacterial blight (CBB), cassava anthracnose disease (CAD), cassava mealybug (CMB) and cassava green mite (Akoroda *et al*., 1985).

Table-2. Cassava breeding developmental stages in Nigeria with conventional and biotechnology options.

Breeding Activity	**Conventional breeding**	**Biotechnology (e.g., MAB)**
Female x Male (Elite parents)	year 0	year 0
F1 and clonal evaluation trials (CET)	year 1 – 2	year 1 - 2
Preliminary yield trials (PYT)	year 3	skipped
Advanced yield trials (AYT)	year 4	skipped
Uniform yield trials (UYT)	year 5- 8	year 3- 4
On-farm trials (OFT)	year 9	year 5
Varietal release (VR)	year 10	year 6
Multiplication	year 11- 14 or 15	year 7-10 or 11
Total number of years	15	11

Table-3. Attributes of the 17 cassava varieties released for cultivation in Nigeria.

Cassava variety	Branching habit	Canopy development	Ecological adaptation	Pest and disease tolerance	Fresh root yield (t/ha)	Dry matter yield (80-24h)	Garri yield (%)	Starch (%)	HCN in products (mg/100g)
TMS 90257	Profuse	Moderate	Wide	High	43	25	23	23	15.5
TMS 84537	Profuse	Sparse	Wide	High	35	28	18	27	6.3
TMS 82/00058	Profuse	Moderate	Wide	High	35	28	21	26	6.4
TMS 82/00661	Profuse	Moderate	Wide	High	39	30	22	26	4.1
NR 8212	Profuse	Moderate	Wide	High	27	37	25	21	High
NR 8082	Profuse	Profuse	Wide	High	32	32	22	19	High
TMS 50395	Moderate	Moderate	Wide	Moderate	36	26	24	12	High
TMS 30001	Moderate	Moderate	Wide	High	16	28	23	22	low
NR 8208	Profuse	Moderate	Wide	High	26	32	25	23	High
NR 8083	Profuse	Moderate	Wide	High	31	43	36	25	High
NR 83107	Profuse	Moderate	Wide	High	22	31	22	19	High
TMS 81/00110	Profuse	Moderate	Wide	High	28	31	24	25	4.5
TMS 91934	Moderate	Sparse	Wide	Moderate	32	34	26	21	High
TMS 30572	Profuse	Profuse	Wide	Moderate	27	34	25	24	750
TMS 4(2)1425	Moderate	Profuse	Savannah	Moderate	26	36	25	22	31
TMS 30555	Moderate	Profuse	Wide	Moderate	17	32	24	20	High
NR 41044	Moderate	Profuse	Forest	Moderate	37	34	25	23	High

Source: Annual reports, NRCRI, 1999-2010.

In its contribution to fight the virulent cassava bacterial blight disease ravaging cassava in Nigeria, the National Root Crops Research Institute, Umudike, shortly after 1976 released some resistant and high yielding cassava varieties namely:-NR 41044, NR 8082, NR 8083, NR 8212, NR 8267 and NR 8233 etc. The attributes of these varieties are shown in Table-2. In order to reduce the fear of cyanide poison pre-empted by cassava consumers, IITA, Ibadan, developed some high yielding and low cyanide cassava varieties notably - TMS 4(2)1425, TMS 30001. The National Root Crops Research Institute, Umudike, in the late 1980 also developed five low cyanide cassava varieties (Sweet cassava varieties) namely: NR 84175, NR 84292, NR 84104, NR 8959 and NR 8421. The attributes of these varieties are shown in Table-4.

Table-4. Low cyanide cassava varieties and their cyanide content mean cyanide content (mg/kg of material).

Cassava variety	Fresh peeled root	Boiled root	Unfermented dry flakes	Fermented dry flake	Dry root meal
NR 84175	27.0 ± 0.8	6.8 ± 1.2	3.4 ± 1.4	0.4 ± 0.0	34.2 ± 1.2
NR 84292	47.0 ± 1.4	23.0 ± 1.0	17.0 ±1.2	1.7 ± 0.6	40.3 ± 1.3
NR 84104	30.6 ± 1.0	13.6 ± 2.1	20.4 ± 0.9	17.0 ± 0.3	37.3 ± 1.3
NR 8059	139.0 ± 1.8	27.2 ± 1.6	53.0 ± 1.0	34.0 ± 0.9	48.2 ± 0.9
NR8421	25.8 ± 0.9	3.6 ± 1.0	4.0 ± 0.8	0.3 ± 0.1	37.1 ± 1.1

Source: Oti and Ene, 1992.

Pre-emptive - CMD cassava development period (1995-Date)

The pre-emptive - CMD cassava development period is a period when cassava improvement and development focused on resolving the negative production pressures of a new strain of cassava mosaic virus from east Africa pre-empted to infest Nigeria cassava farms in future. The cassava breeding programme of the International Institute of Tropical Agriculture, later in 2005 in collaboration with the National Root Crops Research Institute, Umudike, released five new cassava varieties namely:-TME 419, TMS 97/2205 TMS 98/0505; TMS 98/0581 and TMS 98/0510 with a view to check this new strain of virus. These varieties have an average yield between 35-45t/ha, 15-20% starch content, 30-35% dry matter and resistant to cassava mosaic virus disease of all the virus strains (Table-4).

Thus, from the incipient cassava development period to the recent pre-emptive (CMD) cassava development era, more than thirty cassava varieties have been developed and injected into the Nigerian farming systems. The availability of these improved cassava varieties have led to high trend of yield increase in our farms.

Nationally coordinated research programme (NCRP) on cassava (1996- date)

In July 1996, Nationally Co-ordinated Research Programme (NCRP) was approved for cassava. Earlier national programmes such as Priority Research Projects (PRP) and National Agricultural Research project (NARP) dove-tailed into NCRP. The NCRPs constitute a step in the implementation of the Medium Term Research Plan (MTRM) of the National Agricultural Research Strategy Plan (NARSP) (1996 - 2010). Under NCRP well-focussed research programmes on roots and tubers crops are collectively planned and executed by NRCRI, other National Research Institutes, Universities, Institute of Agricultural research (IARs), International institute of Tropical Agriculture (IITA), Agricultural development programs (ADPs), NGOs and farmers.

Some of the research themes and achievement of NCRP on cassava are as follows:

a) Selection of improved cassava varieties for intercropping and resistance to major pests and diseases.
b) Evolving integrated pest and diseases management practices for cassava pests and diseases.
c) On-farm validation of existing technology for small scale storage of cassava tubers.
d) Training of extension agents and selected farmers in the art of rapid multiplication of cassava.
e) Determination of techniques for preserving cassava stems for storage.
f) Determination of fertilizer requirements in cassava mixed cropping systems and so on.

The major achievements in technology development under NCRP include:

a) Improved production technologies leading to increased national output of cassava from 23.3 million tons/annum in 1994 to 45.6 million tons/annum in 2010.
b) Development of low cyanide as well as high yielding, pest and disease resistant, cassava varieties.
c) Selection of high yielding, pest and disease resistant cassava varieties that is also suitable for intercropping.
d) Development of a cassava hand peeling tools for peeling of cassava.
e) Integrated control measures for control of cassava mosaic disease, (ACMD), cassava bacterial blight (CBB) and cassava green mite (CGM) were developed and documented. NRCP for cassava and yam are still implemented until date in Nigeria.

Synergistic components of cassava development in Nigeria

Cassava improvement programmes stimulated advancement in research on the best agronomic/cultural practices for optimum production, cassava health management techniques to tackle negative biotic and abiotic stresses that limit production. Others are micro-propagation by Tissue culture; Bio-control measures; processing technologies; application of molecular marker assisted breeding to dictate promising lines early in breeding cycles and farm management. These research components contributed in several measures towards cassava development in Nigeria.

Nigeria was a major cassava producing country ranking fourth in the World after Brazil, Zaire and Indonesia in the 18th Century and later part of the 19th Century. However, today, Nigeria is the largest producer of cassava in the World with an annual estimate of 44 million metric tons (CBN, 2004). This is as a result of advances in cassava improvement and development which gave rise to improved varieties that are high yielding and resistant to cassava pests and diseases.

Salient factors that contributed to cassava development in Nigeria

Some salient factors contributed in several measures to the success history of cassava development in Nigeria. These factors are enumerated below.

i. Government and government policy

The contribution of succeeding Governments in Nigeria and her policies is of great importance in cassava development in Nigeria. Between 1960 and 1970, most agricultural policies were directed towards export of crops (ground nut, cocoa, rubber, oil palm etc) However, from 1975 to the present time, most governments in Nigeria have decided as a matter of policy to promote and reinforce research and development in cassava improvement and production. This singular policy of the Government has led to diversification of cassava products into diverse food forms that were not in existence in the last two centuries in Nigeria. The Government policy on food security, food self-sufficiency and diversification of the economy has encouraged agricultural policy makers to reinforce cassava development in Nigeria. The recent presidential initiative on cassava development and export is a policy made to encourage cassava improvement in Nigeria.

ii. Financial agencies

National and International Financial Agencies and Organizations such as Food and Agriculture Organization (FAO), United States Agency for International Development (USAID), Deutsche Gesellschaft Fuer Technische Zusammenarcheit (GTZ), International Fund for Agricultural Development (IFAD), United National Development Programme (UNDP), Generation Challenge Programme (GCP) of CGIAR and Counter-part Funds of Federal and State Government, have provided the enabling financial backing which stimulated the development of many cassava varieties in Nigeria.

iii. Research collaboration

The initiation of research collaboration between national, regional and international research Institutions tremendously contributed to cassava development in

Nigeria. Following the devastating effect of cassava bacterial blight in 1972 and the current devastating effect of new strain of mosaic virus ravaging cassava in the continent (Africa), which was detected by IITA, Ibadan, the Federal Government of Nigeria decided to reinforce research collaboration between IITA and NRCRI through the policy of the presidential initiative on cassava. This initiative led to the development and release of five new cassava varieties to check-mate the recent virulent mosaic virus strain that is ravaging cassava in Africa.

iv. Production of research manuals, extension guides and information

The exchange of information, extension services and production of training manuals such as the current manual on cassava stem and root production produced by the National Root Crops Research Institute, Umudike, (Eke-Okoro *et al*., 2005) provided information and practical knowledge thereby encouraging cassava development in Nigeria. The publication of Extension guide on cassava in Nigeria by NRCRI is a useful tool for disseminating information among scientists, farmers and donor agencies. The recent training of Nigerian farmers, local women and men on production of value added products of cassava embarked by NRCRI, is another milestone - capacity building for cassava development in Nigeria.

The recent improvement of cassava varieties of diverse architecture and wide adaptation encouraged further cultivation of cassava in areas traditionally do not produce cassava. Cassava can now be grown in an ''unfavorable'' environment of Yobe and Borno States of Nigeria. This development has brought cassava cultivation to about 28 States of Nigeria, thereby stimulating expansion in cassava cultivation in Nigeria.

Cassava improvement through breeding and genetics

Cassava plant produces both male and female flowers in one plant at different dates and pollination is done manually in a controlled way to produce full-sibs families or else polycross nurseries where open pollination takes place, and therefore half-sibs families are produced (FAO, 2007). Self-pollination is feasible when using male and female flowers on different plants of the same genotypes. Some clones flower relatively early at four to five months after planting whereas others flower at eight to ten months after planting. Considering the time required for the seed to mature, the growing cycle of the crop and the need to plant with the arrival of the rains, it takes about two years between a given cross being planned and the respective seed becoming available. On average, between one and two seeds (out of the three possible in the trilocular fruits per pollination are obtained (Kawano, 1980).

Cassava is a non-inbred crop propagated clonally. Its genetic improvement is made possible by the fact that a superior genotype can be fixed at any stage of the breeding scheme, even after a single cross; the equivalent of an f1 in commercial hybrids (FAO, 2007). Therefore non-additive gene actions including dominance and epistasis become important component of the genetic variance to be manipulated by the breeder (Jaramillo *et al*., 2005 and FAO, 2007). Large effective breeding population sizes are required to retain favorable dominant alleles and epistatic loci combination. Breeding cassava starts with the production of new recombinant genotypes derived from selected elite clones. Scientific improvement of cassava started, some few decades ago thus the divergence between landraces and improved germplasm is not as wide as in other crops (FAO, 2007). Accessions for germplasm bank collections from different research institutes play more relevant role in cassava. Parental lines are selected mainly based on their performance *per se* and little progress has been made to use the general combining ability (Hallauer and Miranda Fo, 1988) as criterion for parental selection. Sexual seeds obtained by different schemes are germinated to initiate a new cycle of selection. The multiplication rate of cassava planting material is low. A maximum of ten cuttings can be obtained from a plant. This implies a lengthy selection process that takes about six years from the time the botanical seeds are germinated until enough planting materials are generated for multiplication replicated trials (Table-2). Strong emphasis is placed on heritable traits (plant type, branching habits and reaction to disease, harvest index and dry matter content) is applied during the early phases of selection (Hahn *et al*., 1980,). As the number of plants representing each plant increases, the weight of selection criteria shifts towards low heritability traits such as root yield. The clones that show exceptional performance in the regional trials are released as new varieties, and eventually incorporated as parents in the crossing nurseries. From the above, cassava breeding is difficult, expensive and to a certain degree inefficient.

Efficiency of cassava breeding can be enhanced through the use of molecular markers. Markers enable the efficiency of selection by enhancing the precise identification of genotypes without the confounding effect of the environment, thus increasing inheritability. MAS helps to reduce the large breeding populations at the seedling stage and the reduction of the breeding populations could greatly reduce the expense involved in the evaluation process (FAO, 2007). Cassava has a lengthy growing cycle, MAS reduces the length of time required for the introgression of traits from wild relative. Wild relatives are rich reservoirs of resistance genes in cassava but the need reduce or eliminate undesirable donor genome content and linkage drag can lengthy the process, making it unrealistic for most breeders (Terry *et al*., 1980 and Chavarriaga *et al*., 2004). Simulations by Stam and Zeven (1981) indicate that markers could reduce linkage drag and would reduce the number of generations required in the backcross scheme. Hospital *et al*., 1992 validated this in achieving a reduction of two backcross generations with the use MAS. Frisch *et al*., (1999) in a simulation study used molecular markers for the introgression of a single target allele saved two to four backcross generations. They inferred that MAS had the potential of

reaching the same level of recurrent parent genome in BC3 as reached in BC7 without molecular markers.

Table-5. Pre-emptive CMD cassava varieties.

Variety	**Mean Yield** (t/ha)	**Dry Matter** (%)	**Starch** (%)	**Protein** (%)
TME 419	35-40	30-35	15-20	1.9-2.8
TMS 97/2205	25-29	30-41	60-74	1.2-4.2
TMS 98/0505	21-37	25-41	62-75	2.3-5.7
TMS 98/0581	20-31	29-40	60-75	2.2-4.5
TMS 98/0510	13-27	20-33	66-74	2.6-4.6

Source: Annual report, NRCRI, 2005.

Table-6. Total production of cassava in Nigeria from 2002 - 2008 ('000 MMT).

Year	**Production of cassava**
2002	34, 120
2003	36,304
2004	38,845
2005	41, 565
2006	45, 721
2007	43, 410
2008	44, 583

Source: FAOSTAT, 2008

CONCLUSIONS

The development and spread of early-maturing, pest tolerant and high yielding cassava varieties have been promoted partly by demand for cassava products such as gari, fufu etc. Several measures have been taken from colonial era to the present time to improve and extend the crop to Nigeria farmers and other end-users. NRCRI has contributed substantially to the development of the crop through the release of 33 improved varieties towards increased productivity in Nigeria. In assisting farmers to meet the challenges of the Presidential Initiative on Cassava, NRCRI provided 4,481 bundles of cassava stem cuttings to farmers free of charge in 2004. Also, in collaboration with NRCRI, IITA through the Integrated Cassava Project also made available 2,273 bundles of stem cuttings to farmers free of charge, and these quantities of stem cuttings were sufficient to plant 112 hectares. The progress in cassava varietal development, coupled with the current government policy on cassava development, Nigeria will soon or later discover an ideal cassava for the 21st Century to enable her feed her growing population and have reserves for export and storage.

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