THE BEST SEEDS OF THE BEST CROP VARIETIES: A BASIS FOR NIGERIA'S FOOD SECURITY

An Inaugural Lecture delivered at the University of Ibadan

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by

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The Vice-Chancellor, Deputy Vice-Chancellor (Administration), Deputy Vice-Chancellor (Academic), Registrar, Librarian, Provost of the College of Medicine, Dean of the Faculty of Agriculture and Forestry, Dean of the Post-graduate School, Deans of other Faculties, and of Students, Distinguished Ladies and Gentlemen.

Introduction

I thank the University of Ibadan for the unique opportunity to give this inaugural lecture, more so before my turn by rank. I welcome you all to the ***thirty-fifth*** inaugural lecture from the Faculty of Agriculture and Forestry and the ***ninth*** from the Department of Agronomy. Two previous inaugural lectures have dwelt on plant breeding from the Department of Agronomy. First in 1976 by Professor H.R. Chheda titled "Plant Breeding and the Conquest of Hunger", and that of Professor M.E. Aken'Ova on "Plant Breeding and the Enjoyment of Life" in 2003. Both discussed the development of new varieties through plant breeding. But today's lecture would focus on seed production and touch also on the link of seeds and varieties that are appropriate to each geo-space or eco-zone. For it is this matching of the variety to the eco-zone that makes the equation of 'Phenotype = Genotype + Environment', appropriately applicable. Today's lecture titled "The Best Seeds of the Best Crop Varieties: A Basis for Nigeria's Food Security," is, perhaps, the ***first*** inaugural lecture from a Professor of Seed Production and Plant Breeding from any Nigerian University to date.

Mr Vice-Chancellor, Sir, this lecture is on food security through the agriculture of crops, focusing on seeds and varieties. Verily, seed production and plant breeding are two sides of the same coin.

When the lot fell on me to give this lecture, it was by a wave of serendipity. It was thus the pleasure of my faculty that I urgently arise with wings as should be expected of those who 'set forth at dawn'. Immediately, I took the advantage of the wind under my wings to fly. Whether I fly well or not is not mine to judge, what is important is that I fly

and fly I shall attempt to do. I also note that this lecture has come 15 years after being promoted to the rank of professor in October 1994. Since then, many waters have passed under the bridge.

Agriculture is about 10,000 years old. It is 'a man-made construct' that is still developing. Its growth depends entirely on the calibre of the human population practising it in any geo-space or community. The more progressive the people operating the agriculture, the more advanced is their agriculture. Agriculture provides foodstuffs, feedstuffs, fibres, and herbals. These four items are crucial for human survival on earth. Foodstuffs contain nutrients and medicines for human growth, repair and protection. Hippocrates the Greek and father of modern medicine advised us all thus, "May your food be your medicine, and may your medicine be your food".

That was over 2000 years ago, yet it is still as true today as it was then. As agriculture developed, the selection of the more useful crops continued. A crop is a plant that is grown or protected or at different stages in the process of being domesticated by humans for the aim of harvesting some produce from it (Harlan 1975). Domestication actively changes the genetic make-up of living organisms, adjusting their morphologic appearance and behaviour to satisfy the needs of farmers and consumers. This process is on-going through the work of breeders who design and construct the genetic architecture of crops. These crops are used by humans to make varied products at home, in cottage industries, and factories.

The importance of crop production and the seeds for producing food is well recognized, and an axiom, as God stated in the Bible, in Genesis 8:22 that

> "while the earth remaineth, seedtime and harvest, and cold and heat and summer and winter, and day and night shall not cease".

This ceaseless activity of man of sowing and reaping constitutes the major activity that controls the livelihood of the overwhelming majority of people worldwide. Most

human beings are farmers across the 195 nations on earth, this is the fact of life till date, and would be in the foreseeable future. This is so because food is the *first* requirement for life that we must acquire after oxygen and water that come to us rather free. Food also contributes most to the inflation of the cost of living in Nigeria (Ukoha and Nyong 2002).

Agriculture in Nigeria today is farming by 'trial and error'. We know only little of how the soil, weather and crops interact with the market place to generate reliable and predictable production that can equalize and overtake the rapid rate of fertile reproduction of Nigerians. The soil is rarely routinely analysed to determine levels of nutrients available for crops; the growing of food crops are not zoned to areas best suited for them; and there is inadequate post-harvest handling of all produce thereby incurring huge losses. Nearly one half of all that is grown and harvested are lost before they are consumed by humans in Nigeria. This negates food security efforts.

Food Security

Food security relates to the status of food supply to people in a defined territory. The food we eat is grown in Nigeria, or imported into the country or is gathered from the forest or savannah as well as from lakes and rivers or adjoining sea and ocean. Nigeria covers 92,376,800 ha of land surface, 79,000,000 ha are cultivable, but 32,000,000 ha are annually cultivated. More than 90% of the farmers cultivate 0.8-1.2 ha in the south and 2-4 ha in the north but generally less than 2 ha per farm household. To date, these smallholder farmers have continued to produce most of the food we consume and export from Nigeria.

Mr Vice-Chancellor, Sir, we must make the best use of what we have to get what we want from those small field plots. There are three ways to do this: give them the best *seeds* of the best crop varieties, enable them with the best *skills* for farming, and avail them the best *support* for all operations relating to food supply. I am most at ease to discuss the first of these essential requirements for food security in Nigeria. Each of the three key words: *seeds*, *skills*,

and *support* represent a host of components that would be elucidated in this lecture.

Adequate Support

Adequate support is not often there for the agencies that are supposed to help provide the best seeds. They are short of funds and are unable to do as they are mandated to. In 2008, Professor Ango Abdullahi (*Magajin Rafin Zazzau*), an alumnus of this University, serving as the former Special Adviser to the President on Food Security wrote,

> The political will of African leaders on the vital issue of agriculture is questioned. Otherwise, how do we explain a situation where, for example in Nigeria, about 70% of its people are engaged in agriculture, that still contributes up to 40% of the GDP, yet only 2% of the Federal Budget is allocated to agriculture and related development.

The universal problem relating to serious research and development work has been stated by Montagu (2006) thus: "How to reconcile the rationality of science with the emotions of society?" As the political support is important, so too would be the level of general understanding of issues by the populace that scientist serve. We fathom with difficulty how wealth accumulates yet the bold peasantry decays in Nigeria.

Poor Policy Support

This denudes the efforts towards achieving food security. The Economic Commission for Africa reports that in 2009, Africa received foreign aid worth $3 billion but spent $33 billion in food imports and is still largely hungry. The cost of imports could have been diverted to domestic production to reduce poverty and reposition Africa in the global economy. Similarly, the percentage of bank credit in Nigeria to agriculture progressively declined from 17.5% in 2002 to 4.0% in 2007 (*Daily Sun*, 12 March 2010, page 50). This was the case while the media was awash with bank propaganda.

Agriculture's contribution to the gross domestic product averaged 41.4% during 2003-2007. After a higher level of

66% in the 1970s, it fell to 32% in 1990 and through some efforts by governments it has risen to 42% in 2009.

Similarly, is the case of the N200 billion of 2008 that was to be disbursed as loans to farmers. This fund has not been released to farmers one full year after. These figures show that there can be no food security without appropriate actions and if persistent promotion is not sustained. We can now appreciate why the best seeds do not reach Nigerian farmers. The reasons are many, devious, devilish, and complexly twined with voodoo-like arrangements that require the '*finger of God*' to break loose. In short, Nigeria needs spiritual, moral, and civic deliverance.

Skills of Operators

The skills needed by the operators for the seed system to supply the best seeds, require education of rural people in the understanding of how to handle the seed business. Data from the 2006 national census (National Population Commission 2009) showed that the level of education of active Nigerians that are 15-59 years old was appalling. A pool consisting of 55.5% of women and 43.5% of men were found not educated enough to practise modern agriculture in Nigeria. Only about 31% of rural Nigerians are able to. Thus, the large number of Nigerian farmers, by virtue of their levels of education, are certainly in need of more training from the agricultural extension system. Also, the amount of seeds required to plant 2 ha is small, thus it behoves us to avail farmers the best seeds to plant such small field plots.

Carrying Capacity of Nigeria

As to the number of people to feed, control is yet to be achieved. The equation for food security relates to ways to reduce the rapid growth in population and to accelerate food supply and affordability among the majority of Nigerians. Just how many people can Nigeria comfortably contain or carry considering the known resources and the systems that currently manage them? The population of Europe has a stabilizing growth at around 1% annually, and that of Nigeria is increasing at 3.18% annually, while our food supply grows

at around 2% and declining, suggesting that a Malthusian cloud hangs above us. Food security depends on the viability and vigour of the food production and conservation strategy in relation to total population. Monitoring this relationship is critical for any guarantee of food for peoples in a geo-space (fig. 1).

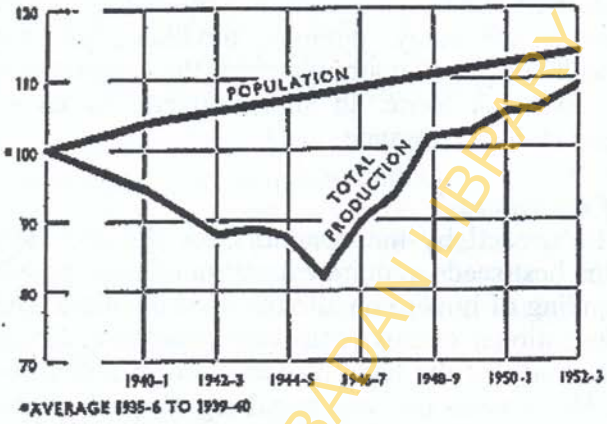

Fig. 1. Change in UK population and total food production, and the emergence of modern farming after World War II.

The excess of mouths over the food basket is the worst national insecurity any country can ever face. But we are at ease while the signs of our times tell of ill winds to come. Planning for food security requires an understanding of the relationship between number of human mouths to be fed and the mechanisms for producing food for them assured for a reasonable period. How could we talk of food crop production without first arranging and finding the seeds for planting the fields that will produce the required food? Who will produce the food if new farmers are being discouraged away from the farm and there is growing agro-phobia among the youths of today?

Food security integrates the numbers of mouths, fields, crops, seeds to plant the fields and the ways and means for assuring that all we have produced are well stored and hygienically processed before human consumption. Food

shortages and rampant hunger are symptoms of food insecurity appearing first at the level of a person, then a family, a clan, a community, a local government area, a state, a geo-political zone, a nation before we go international, regional, continental, and finally global.

It has been my lot to visit or work in some countries on matters relating to seeds and varieties and food security. With some 26 degrees of freedom excluding replications, I can say that hunger is no respecter of person, race, tribe, or nation. When mass hunger strikes, people move and migrate from one village to another favoured village or to other countries, as from Israel to Egypt, and from Nigeria to nations overseas or any imagined Eldorado.

With the supply of good seeds of major and minor crops to every settlement, farm or garden, people can engage in *surer* food crop production. This also reduces the distance of transportation of food which is bulky compared to the seeds for producing it. My calculations while writing on *'Feeding all Nigerians'*, show that *food and nutrition security* cannot be achieved *quickly* as our politicians are often wont to expect, even if we do agree to a common work plan. This is because the sigmoid curve of growth indicates that growth in food supply is a function of time and sustained accumulation of small increments. Malaysia did not develop their oil palm industry in one year after collecting the best seeds of improved oil palm varieties from the National Institute for Oil palm Research, near Benin City. Malaysia continued to plant and maintained their plantations till they reached a production asymptote before beginning to export bleached vegetable oil from their palm oil to Nigeria. The issue of food security is, therefore, a matter of focus, patience, discipline, hard work on a robust plan over a period of time. Every other arrangement is *failure postponed.*

Supplementing Food Supplies of Nigeria's Neighbours

Another dimension of food security deals with our being able to feed a proportion of the population of neighbour nations. When in food crises, they lean on Nigeria for help. They cross the borders to buy food. Legally or illegally, foodstuffs

continue to cross the borders daily in cross-boundary trade or smuggling. Cross-border trade is common and evident, though piecemeal. Our planning must accommodate some needs of Nigeria's neighbours. Fights among neighbours for shrinking hectares of grazing land occur as more land is put to cultivation, roads, schools, airports, and residential settlements and housing estates clearly indicate a closer review by *'master planners'* in Nigeria. Can we be our neighbours' keeper as regards supplementing their food supplies when hit by inclement weather, as is often the case? Their populations are small but their agro-climatic challenges are disproportionately heavier (fig. 2).

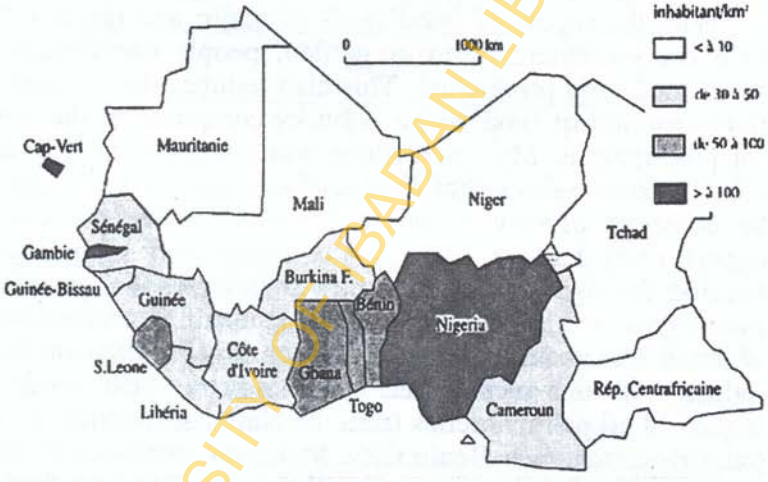

Fig. 2. Nigeria's neighbours and their relative populations.

Declining Hectares Per Caput

The land area of Nigeria is fixed and the rising population instigates the use of force to take over or acquire land. Family members fight and kill for land, adjacent communities fight for land. In the northern states, frequent skirmishes among livestock herdsmen searching for grazing strips and cultivators trying to expand their farm land are rampant, not isolated. The trend will continue as long as there is shortage of land to grow food for all. Dependence on land expansion is not always possible; so increase in crop yield on already

opened farmlands should be intensely pursued. Higher yields imply using the 'best seeds'. Farmland expansion as a means of raising food supplies is bound to hit the rocks as we have seen in Jos Plateau region. Total dependence on transhumance for meat production is also going to hit the rock in the long run.

Sourcing Food in Nigeria

Food is any substance that provides an organism with energy and nutrients. Humankind is heterotrophic and must ingest energy-rich organic molecules (mostly fats and carbohydrates) to sustain life. Conversely, plants are autotrophic (being able to feed themselves). Plants use sunlight, water and carbon dioxide during photosynthesis to produce energy-rich organic molecules. These with nutrients from the soil are transformed into other complex organic molecules. Food may be produced or gathered from gardens, farms, savannas, forests, as well as bought from a shop, market, road sides, or may be smuggled or imported into Nigeria.

Food Security

Food security is a complex game of numbers comprising the number of people to be fed, soil conditions, vagaries of weather, exactitude of planning and implementation, actual political support to agriculture, general knowledge about food composition, the pursuit of healthy rather than traditional feeding patterns, storage, preparation, as well as the proper use of adequate types and amounts of food. Food security incorporates several seamlessly linked aspects of the food system touching on transportation, production, processing, storage, and marketing before use by consumers. Every civilization is based on the successful provision of food to the vast majority of the population of a community. Widespread hunger denudes the human heart, corrupts the soul, degrades the attitudes of a people, and ultimately breaks their mettle and mind to work. So, in Pidgin English, we say *'man must wack'*.

Food security as a concept relates to a defined region be it a local government area, state, geo-political zone, or a nation.

The numbers of people that have enough food to eat to meet their daily body requirements are counted as a proportion of the total population. Secondly, food security also relates to the number of days over which there is an assurance of adequate food. Initially, for each specified small geo-space, we calculate the level of food security of Nigeria (**F**) as follows:

Let ***n*** be the number of persons who eat nutritionally adequate and sufficiently balanced meals each day; let **N** be the total number of people in the domain or space, which in this case is Nigeria; let ***d*** be the number of days in a reasonable period (say, a year) over which that adequate food supply can be sustained. Then:

$$\mathbf{F} = n/\mathbf{N} \times d/365 \text{ days of the year;}$$

Alternatively, (with daily data):

$$\mathbf{F} = \mathbf{N} \Sigma (n_1 + n_2 + \ldots + n_{365})/365$$

Sir, we must consider ways and means to feed Nigerians from food produced in Nigeria from every square meter of land that can be put to growing food or feed for our livestock or herb for human consumption. To do that, only the best seeds of the best varieties would be adequate for each square meter of plot. This is a call for home gardens of a few square metres which will collectively sum up to much.

The Value of Seeds

Seeds: Same as their Sources

Seeds, planting materials or propagules are terms often used interchangeably. Seed production precedes farming and is a basis for food crop production. The link of seed to output is strong and powerful. Figuratively, seed is whatever we ***invest*** in the hope of a ***harvest*** sometime in the future. So we hear of mustard seed, seed money, seed-faith offerings, and so on. Seed is the only input to crop production that determines the limit of the crop yield. Any other input can be quantitatively

adjusted and supplemented. In this vein, biotechnology seeks to create new genotypes for use by breeders to use in developing better varieties.

The value of seed is hard to fully comprehend by many. Consequently, poor quality seeds predominate across human communities globally more so among the less developed nations. We cannot get anything beyond what is sown. You sow excellence, you reap excellence. Thus, without exception, any harvest is always of a similar *kind or stuff* as the item we have sown. The genes of the parents are locked up in the seed which unfold their coded message with the passage of time during growth and development. Thus, caring for and preserving seed quality is *sine qua non* for the survival of any species, humankind included.

Seeds as Sacrifice of Today for a Better Tomorrow

In seed systems, humans care about the quality and type of seed so as to obtain the best harvest. This linkage of seed and future reward traverses the psyche of all men. Every seed is a capital to be invested to achieve the higher purpose we seek. We '*sacrifice*' the yam seed tubers as an investment so as to get a larger ware tuber at the end of the season. The aim of all who invest is to sacrifice the present to gain a larger dividend in the future. Abraham was willing and ready to sacrifice Isaac, his very best and only precious seed to be a friend of God. God also sacrificed His only begotten and precious Son to save all humankind.

This concept of sacrificing the best seed is well understood by the Incas of the Andean Highlands of South America. They were always concerned about realizing their best outcomes after sowing the '*best seed*' to their Sun-god. The best offering must be given if the best blessings are to flow to them from their Sun-god. So, in the selection of their offerings of humans, great care was taken to pick only the most beautiful maidens and only *virgins.* Nothing but *'the best'* was fit to be offered as sacrifice to their Sun-god. After screening among these elites, only the most intelligent girls were retained. Such excellent girls were kept in the temple

courtyard of the Sun-god. They fed well and lived the most religious lives and considered themselves lucky and happy to be the ones selected to die. Nay! Not to die but to 'marry' the Sun-god at their destined time; the best time of their lives, yes, in the very prime of their youth. So when the day came for their sacrificial death or 'marriage' with the Sun-god, they stepped forward with joy to take all the concoctions that would allow them *pass on* through a trance provoked by pharmacologically active substances. The point here is that the '*best seed*' is the only link we have to the fullest achievement of our highest gains.

Seeds Feature in all Aspects of Life

Understanding the seed system of a culture is to know the people and their food supply and the chances of sustained peace and welfare. For no nation can afford to neglect their seed system or play games with their food supply. Food supply and the seed industry are closely linked. Some may recall the story of Sheikh Said of Oman who made Zanzibar Island of Unguja, the capital of the Oman Empire. He decreed, as history tells us, a death sentence to anyone who left Zanzibar Island with one seed of the clove tree. This pain of death decree helped save his clove trade; understanding that with one seed, a new plantation could start elsewhere and his supremacy over the spice trade from which he made his wealth would be deflated and wane.

Seed Used as Rent

The International Institute of Tropical Agriculture, Ibadan occupied 1000 ha of land retrieved from 31 villages by an Act of the Federal Government of Nigeria in 1967. IITA was, however, to pay an annual rent of one seed or peppercorn for the 1000 ha. But a ₦10 fruit of peppercorn *Aframomum melegueta* (*atare* in Yoruba, *oso-oji* in Igbo, *eerhie* in Urhobo) contains about 100 seeds. What this implies is that the transfer of seed is a symbol of the relationship between the land owner and his tenant. He who pays a *seed-rent* is a tenant. That is the point.

High Quality Seeds

In my submission for the 1994 professorial promotion exercise, I stated:

> Seed production and technology is, to a large extent, a specific but applied aspect of plant breeding and cultivar development; which is in turn a branch of agronomy and crop production. ...Consequently, seed research includes relevant areas of plant breeding and field agronomy required to generate and multiply seeds of high quality as regards genetic, physiologic and physical characteristics. These seeds should then be packed and systematically distributed to growers without loss in their quality.

The concept of the best seed is very well ingrained in the psyche of farmers. Only quacks and the ignorant sow sub-standard seeds. The Seed Laws of developed nations seriously penalize whoever offers bad seed for sale. Nigeria is yet to get there, so the use of bad seeds is rampant.

Best Seeds

According to various dictionaries, the *adjective* 'best' in the title of this lecture means—the superlative of good; good in the highest degree; first; highest; most excellent or excelling all others; most productive of good, or of advantage or utility, satisfaction; most or largest. The seed is 'best' if it retains the best quality traits. Internationally recognized seed quality features, that are usually measured, include:

- analytical purity (the amount of true seeds), species purity (the level of other species seeds apart from that declared on the label on the seed pack), and varietal purity (the amount of seed from any other varieties apart from that declared on the label),
- freedom from obnoxious weed seeds,
- colour, health as indicated by freedom from pest and diseases,

- content of moisture and composition of nutrient chemicals (useful and otherwise),
- weight, size, shape, and uniformity of the seeds in a batch or lot offered for sale,
- viability, germination percentage, vigour of seedlings to be able to withstand adverse conditions on the field.

Classes of Seeds

There are four classes of seeds that decline in goodness and *quality* but increase in *quantity* from breeder seed, to foundation seed, registered seed, and certified seed. Their major differences relate to the competence of the seed agent to produce high quality seeds, maintain isolation distances, use the right equipment and techniques of operation, as well as strictly adhere to regulations with a knack for the finest details.

Breeder Seed. Breeder seed is the seed produced by the breeder under controlled conditions of the research station, in the most exacting and well supervised manner. The seeds are not in large quantities as they are not intended to be given directly to farmers to produce food. Any time such seeds leak to farmers the system suffers in a measure indicated by a longer time of meeting the demand for the next class of seeds.

Foundation or Basic Seed. Foundation seed is produced directly from the breeder seed. The genetic identity and purity of the seed is maintained and the production is carefully supervised or approved by representatives of the agricultural research institute or other authorised agencies. Foundation seed is the source for producing certified seed directly or through the registered seeds.

Registered Seed. Registered seed is the first generation of seeds from the basic seed. It is used to produce certified seeds. Many times the registered seed is omitted in order to fast-track the supply of seeds. But this always produces seeds of lesser quality.

Certified Seed. Certified seed is the first generation of increase of breeder seed from the registered or foundation seed as the case may be if we skip the registered seed stage in the multiplication process. The production process is less stringent but must be handled so as to maintain sufficient genetic identity and purity of the variety before it is approved for sale to the public.

Seeds of which Crops?

There about 350,000 plant species on earth, but most Nigerian foods come from 70 species. In urban areas, Nigerians subsist on fewer crop species because transportation costs account for a huge percentage of the retail price of foodstuffs. In rural areas, their more diversified foods are in smaller amounts from many more crop species. Okigbo (1975) named 150 leafy and fruit vegetables consumed in Tropical Africa with most of these also used by Nigerians. How many species do city dwellers consume in their fast-food city diet? The fewer the crop species we use, the less the emphasis we give to producing the seeds of the remaining species that are neglected till they are lost. The principal food crops for members of each family differ. Some eat what others would not touch. Some families dislike some crops which others relish. This diversity of choice poses a challenge to plant breeders and seed producers. The '*vote is cast*' by what we *buy* or *grow* in our farm or garden. If we buy, then it is possible to identify the crops of importance. If we grow then we would seek to acquire the seeds of the species we select. Thus, a majority of people in any community usually concentrate on a few popular crops. The reason for the selection of these species and the characteristics that enthral us in each variety we grow or buy are useful guides to breeders and seed producers.

In Nigeria, the number of plant species used as food is highest among the south-east tribes. The *frequency* of their use rather than the *quantity* considered together with the abundance of vegetation of indigenous or native flora is the basis for the assertion. Okigbo (1981) in his famous Ahiajoku Lecture in 1980 listed 120 food crop plants consumed by the

Igbos of Nigeria. Dough and soup is the traditional food of most Nigerians. The dough is usually from yam and maize across tribes; sorghum, millet, and rice for the north; cassava, cocoyam, plantain, potato and sweet potato in enclaves across Nigeria. These 10 crops provide food energy for most Nigerians. Therefore, their seeds supply should be guaranteed as a matter of national priority for the assurance of food security.

Officially Released Crop Varieties

Officially, only the National Committee on Registration and Crop Variety Release and Livestock Breeds established by a Federal Government Decree 33 of 1987 is empowered to regulate the release of crop varieties in Nigeria. It meets once a year and takes all information and data on the performance of varieties from on-station and on-farm trials to consider the adequacy of the nominated varieties for general use among farmers in the country as whole or a part. The released varieties may be many but there are few agencies producing seeds of some of them (table 1).

Table 1. Number of Registered Varieties of Food Crops as at 2009 Season

Cassava	31	Pearl millet	10	Yam	11
Cotton	13	Rice	57	Melon	2
Cowpea	25	Sesame	3	Pepper	5
Soybean	16	Sorghum	38	Oil palm	1
Groundnut	23	Sugarcane	20	Sweet potato	5
Maize	62	Wheat	9	Potato	3

Source: NACGRAB (2009)

As crop plants form the basis of all foodstuffs and feedstuffs, seeds of the select species that humans eat must form the basis of food security. Some species may be eaten raw, parboiled, cooked, stewed, or boiled. Of the 70 plant species Nigerians target, the 35 food crops accounting for most of the foodstuff that the people consume daily are: maize, sorghum, rice, millet, *acha*, wheat, cassava, yams, cocoyams, sweet potato, Irish potato, plantain, banana, groundnut, cowpea,

soyabean, *bambara* nut, pigeon pea, beniseed, oil palm, coconut, cotton (seed oil), shea butter, *Treculia africana* (*ukwa*), melon, onion, okra, pepper, tomato, sugar cane, ginger, *Corchorus* (*ewedu*), *Telfairia* (*ugu*), bitter leaf, garden egg, and garlic. But by regions of the country, the emphasis shifts between cereal crops and the root and tuber crops. A list of the major crops of Nigeria food system for which good quality seeds must be provided is given in table 2.

Table 2. The 70 Major Commonly Cultivated Food Crops of Nigeria food system

Cereal crops: sorghum, maize, millet (finger+pearl), rice, wheat, *acha* (hungry rice, *Digitaria exilis*),

Starchy crops: cassava, yam (6 species), cocoyam (2 species), sweet potato, plantain, potato, hausa potato

Oil seeds crops: groundnut, sesame (beniseed), soyabean, oil palm, sunflower, melon,

Pulse crops: cowpea, pigeon pea (*Cajanus cajan*), *Bambara* nut,

Other crops: Sugarcane

Fruits: citrus (5 species), pawpaw, banana, pineapple, guava, mango, avocado

Trees: oil palm, coconut, shea butter, star apple (*Chrysophilum albidum*), *Ogbono* (*Irvingia gabonensis*), African pear (*Dacryodes edulis*), pepper fruit, raphia palm, sour-sop, breadfruit

Vegetables: amaranth, *Telfairia*, bitter leaf, celosia, *Corchorus*, tomato, pepper, onion, garlic, roselle, cabbage, green beans, okra, watermelon, carrot, pumpkin, ginger, eggplants

Best Crop Varieties

This phrase has two possible interpretations. First, it implies the best varieties of the best crop. That is, the best varieties of the best adapted crop or crops in a particular locality or environment. Secondly, it means the varieties of the best crops which are those that are well known to contribute most to the local diet in any region and/or give the preferred sensory assessments of taste, colour, texture, aroma, and general acceptability. Crop-plant breeding activities seek to

develop new varieties that are superior to existing varieties in some factor variables. Such operations according to Burton (1966) are described by six verbs, namely: *variate, isolate, inter-mate, evaluate, multiplicate,* and *disseminate*. In truth, seed production properly covers the last two steps; whereas the first four steps outlines the work of breeders. Varieties arise from breeding work and the vehicle for moving varieties is seed. Thus, seeds and varieties are inseparable.

Food Consumption Patterns

Food consumption patterns vary with the zones in Nigeria (table 3). These patterns which remain as cultural preferences are stagnant, rather unchanging, more so under declining or tighter budgets and family credit crunch conditions. Considering the use of *gari* and other forms of cassava implies that the crop is eaten by 28.5% of the population nationally, followed by 26.1% for yam (as tubers and as *amala*). The spread across zones shows that yams are the most well distributed or preferred food crop across the six zones in Nigeria. This fact implies a need to device effective supply systems for seed yam tubers for planting each season in the major yam growing areas.

Table 3. Patterns of Food Crops by Zones in Nigeria, 1997

Percent by column	National Average	North East	North West	Middle Belt	South East	South West	South South
Gari	27.2	6	1.8	20.4	48.1	28.1	60.1
Yam	24.6	16	5.7	39.6	23.4	27.9	28.9
Rice	18.9	19	14.9	27.3	28.5	15.1	9.4
Sorghum	14.1	21	50.6	6.8	0	0.7	0
Millet	6.2	16	24.4	1.7	0	0	0
Maize	4.3	22	2.6	4.2	0	2	0
Cassava	1.3	0	0	0	0	9.5	1.2
Cowpea	1.4	0	0	0	0	7.8	0.4
Amala	1.5	0	0	0	0	8.9	0

Source: Awoseyila (1999)

Cassava, Yam, Sweet potato and Vegetables Varieties

Cassava in Nigeria

Many varieties are grown in Nigeria. A recent survey (in December 2009) showed about 100 varieties are grown by farmers in eight states, namely: Abia, Benue, Delta, Edo, Enugu, Kwara, Oyo, and Ondo. The plantable stems of these varieties are not kept anywhere for anyone to buy in bulk, but may be sourced piecemeal from many farmers in these areas. Their characteristics are also not well known to people outside the zones of their cultivation. Consequently, their suitability is difficult to ascertain for another state or locality and as such cannot be confirmed to be the best variety of cassava for a locality. In 1989-1991, there were 151 cassava varieties under cultivation in 65 representative villages spread across Nigeria south of latitude 10°N (COSCA 1997). The many less-than-best varieties of crops mostly grown across the 774 local government areas of Nigeria add up to poor yields, low outputs, and eventually result in food insecurity.

Cassava Multiplication Programme (CMP)

The importance of cassava in Nigeria is well known. In the 1987-1996 cassava stem promotion years in general, awareness and adoption of improved cassava varieties were higher in Imo and Ogun States where cassava is the traditional and main staple than in Benue where cassava was relatively newer in the farming systems. Of the 2,122,582 bundles (50-meter-long stems) of eight cassava varieties distributed from 3600 ha in 12 states for the improved cassava clones being promoted under the IFAD-CMP, three—TMS 30572, TMS 4(2)1425, and TMS 30555 were common; but TMS 30572 was the most preferred and widely adopted. Reasons provided for this preference include high yield, early maturity, good *gari* yield and quality, pest resistance, and weed suppressing qualities and suitability for intercropping (table 4).

However, some of the farmers who adopted or are using improved varieties of cassava still retain some of their local varieties mainly because of food habits and preferences or the varying uses to which such a variety is put. For example, for

those who like boiled and pounded cassava, there is hardly any improved substitute because breeding emphasis is for high starch varieties for *gari*, flour and starch required by local agro-industries and manufacturers. The major obstacle to the rapid spread of improved varieties in all zones is the unavailability of suitable plantable stem cuttings.

By 1998, the improved varieties multiplied and distributed to farmers had occupied 75% of the cassava cultivated area in Abia, Akwa Ibom, Anambra, Benue, Cross River, Delta, Edo, Enugu, Kogi, Imo, Ogun, and Plateau States. Some 24 years after the 1987-1996 decade of intensive cassava stem multiplication, the ratios among the varieties have changed as revealed by a survey among 100 varieties encountered in cassava fields aggregating to 154.2 hectares belonging to 320 farmers in 64 villages of 8 states of Nigeria in December 2009. The relative numbers of bundles multiplied in 1986-1996 compared to the ratios of the stands of the different cassava varieties on farms in December 2009 (table 5) shows that many of the varieties have not been promoted or that the farmers have selected what appeals to their own use patterns. Breeders must, therefore, recognize the supremacy of the consumer as having the last word on what are the best varieties for any locality or usage.

Table 4. Annual Hectares of Foundation Seed Produced by the Cassava Multiplication Programme of National Seed Service by Cassava Variety, during 1987-1996

Variety	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Total	Percent
TMS 30572	39	62	59	82	25	65.8	57	31.3	15	13.8	449.9	52.4
TMS 4(2)1425	3	6	10	18	15	18.4	23	37.3	9	2.7	143.4	16.6
TMS 30555	16	24	30	18	12	1	-	-	-	-	101.0	11.8
TMS 30001	2	7	4	3	17	11	9.5	8	5	5	71.0	8.3
TMS 91934	8	-	-	2	5	5	7.5	7	8	-	42.5	4.9
U 41044	5	-	-	-	12	-	-	7.4	2	4.5	30.9	3.6
TMS 50395	1	2	1	-	10	0.5	-	-	3	-	17.5	2.0
Oko-Iyawo	-	-	2	1	-	-	-	-	-	-	3.0	0.3
Overall	74	101	107	124	96	101.7	97	91	42	26	858.7	100

Source: Nigeria: Country Case Study on Cassava (Agronomy Section), 26 pages

Table 5. The Top 25 More Frequently Cultivated Elite Cassava Varieties in Nigeria below latitude 8°N

Cassava Variety	No. of plants	Cases found in 320 farms	Percent of plants	Percent of cases
1.[a] TMS 30572	329,857	73	14.43	11.81
34. TME 1 (*Antiota*)	281,992	58	12.33	9.39
52. K-195	222,390	34	9.73	5.50
8. TME 7 (*Oko-Iyawo*)	199,251	84	8.72	13.59
25. *Onye warri*	120,355	10	5.26	1.62
71. *Akpu Ufie*	102,693	9	4.49	1.46
36. *Okpo roji*	91,490	10	4.00	1.62
94. *Akpu onumme*	71,083	5	3.11	0.81
16. NR 8082	62,765	29	2.75	4.69
43. *Nwai bibi*	54,844	3	2.40	0.49
6. TME 419	44,920	12	1.96	1.94
86. TMS 50395	40,136	8	1.76	1.29
65. *Ohori*	39,425	4	1.72	0.65
46. *Egbo koda*	38,174	5	1.67	0.81
49. *Sakasaka*	36,458	5	1.59	0.81
35. *Nwanyi ocha*	34,160	6	1.49	0.97
78. TME 8	30,705	4	1.34	0.65
5. TMS 98/0505	27,675	7	1.21	1.13
91. *Akpu* red	27,196	5	1.19	0.81
31. *Odongbo*	24,994	11	1.09	1.78
17. Agric (TMS 30555)	13,518	9	0.59	1.46
69. *Akata*	13,008	7	0.57	1.13
56. BNARDA	12,647	17	0.55	2.75
9. TME 117 (*Isunikankiyan*)	6,072	23	0.27	3.72
53. *Akpu*	4,735	11	0.21	1.78
Total	2,286,127	618	100.00	100.00

[a]: Survey serial number

Note: Results are the un-weighted data of stand counts for overall likelihood of the presence of the varieties in farmers' fields across the universe of Nigeria cassava farms.

Yams in Nigeria

Yams in Nigeria largely refer to white yam (*Dioscorea rotundata*) with some percentage under water yam, yellow yam and travellers' yam. However, white yam is the

principally traded yam in all major yam markets across the major yam producing zones of Nigeria. The 3200 accessions of yams conserved at the Genetic Resources Center of the IITA in Ibadan '*in trust for the world*' represent a major future asset for the yam-loving world. It is a safeguard that assures a continued ability to improve the genotypes of yams to suit the shifting and changing demands of consumers. Today, only the best of these collections are marketed across Nigeria for food use and account for less than 1% of that number of conserved accessions.

The yam sector of Nigerian agriculture is a gold mine yet to be tapped. Yam tubers can be dried into chips for milling into flour, or roasted and eaten, boiled or pounded. The only way to fully realize the potentials of yam is to establish a full-scale research and development centre for the crop. Nigeria produces two-thirds of all tubers consumed by humans and yet does not do much for exploiting it as an export crop *par excellence* (Akoroda 1994). Globally, everyone relishes well-spiced yam pottage which contains some palm oil, crayfish, and leafy vegetables. Yet the dozens of varieties on sale are yet to be well documented and produced for export and inter-regional trade. This university can set up a yam research and development centre and adequately address issues of importance relating to its science and business.

Sweet potato in Nigeria

For the first time, a national sweet potato conference was held in the University of Ibadan by the Sweet potato Promotion Group in September 2008. The group office is based at the Department of Agronomy where 125 accessions have been assembled from collection missions in Nigeria and from selected importations from the office of Centro Internacional de la Papa in Kenya, and from The Vegetable Research Institute in South Africa. To date, five new tested genotypes have been identified from multi-site researcher managed plots and await wider on-farm trials.

Vegetable Seeds in Nigeria

Nigeria is rich in a diversity of vegetable species used for food. Visit Ojoo, Ibadan on a market day and you will be amazed at the diversity of vegetable species on sale and what can be sourced from a small radius of farm land. Okra seeds are used across Nigeria but are scarce at each planting season because its production is not fully organized into an enterprise. Thus farmers only keep their own seed stocks, inevitably of a lower quality. Okra seeds are rarely pure because seeds are not from isolated plots (Akoroda 1986); such is the bane of any traditional seed sector. As more and more seeds of vegetables get imported because Nigeria has stopped to do what she should do, the prices of vegetables will soar and rise till only the rich can buy.

The Seed Industry

The Law of Loss

Anything unprotected will be lost. Seeds are lost if not protected after production. That is why they are cleaned, sorted, graded, treated, packaged and put in dry, cool environments to make their chemical reactions such as respiration proceed at a low rate so as not to deplete much of the stored food before they are planted. Structurally, all seeds have three parts: a germ that germinates to make sprouts, the food mass or cotyledon, and the cover or coat for protection. *Any seed having less than these three parts intact is not suitable for planting*. If any of the three parts is injured during production, transportation or in storage by rodents or pests or disease, then the quality of that seed declines in storage till the date it is planted. Thus, seed recovery, drying, processing by hand or machine, must aim at protecting the integrity of these three parts. Rush work, rough work, delayed work and every mistake adds up to poor seeds that mock the efforts of the grower and turn their great expectations to a mediocre harvest. Although seed producers consume part of their seed output (e.g. 40% in PROSAB Project in Borno), they still sell seeds for use as planting materials to other farmers.

Fertile and Weed-free Seedbed

Planting the best seeds of the best crop varieties will not guarantee food security. We have heard that as the '*sower*' went out to sow his precious seeds, some seeds fell by the wayside, others fell among thorns, some fell on rocky ground, and some fell on fertile soil and yielded 100-fold. The best seeds will also need fertile soils and weed control to assure high yields for raising outputs and enhancing food security. Generally, only 15% of Nigerian soils are fertile enough to produce a good yield of staple food crops. Thus, most of the soils require manures and fertilisers.

Training in Seed Production

Aspects on which seed producers must have competence are agro-biological as well as socio-economic (table 6), including a good dose of diligence. The theory and the practice involve operations in the laboratory, screen-house, farmers' fields, genetic resources banks, silos of strategic seed stores, research stations, markets, and law books of seed trade. Therefore, training in seed production is complex. There is no better way to train farmers than to engage them in projects that relate to seeds and varieties of the selected crops they grow (tables 7 and 8).

Table 6. Topics Included in the General Training in Seed Production

1. Importance of seed in farming
2. Basic genetics and genetic control of crop yield and performance
3. Components of seed quality
4. How seed quality is determined
5. Seed quality testing procedures
6. Pollination and its control
7. Seed formation and maturation
8. Stock seed production and maintenance
9. Selecting and preparing seed fields
10. Isolation of seed farms
11. Variety characteristics and identification
12. Field inspection and roguing seed fields
13. Security of seed farms and enterprise
14. Irrigation, fertilisation, and pest control to maximize yield
15. Seed harvest, handling, and storage
16. Seed moisture, quality and longevity
17. Drying, conditioning, cleaning, and separating
18. Seed treating, chemicals, and procedures
19. Containers, bagging, sealing, and weighing
20. Seed longevity and maintaining viability quality, and purity
21. Maintaining identifying seed bags and lots
22. Transport, dissemination, and distribution
23. Identifying seed market needs and demand
24. Marketing and promotion of seeds and varieties
25. Convincing farmers to use better seed
26. Pricing, cost and farmer acceptance
27. Working with seed producers and suppliers
28. Seed business planning and management
29. Carryover seed and food production
30. Socio-economics of the seed industry
31. Plant and seed quarantine
32. Seed certification
33. Seed law and its implementation

Adapted from: Gregg et al. (1999).

Table 7. Mean Yield of Sole Crops in Secondary and Tertiary Farmers' Fields after 2008 Harvests in PROSAB Project Area of Borno State.

	Local Seeds sown (Kg/ha)	Improved Seeds sown (Kg/ha)	Percent increase over local
Rice	1608	2730	70
Sorghum	1537	2114	38
Cowpea	1396	1955	40
Groundnut	1361	2623	93

Source: Ellis-Jones *et al.* (2008).

Table 8. Certified Seed Producers' Views (% of 314) on Benefits of Seed Production to Local Community in Promoting Sustainable Agriculture in Borno State of Nigeria (2004-2008).

Seed producer's view	Strongly agree	Agree	Disagree	Strongly disagree
Improved varieties are readily available locally	68	23	9	1
Yields have increased greatly	80	17	2	0
Families are more food secure	54	41	4	2
Farming is more profitable	81	17	1	2
Producing seed is a profitable business	82	14	2	2

Source: Ellis-Jones *et al.* (2009)

Seed Rates

Seed rate is the amount of seed required to plant one hectare of farmland. There is an optimum population of plants that a field should have to produce the best yields from that area. Farmers who use a seed batch that gives less than that optimum would not achieve a high crop yield, making the farm uneconomic as an agricultural venture. In Nigeria, in 2009, the following crop hectares where cultivated (table 9).

Table 9. Hectares and Seed Rate required for Crop Production in Nigeria

Crop	2008 fields x 1000 ha	Seed rate (kg/ha)	Unit for seed	Average Yield (kg/ha)
Cassava	3629	10,000	cutting	13027
Cocoyam	406	1250	kg/ha	7887
Cotton	1043	25	kg/ha	293.
Cowpea	2560	25	kg/ha	578
Groundnut	2186	45	kg/ha	1230
Maize	4862	20-25	kg/ha	1598
Melon	315	15	kg/ha	490
Pigeon pea	27	20	kg/ha	667
Millet	4110	3	kg/ha	950
Sorghum	4794	5	kg/ha	1176
Soybean	368	33	kg/ha	1410
Yam	3478	2500	kg/ha	9653
Rice	2141	38	kg/ha	1756
Potato	140	3333	kg/ha	7894

Sources: Phillips (1977); NFRA (2008); Ekeleme et al. (2009).

Seed rates depend on the morpho-type of a variety. This concerns the spacing of plants to avoid mutual shading of leaves of their fully expanded short systems, and also concerns the soil fertility conditions. The fertility of the soil, water holding capacity of the soil and the local annual rainfall during crop-life determine how densely arranged the optimum plant population should be. The viability, germination, and pure live seeds in a seed batch or lot will also influence the quantity of seeds needed to optimally saturate the space in one hectare of farmland. These factor variables dictate seed rates and only when these are well understood in relation to local conditions of farming can the best seeds of the best crop varieties be used to their best advantage, to ward off hunger and assure food security.

Varied Seed Multiplication Rates

Firstly, to multiply cassava from one stem takes a minimum of 8-9 months. It is 4-5 months for maize and less than 2 months for cowpea (*ewa, isha, ire-e*). This time factor should always be considered in designing seed programmes.

Secondly, the rate of multiplication is higher for some crops than others. One cob of maize would give 300-600 grains but one stand of cassava would give 7-10 cuttings for planting.

Seed Testing and Certification

In developing the seed industry, there must be *moderation* within the private sector though they engage in seed enterprises to make profits. The use of labels to declare what a seed lot or packet contains is frequently fraught with falsehood. As we experience untrue labelling in the trade of fake medicines and cosmetic products, so too it is in the seed trade. The 'Certification Agencies' must also do their best to regulate and control seed quality (table 10) which is the *'soul'* of a good seed industry (fig. 3). The National Agricultural Seed Council laboratories are not yet optimally functional across every state of the country and the personnel require more motivation to handle the required level of seed testing that will significantly impact on the quality of seeds on a grand scale. A progressive seed industry is hinged on the principle of *Veritas nobis lucem* (Truth shall be our light).

Table 10. Minimum Quality Standards for Certified Vegetable Seed Production in Nigeria

Generalized Certification Requirements		Isolation distance (meters)	
Number of field inspections	3 [a]	*Amaranthus* (tete)	200
Isolation distance (meter)	25-500	*Corchorus* (ewedu)	30
Tolerated off-types (max. %)	0.2 [b]	Cucumber	500
Weed seeds (max. no/kg)	none	Onion	500
Level of pure seed (min. %)	95-99	Pepper	200
Lab. germination count (min. %)	60-80	Tomato	25
Seed moisture content (max. %)	7-10	Watermelon	500
Seed moisture for vapour proof conditions in package (max. %)	6-8	Okra	200
		Eggplant	100
Total inert matter in batch (max. %)	1-2 [c]	*Egusi* (melon)	500

[a] : six inspections for onion; [b] : 1% for *Corchorus;* [c] : 5% for *Amaranthus* and 3% for *Corchorus.*

Source: Shobowale *et al.* (2010).

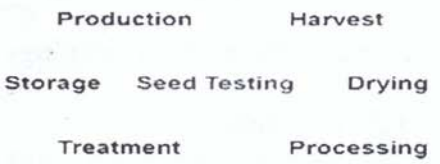

Fig. 3. Seed testing is the cornerstone of a viable seed quality regulation system

Seed Act

This is a series of rules and regulations or the law guiding how seeds are traded in a country. Rules guiding Nigeria's seed trade were first passed under section 12 (3) of the Seed Act (No. 72 of 1992) but it is being amended. The amendment is in its second reading in the National Assembly in 2010. It is illegal to sell bad seeds in Nigeria; but the morale for keeping the law is low. If you buy seed that is not viable, you can get redress in any court of law, if you have the time and nothing to do with it. The existing agricultural laws do not yet cover seed trade adequately. But the United States of America passed their Seed Act in 1912, amended it in 1916, re-amended it in 1926 and more drastically revised and amended it in 1939 for virtually all known agricultural seeds of important crop species and varieties that were listed at that time. The seed act covered a total of 66 vegetable species and 194 species of grass, forage, and field crops. In this way, the majority of all important crops to the agriculture of the USA is protected from greed, fraud, and cheating of farmers by farmers and traders. The penalties are stiff and are *always applied* to deter seed contractors and traders from selling anything but the best seed supported by a solid seed certification system. Constant review of the seed trade and industry is crucial to successful farming and agriculture in Nigeria. That is the way the Nigerian Seed Industry must go if the productivity of our farms and farmers is to advance.

Seeds as Genetic Resources

The collection, conservation and management of crop germplasm is required to stop genetic erosion. This arises with the loss of genotypes as man abandons the cultivation and usage of some varieties or as some genotypes succumb to abiotic and biotic stresses. Genetic resources must be managed carefully, just as we manage the artefacts of our history, language, and culture. As culture is a way of life, so too is agriculture a way of life. Any loss is a veritable denudation and weathering of our own value, worth, and essence. Varieties are fewer than the available genetic stock in the germplasm collections for any crop. Most growers use several or many low-yielding genotypes that are good enough in one or more respects as regards his or her needs but may not be the best genotypes for their circumstances.

The search for the best seeds of the best crop varieties is a continuous activity. Germplasm resources in Nigerian forests and savannas are being depleted with little conservation efforts. The need to preserve all genetic stocks in our vegetation is a duty we must hold in high esteem. It is our life and our pride for it defines our identity as Nigerians. A people are defined mainly by their soil and their flora which in turn defines their fauna. Germplasm is for our use today and tomorrow because new wants and threats will come our way that would make us seek new genes from them while trying to breed for new genotypes. Germplasm preservation is an urgent demand on any forward looking nation. Nikolov Vavilov of Russia collected many accessions of many crops species from all regions of the world and propounded the theories of centres of crop origins and diversity. Such gigantic bursts of brain power, meticulous attention to details and hard work for mega-projects are often lacking on our shores because sustained funding to back such moves and operations are never allotted to scientific enquiry. Germplasm acts as a cornerstone to the development of a flow of the best varieties that would be the pillar of food security of Nigeria. This hinges on the fact that there are four major requirements for

sustainable agriculture, namely: soil, water, crop protection, and genetic resources, and that the last is the most vulnerable according to the International Conference on Crop Science in 1992. Consequently, scholarship funds for training in seed production cum plant breeding should be a priority in any futuristic economy. Currently, there are less than 100 persons in the Genetic Society of Nigeria; seed scientists are few and far apart, constituting an inadequate critical mass for impacting the system. Loss of genetic resources continues daily and thus restricts or limits our abilities to cope with new challenges of biotic and abiotic stresses to crop-plant industries in Nigeria.

Mr Vice-Chancellor, Sir, in 1952, here in the city of Ibadan—the capital of agriculture in Africa, Chief Obafemi Awolowo spoke to the Western Nigeria House of Assembly, that,

> Poverty in Nigeria' is caused by abject state of the peasant class; their inertia through want of health; their enslavement by ignorance and superstition; their antediluvian methods of cultivating the land due to bad husbandry, and also their hopelessly unorganised system of marketing their farm products.

He, therefore, advised on the way to resolve the problem and '*roll away the stone*' from the sepulchre of poverty thus:

> Therefore, introduce scientific and modern methods of cultivating the land to improve their productivity and earning capacity, mass education and medical and social services to 90% of Nigerians that are poor.

May I say that the words of the 'Sage' are as true today as they were nearly five decades ago. Today, 54% of Nigerians are very poor; these families wear a look of pity and defeat showing the symptoms of food insecurity (fig. 4).

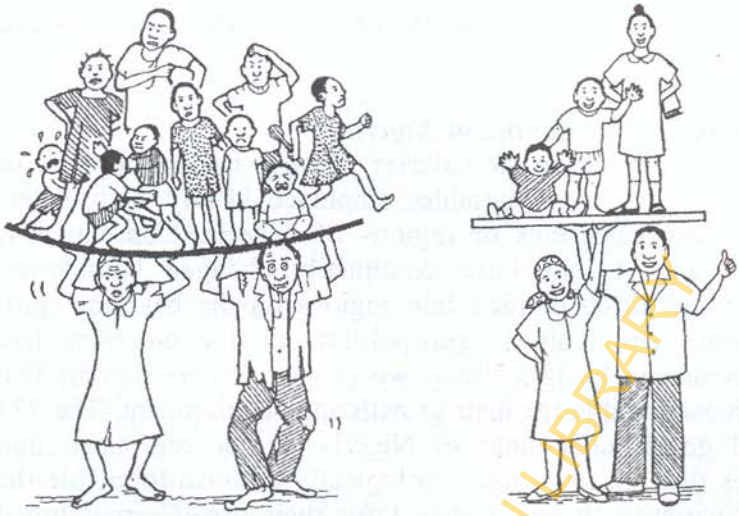

Fig. 4. The burden of poverty and food insecurity and realization of the fears of the Malthusian vision in Nigeria (*Na which side you dey?*)

Contributions to Scholarship

Mr Vice-Chancellor Sir, there are some 200 publications, technical reports, and monographs arising from my research, conducted singly or in groups with students and partners, covering varied aspects of the seed systems, crop improvement, and reproductive biology of 36 named crop species including: yams (*Dioscorea* species), cassava (*Manihot esculentus*), sweet potato (*Ipomoea batatas*), potato (*Solanum tuberosum*), cowpea (*Vigna unguiculata*), maize (*Zea mays*), sugarcane (Saccharum officinale), okra (*Abelmoschus esculentus*), *Ugu* (*Telfairia occidentalis*), *Ewedu* (*Corchorus olitorius*), peppers (*Capscicum annum and C. frutescens*), amaranths (*Amaranthus cruentus*), *soko* (*Celosia argentea*), eggplants (*Solanum* species), tomato (*Lycopersicum esculentum*), melon (*egusi*, *Colocynthis vulgaris* and *Citrullus launatus*), plantain (*Musa* species.) and spice species such as *efirin* or *eran* or *nchaun* (*Ocimum viridis*), *Aloe vera*, lemon grass (*Cymbopogon citratus*), etc. Each of these investigations elucidated and resolved one

problem or the other within the complex systems of seeds and varieties.

Agro-ecological Zoning of Nigeria

There are no clear boundaries for the natural regions of Nigeria. The set of variables employed in any study determines the categories or regions of Nigeria. Consequently, states and regions have continually changed boundaries. Nigeria is often divided into regions on the basis of agro-climate, agro-ecology, geo-politics, or for administrative convenience. In agriculture, we grow crops by regions that are most suitable for their growth and development. The 774 local government areas of Nigeria can be regrouped into zones that are more agro-ecologically uniform to enable the best varieties to be identified for their use. Current broad zonings do not guide farmers to produce the best yields because there is inappropriate use of varieties. We developed a neutral map based on 100 variables digitized for 334 cells of Nigeria's landmass divided along half latitude and half longitude (each square of 30' longitude x 30' latitude is an eco-zone of 55.5 km^2). Optimally, 12 agro-eco-zones were produced in a first approximation (fig. 5). This was generated from a combination of the outputs of the average linkage and group average clustering techniques at 85% similarity between eco-zones of the same group based on the 100 variables from selected aspects of: relief, rainfall, geology, meteorology, vegetation, soils, population density, ground-water potentials, and other related statistics. Each group of squares is a distinct and separate agricultural environment comprising a number of similar eco-zones (Akoroda 1994).

To grow crops most suited to each eco-zone or 'zonal specialization' has always been the best way to maximally exploit the environment. This entails growing the best crop that is most locally adapted and preferred for food and sowing the best seeds of the best varieties at the best sowing dates.

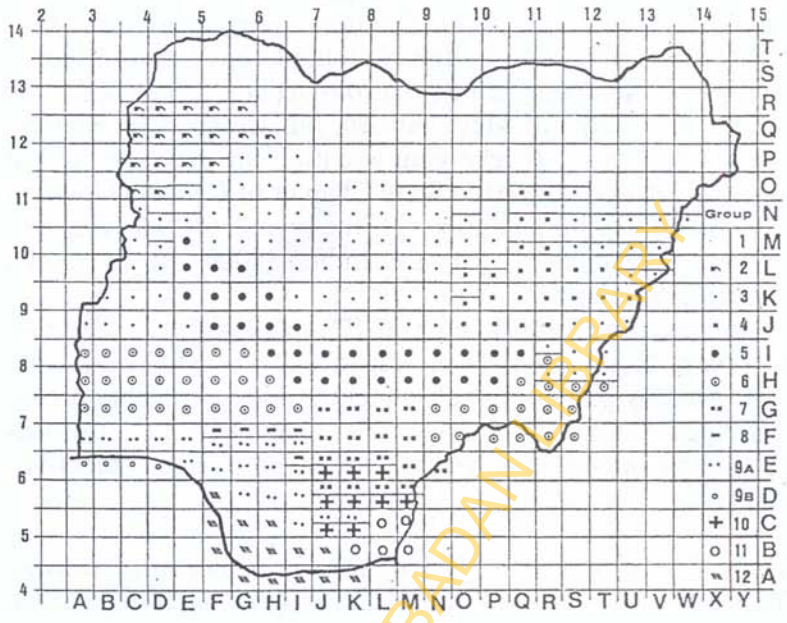

Fig. 5. The 12 agricultural environments of Nigeria (Any intermediate ecozone belongs to two groups).

Breeding of New Crop Varieties

From 1987 to 1990, we identified elite clones from 12,000 progenies of cassava at Meiganga for multi-site testing, while three previously released varieties each for cassava and sweet potato were massively multiplied and distributed across the 800 villages of the highlands of the Adamaoua Province of the Republic of the Cameroons (Akoroda 1989). In this savannah zone, cassava is used in form of flour but immature roots are occasionally boiled and eaten in times of famine and hunger.

Recently in Nigeria, nine new cassava varieties were nominated for release from the Cassava Mosaic Disease project lead by IITA (2006). Following large-scale field trials on researcher-managed, on-farm tests, and demonstration plots in 2500 sites in collaboration with 120 collaborating partners, data on agronomy and postharvest variables were

used to formulate a 31-variable based index for selection. Finally, in 2005 and 2006, the nominated genotypes were released for cultivation by the National Crop Variety Release Committee. Someone hinted that *our team* was entitled to or worthy of a National Merit Award, but we are still waiting, and we do hope 'it is receiving attention' as they say in civil service. However, the Abia State Chapter of Cassava Growers Association did honour me with the award of "*Mobilizer of Cassava Production*" in December 2006 at Umuahia Township Stadium.

As part-time yam breeder at IITA (1984-1987), the first new water yam varieties were identified in 1985. These were to be used as parents in subsequent crossings to obtain new genotypes with better overall characteristics towards developing ideotypes that match set breeding objectives (Akoroda 1986).

Study of Seed Structure, Production, Transport and Storage

The studies were carried out on *Calopogonium*, *Centrosema*, *Mucuna*, cassava, sweet potato, cowpea, yams, maize, potato, soyabean as well as vegetables: Tomato, *Amaranthus*, cucumber, okra, *Corchorus*, *Telfairia*, *Ocimum*, and several others to meet smallholder enterprises.

Design of Seed Systems

Cassava and sweet potato multiplication and distribution schemes have been articulated based on the original work on cassava in Oyo state in the early 1980s as shown in figure 6 (Akoroda 1987; 1997; 1993; 1994; Dahniya et al. 1994; Akoroda et al. 1992). This process-path technology has been adopted in region-wide programmes based on the three hierarchical levels of efficient multiplication. The model has been tested and is in use in 30 countries of Tropical Sub-Saharan Africa. First, clean seed is generated by primary level producers, then by secondary level producers, and then by tertiary level producers before farmers get their seed supplies. Leakages in the system weaken the delivery in quantity and quality and wrong channelling of seeds along the

scheme slows the overall throughput of the seed system. The model serves well the vegetative propagation of root and tuber crops especially yam, cassava, and sweet potato. They have low multiplication ratios and their systems differ from those of grain and pulse seeds.

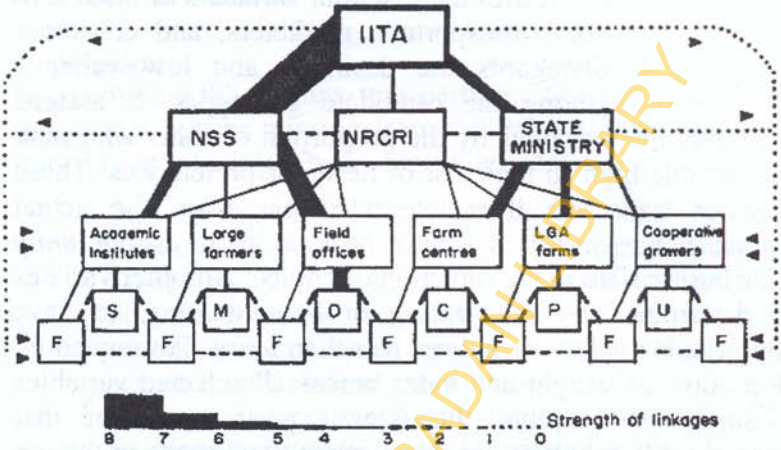

Fig. 6. A proposed hierarchical flow of delivery of plantable stems of improved cassava varieties from IITA. LGA: local government area; S: Schools; M: medium farmers; O: out-growers; C: community contact farmers and pilot demonstration farmers; P: peasants; U: farmer unions and cooperatives; F: village farmers

The flow chart initially emphasizes strategic distribution of breeder stock of stems to only agents with facilities for multiplying released varieties prior to grassroots dispersal and adoption at village-farm level. The agents are principally the National Seed Service (NSS), State Ministries of Agriculture, and the National Root Crops Research Institute (NRCRI).

Development of Index for Selection of Genotypes

The Multi-dimensional Analysis (MDA) assesses options on several important dimensions (table 11). Given that plant breeding *cum* seed production is a game of numbers, mathematics and statistics form the unequivocal nexus of the decision-making process. Till date, the use of the analysis of

variance (ANOVA) and many other statistical tools in selecting varieties have tended to be based on sequential selection of single variables with non-quantitative agglomeration of performances. This path delays breeding, excludes all-round types, and give less throughput of varieties over time. The MDA identifies the essential variables of interest to farmers, processors, transporters, marketers, and consumer end users. It disregards the desirable and low variance characteristics among the candidate genotypes. It assigns weights to the variables by the proportion of users who rank that variable high in their list of needs or preferences. These character traits are then integrated based on the actual performance measures that have been coded to ascribe *unity* to the best variate in the direction of choice. All other variates are determined by *numerating* or *denominating,* to have proportionate values or indices less than *unity*. Consequently, the product of weight and index across all selected variables or dimensions capture the overall performance of that genotype. All genotypes are then ranked and those in the top echelon saved.

Table 11. Crop varieties Selected for Seed Production Based on Six Dimensions

Variety name	Character with unequal weights (*w*) on which to evaluate varieties					
	Yield	Colour	Texture	Aroma	Store days	Taste
	6w	*1w*	*2w*	*3w*	*4w*	*5w*
Abok	1	3	9	12	34	2
Boju	2	3	8	11	67	10
Chik	5	3	4	19	12	9
Diga	4	2	3	5	39	8
Efuh	3	2	2	4	66	7

Finally, Mr Vice-Chancellor, Sir, whereas 70 major food crops are consumed by Nigerians, and whereas each crop has many varieties grown across the nation in 12 agro-ecological zones by peoples derived from 14 erstwhile empires who speak 400 languages and dialects and whereas 56% are

illiterate and 85% are innumerate according to a 20-year average of those who do not pass at credit level in WAEC and NECO; and whereas a huge proportion of Nigerians spend less than one dollar per day, I put it to you that the duties of seed agencies, producers, and traders are herculean and require much greater help and assistance and support than they currently receive.

Conclusion

In concluding this lecture, it is pertinent to recommend a few things that appear missing from our seed system that needs injecting or infusing. These should include:

(a) The establishment of a '*National Yam Research Institute*' to cater for the most important nationally acceptable single cop across all agro-ecologies. As Nigeria accounts for over two-thirds of the world output, and consumes most of it, national and food security will depend on how we manage this great resource. Present work and attention at the NRCRI is far disproportionately insufficient and miniscule.

(b) The establishment of state research institutes to supplement the 17 federal government commodity research institutes. The existing institutes are too broad and shallow in their mandates, but what the farmer needs are more specific guidance at their local government area, in terms of agro-climate, soils, seeds of the best crop varieties, and the management of socio-economic variables peculiar to their very locale.

(c) Passage of the revised Seed Law into an Act and a more serious enforcement of its letters. The sale of sub-standard seed that does not translate to good crop stands on the farmers' field is a waste of money apart from the greater problem of weed infestation occasioned by the many missing gaps that dead seeds create on the farm. Also better implementation of the law is welcome.

(d) Establishment of seed farms from which seeds of the best varieties are distributed to all residents of this university campus is our first step to distributing the

dividends of the work we do here in the 'gown' to meet the demand of the 'town'.

(e) The traditional practice of using substandard seeds kept from 'own' production will continue to hinder our productivity. Unless we separate seed production from food production, the advance towards food security will be slow and sluggish. Empowerment programmes and mega-alliances to promote the separation are solicited.

(f) Support for the formation of a National Seed Association or the Seed Science Society that was inaugurated on 30 May 2006 at the University of Agriculture, Abeokuta but is yet to act with vigour for want of the wherewithal (Akoroda 2006).

(g) As what we sow, is linked to what we reap; poor seeds would yield poor harvests and impoverish the nation's food sector. Better seeds give better yields and for sure the best seeds of the best crop varieties give the best yields. It is necessary, therefore, to encourage wider seed testing. Testing the quality of seeds on offer for sale should be a common feature of our agriculture to ensure farmers do not work hard for low outputs. Corrupt certification processes raise the price of the seed and the cost of crop production thereby increasing food prices beyond the reach of many people.

Mr Vice-Chancellor, Sir, agriculture is a construct of humankind mainly organized by women-folk. It is she who collects, assembles the bits, processes, stores, retrieves, cooks, and serves meals to her household. Men-folk are hunters, wanderers, wayfarers, and stay less at home and do not fully understand the management of food supplies. This is because it is the spiritual and emotional duty of the woman to nurse, nurture, and nestle their children and men-folk. Women own and operate more compound farms than do men worldwide. This is proof that the future of our survival rests heavily on women. So, let us give women the best seeds of the best crop varieties that we may feed well and live.

Because there will be no 'Egypt' to go to for grain, we all have to adopt a *self-help* or *do-it-yourself* approach. Widespread population 'watch and control' *combined* with general adoption of compound gardening was the first and remains the only way to conquer mass hunger where centralized administrative arrangements have failed woefully. Many more people must take to compound gardening, growing vegetables, trees, shrubs and numerous usable economic crop-plants. They would require the best seeds of the best crop varieties as we see in some parts of Nigeria. Honest labelling of seeds, and truth in dealings with each other will help ease the *gelling crises* before they concretize. Believing *Mens molem agitat* (The mind transforms the matter), may each of us transform our nation by what we set our minds to do and may we all set forth at dawn, like the Yoruba's say, *Aro lo jo.*

Acknowledgment

Mr Vice-Chancellor, Sir, at this point, kindly allow me to acknowledge some persons who have contributed to this lecture in more ways than one.

I thank God for all things, great and small, known to me or not. I truly appreciate with gratitude His saving grace, mercies, gift of life and good health. I remember with gratitude my late parents who did their best for me to be my best. They ran well, finished well, and so rest well, Amen. My thanks are due to the Akoroda clan at home and abroad. Names are too many to mention but permit me to appreciate some *dramatis personae* of my academic background. I thank all my teachers, tutors, demonstrators, lecturers, friends, and colleagues at Academy Primary School, Urban Area and Saint Malachy's Secondary Grammar School, Ugbeyiyi, Sapele, King's College, Onikan, Lagos, the University of Ibadan, and the International Institute of Tropical Agriculture, Idi-Ose, Ibadan. Each played a part in what is happening today *without their knowing it.* Acknowledging people is a basket of reminiscences of how numerous, small but valuable contributions *that added up* have helped construct the edifice

of my life till date. It is important at this stage to give honour to whom, honour is due. No man is made but by the contributions of many well-wishers and friends of all ages, as well as *parentis in loco* and *parentis ex loco*.

It was in September 1972 that I arrived at the main gate of this university to read Biochemistry. But my argument that though I had no physics among my subjects I should be allowed to enter the department met with no approval. I was told that the HOD at that time was a former Kings' College old boy, so I tried to convince Prof Olumbe Bassir of blessed memory that I was the best in physics in my secondary school at Sapele but was not advised to take it in the WAEC. He simply looked straight at me and said with all finality, you may go for a course in the Faculty of Science. You are not qualified to do Biochemistry; though I had already secured an FGN bursary. What a day! But Mrs Redhead in the Faculty of Science looked at my grades and subject combination and advised me to also try the Faculty of Agriculture, Forestry and Veterinary Medicine. "Do you mean Agriculture is a subject in a university?" I asked her. "Yes there is a whole faculty devoted to it". That was how I found my way to agriculture and have remained there for 38 profitable years of my professional life. I thank both of them.

Prof. F.O. Aboaba was my BSc project supervisor and groomed me in agricultural engineering but lost me to his close friend Prof. H.R. Chheda who attracted me to plant breeding through an award of a scholarship instigated by my classmate, Joseph Quirino Anthonio of Pepple Road, U.I.

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My interaction with the International Institute of Tropical Agriculture at Idi-Ose, Ibadan has been superlatively beneficial to my career since 1976 to date. I was taken there from UI by late Professor H.R. Chheda –an Indian from Gujarat, who was my major academic supervisor at the Department of Agronomy. Professor Chheda was astute and the master of argument and science of logic, who by habit perused each word in every possible nuance in my thesis as we sat side by side for days and weeks; and Dr Sidki Sadik—a Palestinian American, my co-supervisor in tissue culture techniques and plant physiology at IITA—an expert in precision in science and microscopy. Dr Jill Wilson—of the United States of America, was my co-supervisor in yam breeding and floral biology. She was a woman who loved the outdoors and held with a strong mind that whatever should be done must be done well.

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able to test my mettle in as many field assignments and tasks across Africa which improved my dexterity in many diverse fields and to them all I remain grateful and indebted. I also appreciate the contributions of my collaborators, partners, and colleagues at IITA, TRIPP, CIP, ISTRC-AB, NRI, PDRT, FACU, PCU, ADPs, IBS, IFC, TAC, VITAA, CMD, NFRA, IFAD, FAO, GLCI, EARRNET, SARRNET, NIHORT, EARRNET, ELO, AFNETA, SU, SPG, AGN, NRCRI, RTEP, CMP, GATSBY, IRA, and the ISTRC (Worldwide) from which in November 2006 I received a Life Time Service Award at Trivandrum, Kerela, India. I thank my instructors and course mates at the many professional courses I have attended for adding the needed 'finishing' to my career.

I am grateful to the members of staff of the Department of Agronomy 'family'. I especially thank all the **120** students I have supervised from **1980** to **2010** while at NIHORT and at the University of Ibadan for stimulating me with their rather helpful enquiries and for extending the '*best seeds from this source to other sites*'. I also remain grateful to the 1000 members of ASUU at UI, for not abandoning the '*ship in rough seas during the periodic storms*'.

I greet the members of Assemblies of God and the *Saints of God* Worldwide and maintain my hope that all will be well as the Lord has promised us. I salute my children, 'Karo, 'Chavwe, 'Fejiro, 'Tega, and Manasseh for 'local warming' of the house while they were with us. By all counts, my dear wife has done very well in the training of our children who mostly give us pleasure, I appreciate them all. Finally, the person I have lived with longer than my parents is Omawumi, who has been a most supportive wife these 33 years.

Mr Vice-Chancellor, Sir, It is only you and those gathered here today listening to me who can say how well I have flown. But surely, I have flown to my destination and I have landed. I salute your patience and I thank all who have heard the lecture in this past hour. May the Lord who shares in bundles add more to your basket of goods from this time forth and always, Amen.

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