FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

PLANT GENETIC RESOURCES AND FOOD SECURITY: INCREDIBLE GENEROSITY, INCREDIBLE RESPONSIBILITY

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INAUGURAL LECTURE SERIES 31

20TH NOVEMBER, 2014

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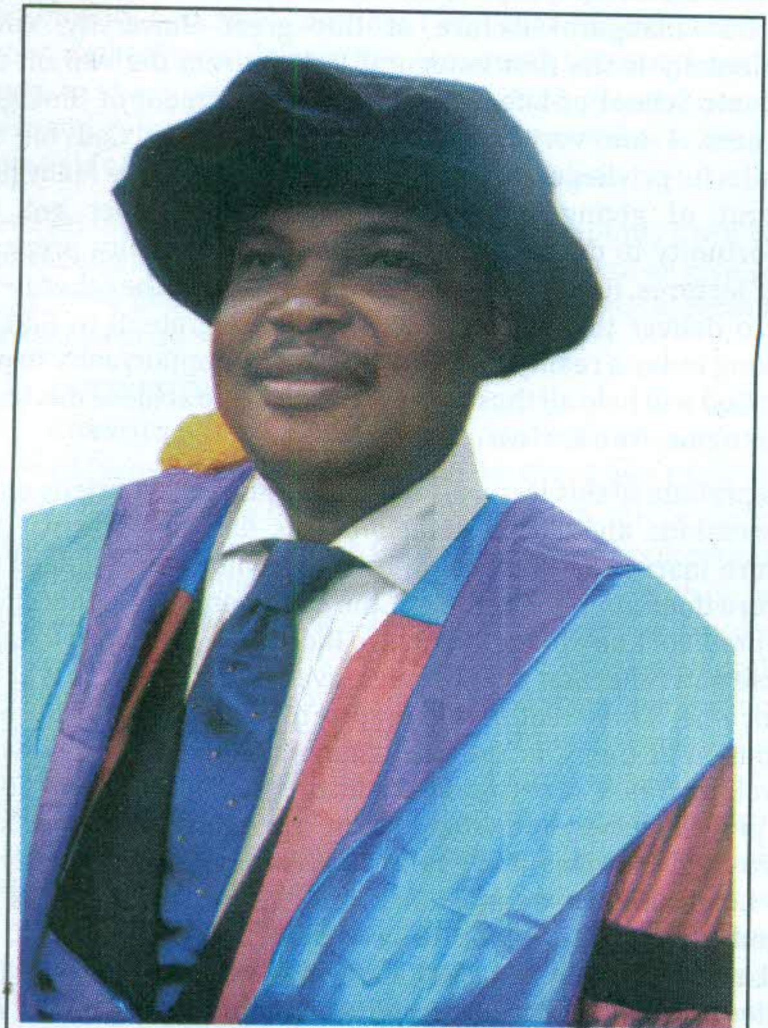

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1. INTRODUCTION

Mr. Vice-Chancellor, Sir, it is indeed an honour for me to present the 31st inaugural lecture of this great University, which incidentally is the first inaugural lecture from the vibrant and dynamic School of Life Sciences and Department of Biological Sciences. I am very grateful to the Almighty God for the wonderful privilege He has given me to be here today. Many have dreamt of giving Inaugural Lectures, but never got the opportunity to do so. Yet others got the opportunity, prepared their lectures, fixed a date, but for one reason or the other, never got to deliver them. Therefore, I am most grateful to God for making today a reality for me. I also use this opportunity to pray that God will help all those who are aspiring to achieve this bar, in Jesus name: *Ire a kari wa o, Amin.*

As a prelude to this lecture, I thought I must reflect briefly on my impressions about this occasion. This day, in particular this lecture marks the pinnacle of my academic career. Indeed this lecture does not only represent the consummation of my efforts in pursuit of knowledge, but it also induces in me a need to take a pause and reflect on the journey traveled to this end. It is at this point when I fully realize that in spite of this journey having been turbulent at times, in the final analysis it was a journey worth travelling. Yes, it is in times such as this, when the magnitude of the grace lavished upon one's life by the Almighty God becomes more vivid. Like **David in Psalm 124, I am persuaded to say: "If the Lord had not been on my side when the storms of life raged against me, I would have been swallowed alive**. But praise be to God who has not allowed lack to define my destiny. Ladies and gentlemen, just imagine with me a young fellow who spent much of his youthful years in the farm (Cocoa farm), this afternoon presenting a professorial inaugural lecture to you. Surely, it can only be by grace, the grace of the Almighty God. Mr. Vice Chancellor sir, I could not have found words or scripture, which better encapsulates my experiences than this account by

David: **The race is not to the swift, or the battle to the strong Eccl. 9:11.** So, it is with total humility and immense gratitude to the Almighty God, the "I am that I am" that I stand before this august gathering to deliver this Inaugural Lecture. I am very happy to share with you and the audience present here this afternoon, some of the knowledge I have **amassed** over the years in the field of Applied Plant Genetics and Breeding.

Based on the near abstract nature of this discipline, I will crave your indulgence, Mr. Vice- Chancellor sir, to first of all give some background information on Genetics, Plant genetic resources and food security.

2.0 DEFINITIONS

2.1 Genetics

The word "genetics" was derived from the Greek and Latin word "*genesis*", which means birth, origin or creation. Interestingly, it has something in common with Genesis – the first book of the Old Testament in the Bible. Thus, genetics is the study of birth or, more broadly the study of heredity. It is a branch of Biology concerned with heredity and variation. Genetics is all about the origin of variation, its organization and how it is transmitted from generation to generation or from parents to offspring. Although various fields of learning try to elucidate the creativity and ingenuity of the Master Creator, there is no other field that is as interesting, dynamic, revealing, challenging and promising as the discipline of genetics. This is because the study of genetics is about the why and what is responsible for the differences in and between various organisms. It is about why you are who you are. It is also about why you look like your brother, sister, mother, father, grandparent or even great grandparent. It is actually the reason why you should accept to be who you are and do your very best with it (Ayorinde, 2004). Genetics is a science which surrounds us and determines our everyday lives. As a fundamental life science, it has been in a state of exceptionally vigorous growth. It has found applications not only in basic biological disciplines such as taxonomy and evolution, but even in applied areas such as human and livestock medicine, agriculture and horticulture even in unrelated disciplines of psychology, sociology, criminology and law.

The first scientific studies in Genetics were carried out by a man called Gregor Mendel who lived between 1822 and 1882. It was through his experiments that the mechanism of inheritance became known. His investigations were on hybridization of plants particularly Garden pea. In his results, Mendel showed that a character was controlled by a factor, which was later termed 'gene'. He explained that a gene has two alleles and there are two forms of an allele: the dominant and the recessive forms. The dominant form expresses itself in the presence of another dominant form or a recessive form. On the other hand, the recessive form can only be expressed in the absence of a dominant form (allele) of the gene. Mendel established the law of segregation, which showed that during gamete formation, the two alleles separate or segregate and enter different gametes. As a result, each pollen grain, ovule, sperm or ovum carries only one of each pair of parental alleles.

Mendel carried out both monohybrid and dihybrid crosses and his experimental results became his two laws of heredity namely, Law of segregation and law of independent assortment of genes respectively. The law of segregation of hereditary factors states that the two particulate members of a gene pair segregate from each other into the gametes, so that half the gametes carry one member of the pair and the other half of the gametes carry the other member of the pair. The law of independent assortment of genes, on the other hand, states that during gamete formation, the segregation of the alleles of one gene is independent of the segregation of the alleles of another gene. Mendel's experimental findings and laws of heredity, published in 1865, remain the basic principles of heredity and classical laws of genetics without which our understanding of genetics today would be incoherent. For this reason, Gregor Mendel is regarded as the father of modern genetics.

2.2 Genes and the Chromosomes

A gene is a code that governs how we appear and what characters we have. There are genes in everything that lives, or has lived (whether plants or animals). The idea that "something" is responsible for the appearance of characters of parents in their children had for a long time taken firm root in the minds of early Biologists. This "something" was given different names by different people at different times. It took the classical experiments of Gregor Mendel to correctly associate the substance that is responsible for the appearance of characters with the sex cells and showed their mode of transmission and expression, generation after generation. This substance according to Okoli (2003) was first called gene by Johannsen in 1909. The word gene is, therefore, used to describe the unit of heredity whose expression leads to the appearance of characters in living organisms. Genes along with the environment, defines the identity and the uniqueness of every organism through their phenotypic effects (Morakinyo, 2003). They are the principal determinants of all life processes, from cell structure and function to reproduction of the organism (Okoli, 2003). The study of genetics involves knowing what genes are, how genes are transmitted from generation to generation, how genes are expressed and how gene expression is regulated.

The Chromosomes on the other hand are definite structures found in the nucleus and on which the genetic materials are located. They are microscopic and appear in a cell nucleus during cell division. Each chromosome is double stranded and each strand is called a chromatid. The two chromatids run parallel to each other, as they are exactly alike in morphology and quality. They are held together at one point only along the length. This point of attachment of the two chromatids is called the centromere of primary constriction. The centromere may be located anywhere along the chromosome length, but its position is specific for each chromosome. Apart from attaching the chromatids of *a* chromosome together, the centromere also organises the division of the chromosome during cell division. The portion of the chromosome on either side of the centromere is referred to as the chromosome arm (Figure 1).

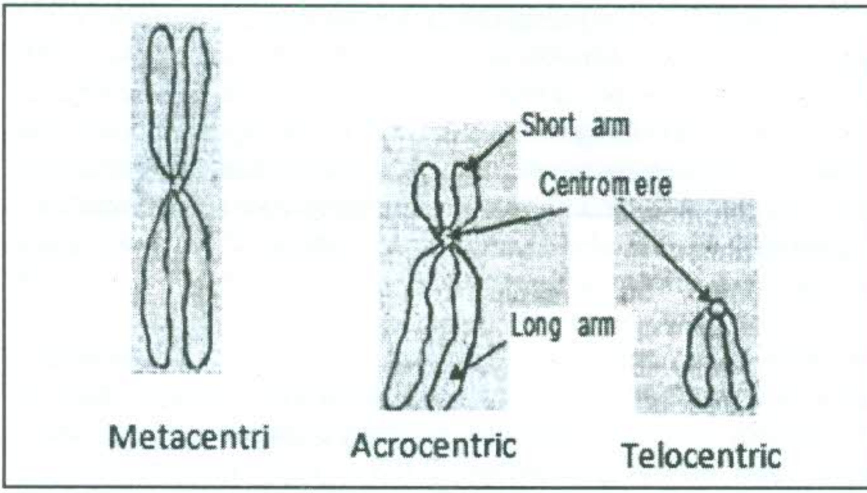


Figure 1. Chromosomes showing chromatids, centromere and chromosome arms

Source: Falusi (2003c)

According to Ogunbodede (2011), the parallel behaviour of genes and chromosomes led to the concept that genes are located on chromosomes which is the kernel of the chromosome theory of inheritance by Sutton and Boveri. This also showed the role of chromosomes in heredity and firmly established the field of cytogenetics. It has been experimentally demonstrated that chromosomes are indeed the vehicles of gene transmission from generation to generation and that their behaviour at meiosis determines patterns of inheritance. Chromosomes are primarily made of long chains of Deoxyribonucleic acid (DNA), the master chemical that controls the development and functioning of organisms. Morakinyo *et al.* (2009), reported on several elegant and decisive experiments conducted with bacteria and viruses which showed that DNA is the genetic material that has the necessary information to direct the synthesis of protein. Therefore, chromosome is essentially one long DNA molecule while genes are functional regions of the molecule. The gene is regarded as the segment of DNA Molecule that is functionally responsible for coding of a polypeptide chain.

Every living species contain a specific number of chromosomes in the nucleus of each of its cells. The chromosome complement for a species is commonly in two sets, each being inherited from either of the parents. Depending on the number of sets of chromosomes derived from parents, a cell or organism can be diploid (one set from each parent), triploid (one set from one parent and two sets from the other parent), tetraploid (four sets made up of two sets from each parent) and etc. Morakinyo (2003), reported that the number, structure and behaviour of the chromosomes in an organism are important genetic considerations in the life of the organism and this has been a subject of intensive research in plants.

2.3 Biotechnology and Genetic Engineering

Mr. Vice-Chancellor sir, Biology today, has become extraordinarily exciting. It is believed in most quarters that Biology rules the world. We are now in an era of Biology termed 'biotechnology' i.e., the science of making useful products and services from any biological system. This involves any technique that uses living organisms or substances from these organisms to make or modify a product for a practical purpose (Food and Agricultural Organization, 2004). The advances and achievements of this wonderful era could not have been envisaged about twenty to thirty years ago. Genetic engineering being the manipulation of DNA to produce useful traits in living organisms has now become the core of modern biotechnology. With recent progress in molecular genetics, it is possible to isolate genes and determine how genetic information gives rise to useful characteristics of the whole organism. This understanding has brought the modification of the genetic information in ways that will create variations, or introduce new and favourable characteristics in organisms. We can now use Genetic engineering techniques to identify, select and modify DNA sequences, for a specific trait from a donor organism and transfer the sequence to a recipient organism in such a way that the trait can be expressed. A DNA molecule known as vector (plasmid) is usually employed to carry the desired DNA into the recipient cell. When the DNA is successfully transferred, the recipient cell is said to be transformed or genetically modified. This is how Genetically Modified Organisms are produced.

Mr. Chairman Sir, Genetic engineering has been recognized as a necessary input in the programme to achieve food security (James, 2012). Considering the declining crop yields experienced by farmers in Nigeria, conventional breeding may not give quick solutions to food insecurity, hence the need for a more robust technique to manipulate genes for improved crop yields. This is possible through the Genetic Modification (GM) technology which enables plant breeders to transfer desired genes among species that do not interbreed. The technology is very precise and transfers only the gene of interest into an adapted variety at a faster rate thereby reducing the time required to produce a variety. According to Uzochukwu (2013), Biotechnology has changed the world and will continue to do so, because a secret once revealed, cannot become a secret again, for that particular age. The biotechnology practiced today has already laid a strong foundation for very significant future milestones.

In Nigeria, the modern biotechnology regulation started in the early 1990s. It is unfortunate that after the initial effort, we have not made any significant move to join the global biotechnology trend. The National Biotechnology Development Agency (NABDA) was established to anchor development of biotechnology in the country while the National Centre for Genetic Research and Biotechnology (NACGRAB) was established at Ibadan to ensure collection, conservation, preservation, utilization and maintenance of valuable germplasm for agricultural development. The International Institute of Tropical Agriculture (IITA) researches on the other hand were obviously restricted to the institute's mandate crops which to me may not serve any strategic national interest. Therefore, there is need for Nigeria to establish and position her own biotechnological industry for economic and socio-political advancement like other countries. Presently, we are still waiting for the passage of the Biosafety bill. When this bill is passed, Nigeria will join other African nations, such as Burkina Faso, Egypt and South Africa in cultivating GMO crops. Again, it must be emphasized that the major constraints facing production of staple food crops and cash crops in Nigeria such as pests, diseases, declining soil fertility, drought and weeds are complex and have no simple effective solution in the conventional management options available to our farmers. This is why agricultural experts the world over, agree that GM crops can complement existing efforts and make developing countries achieve food security (Gudu, 2007).

Mr. Vice-Chancellor sir, distinguished audience, I always feel greatly challenged by the debate on the relevance of GM crops to food security. This debate has suffered from misinformation. I strongly believe that as a Plant Geneticist, I have a duty and indeed moral responsibility to explain to the public the significant contributions that GM crops would make towards alleviation of poverty, food insecurity and malnutrition. In this way, I believe, the public will be provided with correct information for appropriate decision-making as they explore various alternatives and roles that GM crops could play in overcoming these challenges. I want to state here that GM crops and foods have been available and consumed for over 16 years and there has been no credible scientific evidence to show that they are injurious to human health or the environment. Also, the GM foods currently available in the international market have been made to pass risk assessments conducted by appropriate national and international regulatory bodies. Although, the opponents of GM crops have expressed concern on their use and development, it is still very important to note that GM crops are not identical and therefore should specifically be treated on a case-by-case basis and each either accepted or rejected on the basis of potential risks it poses, or the benefits that may accrue from its use (Gudu, 2007). GM crops, like all other new technological products, may have some risks associated with their use. For example, over the years, adoption of new technologies, such as use of aeroplanes, motor cars, cell phones or fertilizers have always suffered from the fear of the unknown but the decision to use them has depended on the cost benefit analysis. Thus, the blanket condemnation of GM crops or their universal acceptance may not be wise without a cost-benefit comparison supported by scientific data and social justification.

2.4 Plant Genetic Resources

All life on earth depends on plants. Without their capacities to fix the sun's energy by means of chlorophyll, man and all other species of animals would die. Besides, plants are sources of our basic needs: food, cloth, house and medicine. They account for over 80 percent of the human diet (FAO, 2013). The plant resources form an integral part of a huge inter-dependent system that encompasses the physical components and the biological community of life (Malik and Singh, 2006). One of the ways to increase food supply is to use a good variety. Plant breeders always search for the genetic materials to build new desired varieties. These genetic materials Mr. Chairman sir, are reservoirs of variation, generally spoken of as gene pools or genetic resources. In these, useful characters may be sought which can be built into new varieties. The larger the reservoirs of variation, the better the chances of finding the desired characters.

Plant genetic resources can be described as any material of plant origin that contains functional units of heredity of actual or potential use. It refers to the reproductive or vegetative propagating materials of the following categories of plants (i) cultivated varieties(cultivars) in current use and newly developed varieties (ii) obsolete cultivars (iii) primitive cultivars or land races (iv) wild and weed species, near relative of cultivated varieties and (v) special genetic stocks including elite and current breeders lines and mutants(FAO,1993). They are genetic materials of plant origin of actual or potential value for food and agriculture, e.g. seeds, tubers, mature plants etc. These include all our agricultural crops and some of their wild relatives which are often of valuable traits. They are the raw materials that farmers and plant breeders use to improve the quality and productivity of crops. These resources according to FAO (2013), are generally referred to as germplasm and the lifeblood of plant breeding. They are a heritage of mankind to be preserved and to be freely available for use for the benefit of present and future generations. The plant genetic resources may also be the plant itself, seeds, tissues, cells, pollen, vegetative materials or DNA. Generally, they are backbones of agriculture which play a positive and unique role in the development of new cultivars including the restructuring of existing ones (Ishaq *et al.*, 2004). There are two main sources of Plant genetic resources that have been utilized by plant breeders. These are the exotic germplasm and indigenous germplasm. The exotic germplasm refers to those genetic resources that exist far away to the native cultivars while the indigenous germplasm refers to those resources that are native to the country.

Mr. Chairman sir, the Food and Agriculture Organization recognized that the genetic diversity of many crop plants was coming under threat and, therefore, recommended strategies for conservation before plant genetic resources go extinct. Among the strategies recommended are: survey of plant genetic resources, plant collection or seed collection and storage of genetic resources in such a way that there will be minimal losses (FAO, 2004). Gene banks or seed genebanks was generally advocated (since the storage technology is relatively simple and well known).

2.5 Food Security

Mr. Vice-Chancellor sir, I believe food is the most basic human need and access to it is a basic human right. The concept of Food security is flexible with numerous, and sometimes competing, definitions. Perhaps, it can be described as an evolving concept that will develop a more settled definition over time. It is a common knowledge that the quality of life people enjoy is a reflection of the food they eat. Also, one of the cardinal achievements of a man is his ability to provide quality food for his family. In the same way, any country that is self-sufficient in food production has reasons to be proud among the committee of nations. A major objective of Nigeria's "new" Agricultural policy is *"attainment of self-sufficiency in basic food commodities with particular reference to those which consume considerable shares of Nigeria's foreign exchange and for which the country has comparative advantage in local production."* This in essence is "food security" – a situation where everyone has access to food three times a day all the year round and at affordable prices. It is also a situation in which all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life(FAO, 1996). Food security is built on three pillars of food availability, food access and food use. We don't need a soothsayer to affirm that our country is still very far from attaining the objective of our Agricultural policy, decades after setting the target. No matter the cause of food insecurity, the bottom line of the matter is that there is insufficient food for the populace. Food demand is higher than supply (CBN, 2001; Fakiyesi, 2001). If adequate food is produced, it will be available to both the poor and the rich and it will be affordable. For instance, a tuber of yam produced in Niger State goes through three or four yam traders before it gets to some consumers. When the transportation costs and the profits expected by each of the yam dealers are put together, the price of the tuber becomes prohibitive to the final consumer. This kind of scenario makes the situation peculiar, and the hope for food security based on the local production system, dicey. It is glaringly clear that food supply is on a steady decline. The consistent rise in food prices attests to this assertion.

Mr. Vice-Chancellor sir, distinguished audience, this is very unfortunate because Nigeria was self sufficient in food production before the oil boom. Things changed dramatically for the worse following the rise in revenue from Petroleum. By 2009, for example, the Federal Ministry of Agriculture estimated that the country was spending over 3 billion Dollars annually on food importation. First, the Agricultural sector was neglected and majority of Nigerian farmers continued to use traditional and rudimentary ways of farming characterized by low investment in agriculture. Secondly, the increase in human armed conflicts resulting from perennial social, economic and political struggles led to forced migration. This is also partly responsible for food insecurity in Nigeria. The government seems to be unable to stamp out civil strife and hence the food insecurity may still remain fragile in the years to come. There is a common saying that a hungry man is an angry man. In the same way, a nation with fragile food security will have a fragile internal security. Thirdly, natural calamities or pestilence such as, floods, erosion, insect and pest invasions coupled with low and/or declining soil fertility are common in Nigeria. All these will continue to limit the chances of producing adequate food through conventional farming practices, unless new technologies are incorporated into the farming domain.

Mr. Chairman Sir, I believe you will agree with me that this type of situation is worrisome. Something must be done and quickly too.

Nigeria is a country where millions of people are on the brink of starvation in a world of plenty. Food availability per capita has declined and the country faces huge food security challenges. At current food production growth rates, Nigeria remains unable to feed its population. The food security challenges are growing with the population. Projections are that, by 2050, world population will increase from the current 6 billion to about 10 billion and Nigeria's current 170 million will increase to between 230 and 430 million. Therefore, the challenge for agricultural researchers to meet the huge food demand is astounding. This ugly trend must be reversed and developments must go hand in hand with food security as it is in other nations of the world.

3.0 NIGERIAN PLANT GENETIC RESOURCES: – Nature's Incredible Generosity

Nigeria is a physically and climatically diverse country that has been endowed with substantial plant resources. According to National center for Genetic resources and Biotechnology NCGRB (2008), the natural vegetation in Nigeria varies from rain forest to savanna with nine distinct ecological zones (Figure 2) which, due to similarity of characteristics, has been streamlined into five namely, (i) sahel/sudan savanna, (ii) guinea savanna, (iii) derived savanna, (iv) lowland rainforest/montane forest and (v) freshwater swamp forest/mangrove forest and coastal vegetation. Nigerian physical and climatic diversity permits the growth of a wide variety of crops. The Federal Ministry of Environment (2006) reported that 7,895 plant species from 338 families and 2,215 genera have been identified in Nigeria (Table 1). These include a wide range of crops in which we enjoy comparative advantage. The fertility of the Nigerian soil and the wide range of variations in climate have allowed the production of a variety of crops. The major staple food crops in the country include Yam, Cassava, maize, Plantain Rice, Sorghum, Millet and a variety of fruits and vegetables. Currently, Nigeria is one of the world's leading producers of cowpea, cassava and yam.

According to NCGRB (2008), the leading cash crops are Cocoa, Oranges, Cotton, Groundnuts, Palm oil, Palm kernel, Beans seeds and Rubber.

Mr. Chairman, Sir, distinguished audience; I hope I will be able to convince you today that certainly God has blessed our country with a variety of plants that can make our existence much better and perhaps longer. The huge genetic resources that we have in the country are meant for our enjoyment, progress, daily survival and livelihood. Unfortunately, we have utilized only very little out of the array of these plant genetic resources. Some of those we have explored for food are listed in Table 2 and Plates 1-32.

Figure 2: A map of Nigeria showing the nine ecological zones in the country.

Source: NCGRB (2008)

Table 1: Inventory of Plant Taxa in Nigeria

Group of plants	No. of families	No. of genera	No. of Species
Algae	67	281	1335
Lichens	-	14	17
Fungi (Mushrooms)	26	60	134
Mosses	-	13	16
Liverworts	-	16	6
Pteridophyte	27	64	165
Gymnosperms	2	3	5
Chlamydosperms	2	2	6
Monocotyledons	42	376	1575
Dicotyledon	172	1396	4636
Total	**338**	**2215**	**7895**

Source: Nigeria's First National Biodiversity Report, Fm Env. (2006)

Table 2: Plants being used for Food in Nigeria

S/N	Plant	Common Name	Uses
A	TUBERS		
1	*Manihot esculentus*	Cassava	Root tuber, processed into flour, (elubo), pu re starch fufu or eaten boiled, used as industrial major starchy foods, e.g. garri raw materials bakery
2	*Dioscorea spp*	yam	Stem tuber, processed into major starchy foods e.g. yam flour or boiled and eaten directly or pounded (pounded yam).
3	*Ipomeae batatas*	Sweet potato	Root tuber, boiled and eaten directly or pounded with yam or fried in oil.
4	*Solanum tuberosum*	Irish potato	Stem tuber, used as a carbo hydrate food fried or flaked. and eaten throughout Nigeria in different forms, boiled, mashed
5	*Colocacia esculentus*	Cocoyam	Root tuber/Rhizome, processed into different carbohydrate foods.

S/N	Plant	Common Name	Uses
B	**CEREALS**		
1	*Zea mays*	Maize (corn)	Grains are eaten boiled or roasted, can be processed into different food items, as feed for livestock, also as industrial raw material.
2	*Sorghum bicolor*	Guinea corn	Grains are eaten boiled, roasted or processed into different food items; also as industrial raw materials in breweries.
3	*Pennisetum americanum* *P. glaucum*	Millet	Grains are used in various forms of staple food
4	*Tritium aestivum*	Bread wheat	Main source of flour bread, cake, and other confectionary.
5	*Oryza spp.*	Rice	Rice is a staple food, a major source of carbohydrate food in Nigeria
C	**FOOD LEGUMES**		
1	*Vigna unguiculata*	Cowpea	The most important legume in Nigeria, cultivated- for food and forage
2	*Glycine max*	Soya bean	Soya bean is an important source of plant protein and is processed to serve as food supplements as soya milk, soyabean or to fortify other food products such as soyaogi, soya feeds formulation. infants food and livestock.
3	*Arachis hypogea*	Groundnut/ Peanut	Groundnut is very rich in plant protein and source of rich vegetable oil. The nuts are processed into various food items and soup, and is an important component of livestock feeds
4	*Parkia biglobosa*	Locus bean tree	Friut pulp is eaten and used in a local brew. The seeds are processed into condiment called iru (Yoruba) or Dadawa in Hausa
D	**OIL CROPS**		
1	*Elaeis guinensis*	Oil palm	Source of red oil and kernel
2	*Sesamum indicum*	Sesame (Beniseed)	source of highly priced rich vegetable oil
3	*Citrullus lanatus*	Egusi, melon	Very rich in vegetable oil Seeds also used in soup preparations
4	*Cocos nucifera*	Coconut	Source of coconut oil
5	*Ricinus communis*	Castor oil	Source of castor oil
6	*Gossypium* spp.	Cotton	Source of cotton seed oil
E	**PLANT-BASED SWEETNERS**		
1	*Saccharium officinarium*	Sugarcane	Main source of the Raw material for the sugar industry.

S/N	Plant	Common Name	Uses
F	HORTICULTURAL CROPS		
1	*Capsicum* spp.	Pepper	Pepper is a major component of Nigerian food with different degree of purgency
2	*Lycopersicon esculentus*	Tomato	Tomato is an important component of Nigerian food.
3	*Alium cepa*	Onion	Onion is an important food.
4	*Amaranthus* spp.	Amaranthus, Tete (Yoruba)	Amaranthus is an important leaf vegetable
5	*Albelmoschus esculentus*	Okra, Ila (Yoruba)	Okra is an important fruit
6	*Corchorus* spp.	Jute Ewedu (Yoruba)	*Corchorus olitorius* is an important leaf vegetable.
7	*Solanum raddi*	Egg plant (indigo)	The fruit of garden egg is eaten raw or cooked
8	*Musa* spp.	Plantain	Fruit rich in iron
9	*Telfairia occidentalis*	Ugu (Ibo)	Leafy vegetable, rich in iron.
10	*Carica papaya*	Pawpaw	This is a fruit vegetable
11	*Ananas cosmotus*	Pineapple	An important fruit and raw materials for juice Industry
12	*Daucus carota*	Carrot	An important root vegetable.
13	*Pisidium guajava*	Guava	Fruit is eaten fresh and as component of jam
14	*Cirtus sinensis*	Orange	Juice taken fresh or extracted and used in beverages
15	*Mangifera indica*	Mango	Fruit is eaten fresh or processed into beverages.
16	*Anacardium occidentale*	Cashew	Juice is taken directly or processed into beverage. The nuts are also eaten
17	*Pyrus communis*	Pear	The fruit is delicious
18	*Ocimum gratissimum*	(Yoruba) Efinrin	The spicy leaves are eaten as vegetable or used to garnish soups.
19	*Cucumis sativus*	Cucumber	Fruit vegetable.
20	*Latuca sativa*	Lettuce	Leaf vegetable
21	*Celosia* spp;	Ajefowo (Yor) Sokoyokoto	Leaf vegetable
22	*Vernonia amygydalina*	Ewuro (Yoruba) Bitter leaf	Leaf vegetable
23	*Hibiscus* spp	Isapa, Zobo plant	Leaf vegetable.
24	*Tetracarpidium conophorum*	Awusa (Yor)	The cotyledons are proteinous and eaten cooked.

Source: NCGRB (2008)

Plate 1: Seeds and fruits of Guinea Corn *(Sorghum bicolor)*

Plate 2: Fruit and seeds of Millet *(Pennisetum americanum)*

Plate 3: Seeds and fruit of Maize *(Zea mays L.)* plant

Plate 4: Fruiting Rice *(Oryza spp)* plants

Plate 5: Fruits and seeds of Cowpea *(Vigna unguiculata* (L) Walp)

Plate 6: Leaves and tubers of Cassava *(Manihot esculanta,* crantz)

Plate 7: Yam *(Dioscorea rotundata)* tubers and seed yam

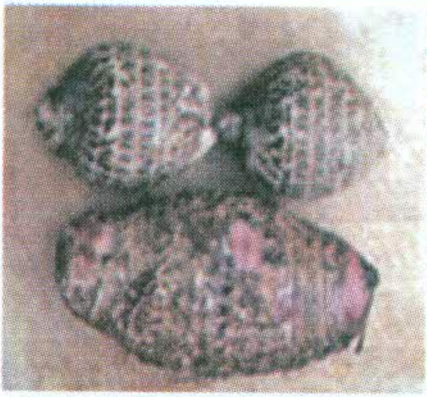


Plate 8: Tubers and shoots of Cocoyam *(Colocacia esculentus)*

Plate 9: Seeds and shoot of Groundnut *(Arachis hypogea)*

Plate 10: Fruit of *Parkia biglobosa*

Plate 11: Fruit of *Mango (Mangifera indica)*

Plate 12: Fruit of Cashew *(Anacardium occidentale)*

Plate 13: Fruit of Orange *(Citrus sinensis)*

Plate 14: Fruit of Tomato *(Lycopersicon esculentus)*

Plate 15: Fruit of Melon *(Citrullus lanatus)*

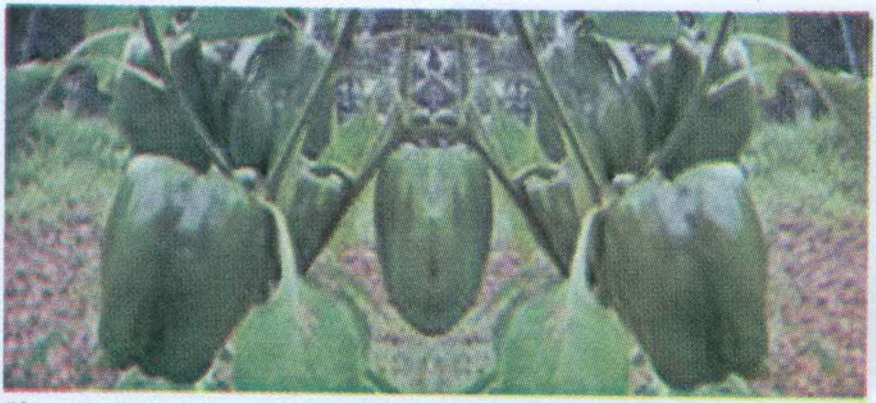


Plate 16: Fruit of Pepper

Plate 17: Plant and seeds of Bambara nut *(Vigna subterranean)*

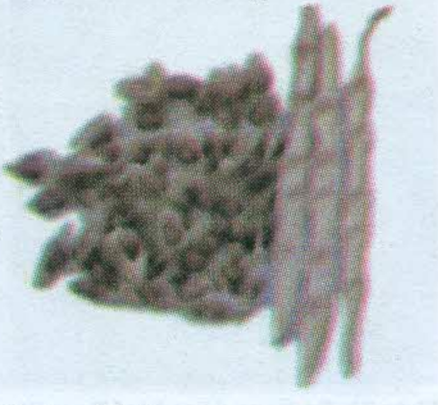


Plate 18: Shoot, Fruit Pods and Seeds of *Moringa Oleifera*

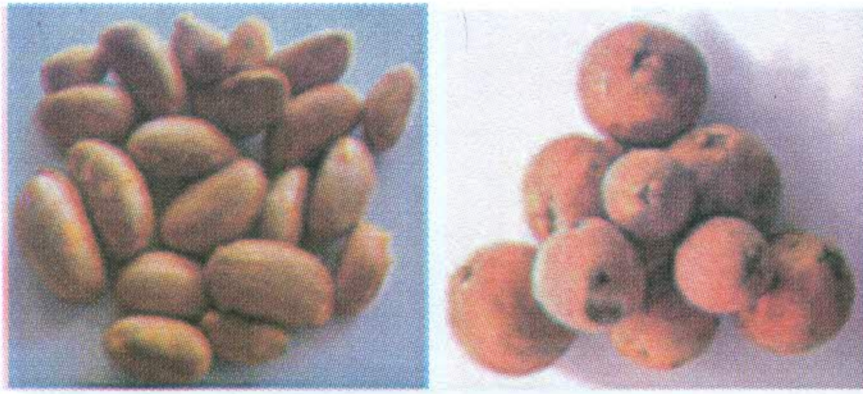


Plate 19: Fruits and Seeds of *Garcinia kola (Bitter kola)*

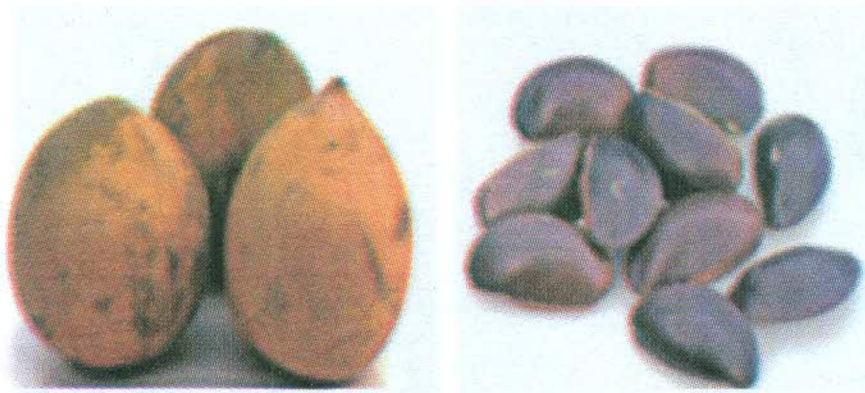


Plate 20: Fruits and Seeds of *Chrysophyllum albidum (African Star apple)*

Plate 21: Fruits and Seeds of *Treculia africana (African Bread fruit)*


Plate 22: Fruits and Seeds of *Irvingia gabonensis* (African Bush Mango)

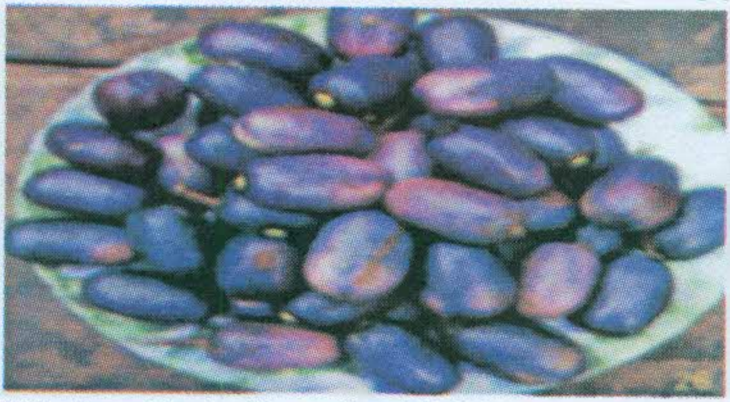


Plate 23: Fruits and Seeds of *Docryodes edulis* (African Bush Butter)

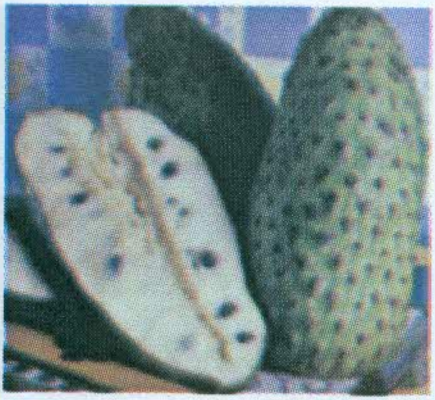



Plate 24: Fruit head of *Annona muricata* (Soursop Fruit)

Plate 25: Fruit and shoot of Soyabean *(Glycine max)*

Plate 26: Sugarcane *(Saccharin officinarum)* stems and leaves

Plate 27: Cucumber *(Cucumis sativus) fruits and leaves*

Plate 28: The Jute *(Corchorus spp)* plant

Plate 29: Onion *(Alium cepa)* leaves and bulb

Plate 30: Banana *(Musa spp)* fruits and shoots


Plate 31: Okra *(Abelmoschus esculentus)* leaves and fruits


Plate 32: Flowers, fruits and seeds of Sesame *(Sesamum indicum)*
Sources of Plates: Falusi et al. (2001) Falusi and Salako, (2002); Falusi et al. (2002); Ndukwu et al. (2012)

Apart from these plants, Nigeria also has a wide diversity of other plant species which have not been mentioned here. The country is very rich in plant genetic resources which exist in wild forms in the plants' natural habitats and in diverse crop landraces/ecotypes/cultivars. They include grasses and many browse species. Nigeria has a list of 2, 200 verified nutritious species which include 600 grasses, 540 herbaceous legumes and 380 browse species and over 600 others of lower values (NCGRB, 2008). Most of these species are components of the high forest, guinea savanna, sudan savanna and some very hardy plants in the sahelian zone. The number of non-domesticated plants that has been collected from the wild to bridge hunger gaps is far more diverse.

Mr. Vice-Chancellor sir, distinguished audience, from the foregoing attempt to highlight the value and incalculable magnanimity of Mother Nature in Plant genetic resources towards food security in Nigeria, you and all listening to me this afternoon can unanimously attest that it is indeed an INCREDIBLE GENEROSITY. It is a generosity so thrilling, exhilarating and bewildering. It is simply a wonder and a marvel. I believe it is God's generosity, incredible gifts that we need to explore for food security in our country.

3.1: The need for Conservation of plant genetic resources

Mr. Vice-Chancellor sir, distinguished audience, the rate of loss of the diversity of plant species today is alarming. Apart from being over-exploited in the wild, our natural endowment is also being threatened by the wanton destruction of vegetation. By these destructive activities of man, the genetic variability and the genes that bring it about are being lost forever. Many plants species have already gone into extinction and it is estimated that if the trends do not change, 34,000 more plant species will become extinct (Jeffrey, 2004). Therefore, the conservation of plant genetic resources is vitally important for a stable biosphere and sustainable supply of human needs (Morakinyo, 2003). Mr. Chairman sir, please permit me to quote the concluding remarks made by Professor A. E. Arinze, the University of Port Harcourt 43rd Inaugural Lecturer (Arinze, 2005). He observed thus '*the basis of any Agriculture is the healthy productive green plant. We should be concerned about the health of these plants. If we are not, it is to our peril; indeed our extinction as human beings. All life depends on the photosynthetic factory of green plants. It behoves on man to do everything possible to keep these plants healthy'*. Plant genetic resources therefore need to be protected in order to preserve the quality of life on Earth (Bowen, 1999; Jeffrey, 2004).

Strategies and Methods of conservation

Two main methods of Plant genetic resources conservation are in practice. These are: *ex situ* and *in situ* conservation methods. These methods are currently practiced and expanded in many countries including Nigeria (Ishaq and Falusi, 2008).

In situ conservation

This simply means on-site conservation or protection of plant species in their natural habitat. In situ conservation enables species to be conserved under conditions that allow them to continue to evolve. *In-situ* conservation is usually done by declaring a natural habitat as a legally protected area, e.g., Forest Reserve.

Ex-situ conservation

Ex-situ conservation on the other hand is the preservation of components of plant genetic resources outside their natural habitats. This involves conservation of plant genetic resources, as well as wild and cultivated species, and involves techniques such as:

* Gene banks, e.g., seed banks, field banks;
* In-vitro biotechnological techniques being used to preserve cultures of plant organs, embryos, anthers, callus, tissues, cells and even microbial cells; and
* Collection of plants for botanic gardens for research and public awareness (Ishaq and Falusi, 2008).

4.0 OUR INCREDIBLE RESPONSIBILITY

Mr. Vice-Chancellor sir, distinguished ladies and gentlemen, I believe that the nature's intention and generosity was for us to use plant genetic resources to ensure our future survival. It is, therefore our responsibility to be wise on the exploitation of the resources. According to Ndukwu, *et al.* (2012), the magnanimity and incredible generosity of Mother Nature carries with it an equally incredible responsibility. ***"And the Lord God took the man, and put him into the Garden of Eden ... to DRESS IT and to KEEP IT ......"*** **Genesis 2:15.** Permit me Mr. Chairman sir, to inform us that we may not have an Eden in that original sense anymore. However, each of us has been handed over an Eden of a sort. Your own Eden could be Federal University of Technology, Minna or your village, compound, estate or homestead garden, depending on your sphere of influence. I wish to inform all of us that those words 'DRESS IT' and 'KEEP IT' are heavy, if we understand them. It requires our greatest RESONSIBILITY. We may sound religious about this. We may trivialize and gloss over it. But I assure us that if we ignore them, the implications will not be good enough. This is because our very lives, livelihood and continued existence in the beautiful EDEN – planet earth is inextricably hinged on how we utilize our God-given plant genetic resources. It is this dynamic approach that has guided our research efforts and interests over the years.

Mr. Vice-Chancellor sir, I believe it is our collective responsibility to conserve and make proper good use of the generous gift of God in plant genetic resources. There are several of the benefits of these plants that are hidden in deep secrets. *'It is the glory of God to conceal a thing; but the honour of kings (men) is to search out a matter'......... Proverbs 25; 2,* Part of our responsibilities and indeed honour is to discover, and wisely exploit them for our advantages. If we humble ourselves and quietly approach Nature, we will be shown some of these deep secrets. I believe that is the basis of all human ingenuity and inventions. Our God has given Human beings a free hand to use all life forms and indeed the genes and gene complexes that condition them for the good of humanity.

4.1 What We Have Done

Mr. Vice-Chancellor sir, eminent scholars, distinguished ladies and gentlemen. It has always bothered me that a billion people go hungry every single day. Hunger has continued to be a reality for mankind. So, in an attempt to help remedy the billion-strong calamity, I have spent the last 24 years of my career working with national and international colleagues with focus on the use of plant genetic resources to eradicate hunger. At this juncture, I humbly wish to attempt to highlight some of the modest efforts that we have knowingly but also unknowingly made in this regard.

A. Germplasm Collection, Survey and Conservation of Economic crops in Nigeria

The role of germplasm in the improvement of cultivated plants has been well recognized (Gill, 1984). Falusi (2004), reported that despite this wide recognition, the use of germplasm collections, particularly in the developing countries, is still very limited. Genetic conservation of crops is very essential to avoid genetic erosion and loss of food security. Therefore, our goal in germplasm collection was to collect, conserve, characterize and identify genes for valuable traits. The following are some of what we did.

i. Assemblage of Sesame germplasm for conservation and genetic improvement in Nigeria

Survey missions were undertaken to all the major sesame-producing areas of Nigeria towards the end of the cropping season in September 1998, when the farmers were expected to be harvesting the crop. A total of 36 farmers were interviewed and 27 accessions were collected from 20 farmers. The highest number of sesame accessions collected was from Benue and Kaduna States, closely followed by Niger and Nassarawa States, an indication that these states have the greatest diversity of the crop genetic resource in Nigeria (Falusi and Salako, 2001). The collections were deposited at the gene bank of the National Cereals research Institute Badeggi for conservation and further utilization. This study has provided the backbone information and materials required in the improvement of the crop in Nigeria (Falusi, 2008a).

Table 3: Description and sources of sesame germplasm materials

S/N	ACCESSIONS NUMBER	LOCAL NAME	SOURCE	SEED COLOUR	SEED SIZE (Length) mm
1	BE-01	Ishwa	Otukpo (Benue State)	Creamy White	2-3
2	BE-02	Ishwa	Yandev (Benue State)	White	2-3
3	BE-03	Ishwa	Markurdi (Benue State)	White	2.5-3
4	BE-04	Ishwa	Otukpo (Benue State)	Black	2-3
5	BO-01	Fari Ridi	Maiduguri (Borno State)	White	2-3
6	BO-02	Fari Ridi	Gozo (Borno State)	White	2-2.5
7	GO-01	Fari Ridi	Billiri (Gombe State)	White	2-3
8	GO-02	Beki Ridi	Billiri (Gombe State)	Black	2-2.5
9	JG-01	Fari Ridi	Gumel (Jigawa State)	White	2-3
10	KD-01	Beki Ridi	Kafanchan (Kaduna State)	Black	2-3
11	KD-02	Jai Ridi	Kafanchan (Kaduna State)	Light Brown	2.5-3.5
12	KD-03	Ijai Ridi	Kafanchan (Kaduna State)	Light Brown	1.5-2.5
13	KD-04	Fari Ridi	Kafanchan (Kaduna State)	White	2-3
14	KN -01	Fari Ridi	Yankaba (Kano State)	White	2-3
15	KN -02	Fari Ri di	Janguza (Kano State)	Light Brown	2.5 -3
16	KB -01	Fari Ridi	Zuru (Kebbi State)	Creamy White	2-3
17	KG -01	Igorigo	Okene (Kogi State)	White	2-3

S/N	ACCESSIONS NUMBER	LOCAL NAME	SOURCE	SEED COLOUR	SEED SIZE (Length) mm
18	KG -02	Igorigo	Ogaminana (Kogi State)	Creamy White	2.5 -3
19	NA -01	Fari Ridi	Doma (Nassarawa State)	White	2-3
20	NA -02	Fari Ridi	Doma (Nassarawa State)	Creamy White	2.5 -3
21	NA -03	Fari Ridi	Lafia (Nasarrawa State)	White	2-2.5
22	NG -01	Wild Sesame	Bida (Niger State)	Black	2-3
23	NG -02	Fari Ridi	Gawu-Babangida (Niger State)	White	2.5 -3
24	NG -03	Fari Ridi	Minna (Niger State)	White	2-3
25	PL -01	Fari Ridi	Pomshere (Plateau State)	Creamy White	2-3
26	PL -02	Fari Ridi	Panshin (Plateau State)	Creamy White	2-3
27	FCT -01	Fari Ridi	Gwagwalada (FCT)	Creamy White	2-3

Source: Falusi and Salako (2001)

ii. Pepper (*Capsicum* Spp.) Germplasm collection, Survey and conservation in Nigeria

Mr. Vice Chancellor sir, our second germplasm collection mission was on Pepper. A survey was carried out in the major pepper producing areas of Nigeria towards the end of the cropping seasons in October 2004 and 2005. A total of 70 farmers were interviewed and 40 accessions were collected from 38 farmers.

The study showed that many Pepper accession entries were replicated across the states, local governments and villages. Kaduna state had the highest number of pepper accessions followed by Nassarawa, Niger and Benue states, an indication that these states have the greatest diversity of the crop genetic resources in Nigeria. There was a clear evidence of Pepper morphological diversity in Nigeria. These collections became the foundation from which Pepper research took off at the Federal University of Technology, Minna in 2005. The study also provided the backbone information and materials required in the improvement of the crop in Nigeria (Falusi, 2007c).

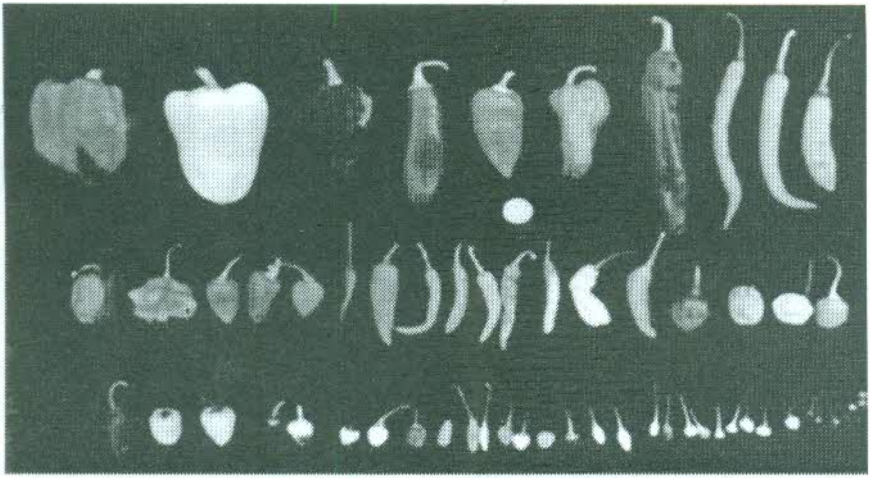


Plate 33: Capsicum Peppers showing clear evidence of morphological diversity In Nigeria

Source: Falusi (2007c)

iii: Roselle *(Hibiscus sabdariffa L.)* Germplasm collection survey and conservation in Nigeria

Survey missions were undertaken to all the major Roselle producing areas of Nigeria in October 2001, when the farmers were expected to be harvesting the crop. The survey covered 31 towns and villages in 22 states. Forty-two farmers were interviewed and 39 accessions were collected from 25 farmers. Collections from Kano, Katsina, Jigawa, Sokoto, Kebbi, Borno and Gombe States revealed that many of the accessions were actually replicated over states towns and villages. The highest number of Roselle accessions was collected from Kaduna and Niger states followed by Katsina and Benue States, an indication that these states have the greatest diversity of the crop genetic resources in Nigeria(Falusi, 2004; Falusi,2009). The Roselle collections showed clear evidence of the crop's morphological diversity (Plate 34) in Nigeria and they became the foundation from which Roselle research took off at the Federal University of Technology, Minna in 2003. This study also provided the backbone information and materials required in the improvement of the crop in Nigeria.

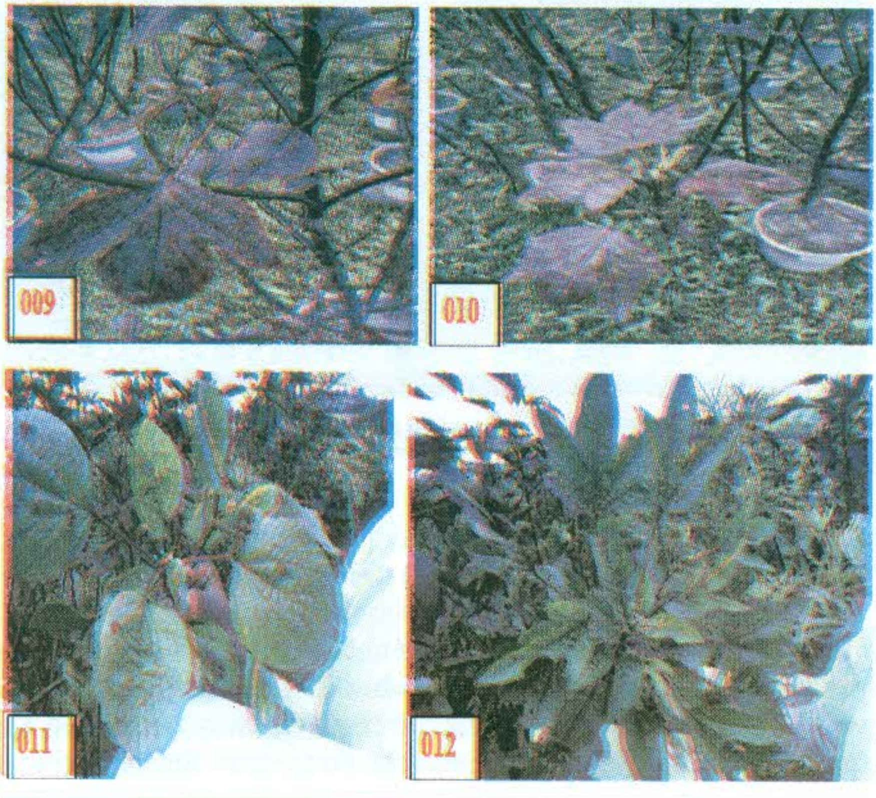


Plate 34: (009-020) Roselle germplasm showing clear evidence of morphological diversity in Nigeria.

Source: Falusi et al. (2014b)

B: Assessing the level of cross compatibility in selected germplasm materials

Mr. Vice-Chancellor sir, distinguished audience, our goal on this subject was to carry out intra- and inter-specific hybridization and pollen viability studies so as to establish genomic relationships, determine the ease of gene exchange and give an insight to the breeding behaviour of some of the germplasm materials and their wild relatives.

i: Crossability Studies in some Nigerian species of *Capsicum*

Studies on crossing relationship between *Capsicum annuum* L. and Capsicum *frutescens* L. revealed that both intra- and inter-specific hybridization were possible in the Genus "Capsicum".

However, the success rate was low with inter-specific crosses being significantly lower than intra-specific crosses (Table 4). Seeds obtained from the successful inter-specific crosses had low germination percentages suggesting that they were not wholly viable. Pollen viability was drastically reduced in the hybrids particularly in the inter-specific hybrids. The significance of this work is that it has brought into the limelight the fact that, hybridization is very important in the population dynamics of the Genus *Capsicum* in Nigeria.

Table 4: Pollination success and germination percentage of intra- and inter-specific hybrids of *Capsicum annuum and Capsicum frutescens*

Cross combination	No. of flowers	Pollination success%	Germination of F1 seeds%
Intra-specific:			
TA2 X SO1	30	10.0	20
SO1 X TA2	35	5.7	0
SO1 X RO2	35	6.5	20
RO2 X SO1	30	0	0
SO1 X TA3	32	9.0	15
TA3 X SO1	40	0	0
TA1 X SO1	45	0	0
Inter-specific:			
TA2 X WE1	35	11.4	5
WE1 X TA1	40	0	0
WE2 X RO2	35	8.5	25

Source: Falusi and Morakinyo (1994)

ii: Intra- and Inter-specific Hybridization in the Genus *Sesamum*

We also studied the Genus Sesamum and made a number of crosses within and between *Sesamum indicum* and *Sesamum prostratum* L., to investigate their genomic relations and determine the feasibility of gene exchange between them. Our results indicated that both intra- and inter-specific hybridization are possible within the Genus. However, the success rate with inter-specific crosses was very low (Falusi, 2007b). Pollen viability was drastically reduced in the hybrids particularly in the inter-specific hybrids (Table 5) (Falusi and Salako, 2007ab).

Mr. Chairman sir, the significance of this work is that it has also brought into the limelight the fact that, hybridization is very *important in the population dynamics of the genus, Sesamum in* Nigeria (Falusi and Salako, 2003ab), (Falusi, 2007a).

TABLE 5: Percentage Successes in Intra and Inter-specific Crosses and Seed Germination in Sesame Collections

Type of Cross	No. of Crosses made	% of Success	No. on which Germination % was based	Germination %
KG-01 x NG-01	45	15.4	25	10
NG-01 x KG-01	40	-	-	-
KD-01 x KD-04	30	10.0	25	5
KD-04 x KD-01	45	8.7	25	-
KD-01 x KD-02	40	-	-	-
KD-02 x KD-01	45	6.5	25	-
KD-01 x BE-01	42	-	-	-
BE-01 x KD-01	40	12	25	11.5
KD-02 x NG-01	42	8.5	25	10.5
NG-01 x KD-02	45	5.7	25	-
KG-01 x KD-01	45	9.0	25	-
KD-01 x NG-01	35	10.5	25	7
NA-01 x GO-02	40	11.4	25	18
GO-02 x NA-01	30	4.7	25	15
KD-02 x KN-02	35	10	50	18
KN-02 x KD-02	35	6.5	50	20
FCT-01 x PL-01	35	25.4	50	23.5
PL-01 x FCT-01	30	18.2	50	24
BO-01 x JG-01	35	26	50	25.0
JG-01 x BO-01	45	20.5	50	26.6

Source: (Falusi and Salako, 2003ab)

C: Studies on Chromosome Numbers and Karyotype

Mr. Vice-Chancellor sir, distinguished audience, an accurate measurement and description of chromosome structure (karyotyping) is fundamental for any meaningful studies of a species (Adelanwa *et al.*, 2014). We have therefore established chromosome numbers and characterization in the following species of plants:

i: Chromosome Numbers and Karyotype in Peppers

Detailed cytological studies carried out on *Capsicum annuum* and *C.frutescence* showed a diploid number of chromosomes of 2n=24. Each plant species was characterized by meta-and submeta-centric chromosomes (Plate 35: 1-3 and Figure 3). A pair of telocentric chromosomes was observed in TA1 which was not found in TA2 and TA3. Two pairs of satellite chromosomes were observed in TA3 and one pair was observed in WE1 which were collections of *Capsicum annuum and C. frutescens* respectively. The number of satellite chromosomes seems to be the main karyotypic difference between *C. annuum* and *C. frutescens.* These studies have revealed the genomic identities of the Pepper plants.

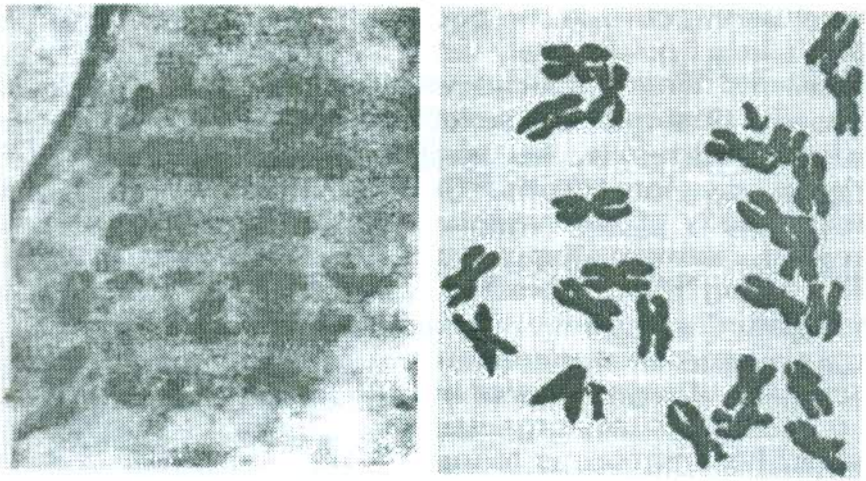


Plate 35:1 and Figure 3: Mitotic chromosome in *C. annuum* showing 2n = 24.

N.B. Arrows show telocentric chromosomes: Scale line represents one micron

Source: Falusi (2003a)

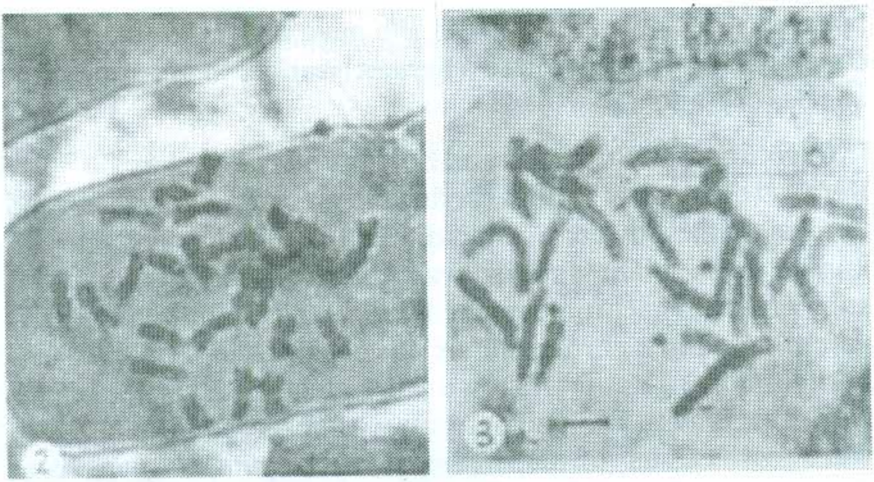


Plate 35: 2 and 3: Mitotic Chromosomes in pepper collections showing 2n = 24.
Plate 35: 2: TA2, Plate 35: 3: TA3, N.B. Scale line represents one micron.

Source: Falusi (2003a)

D: Studies on meiotic chromosome behavior

Mr. Vice-Chancellor sir, distinguished audience, a good knowledge of the cytogenetics of some important commercially cultivated crops is useful in our crop improvement endeavours (Adelanwa *et al.*, 2011; Falusi *et al.*, 2014a). It is helpful in understanding heredity in crops.

i: Meiotic Chromosome behavior of Pepper Germplasm

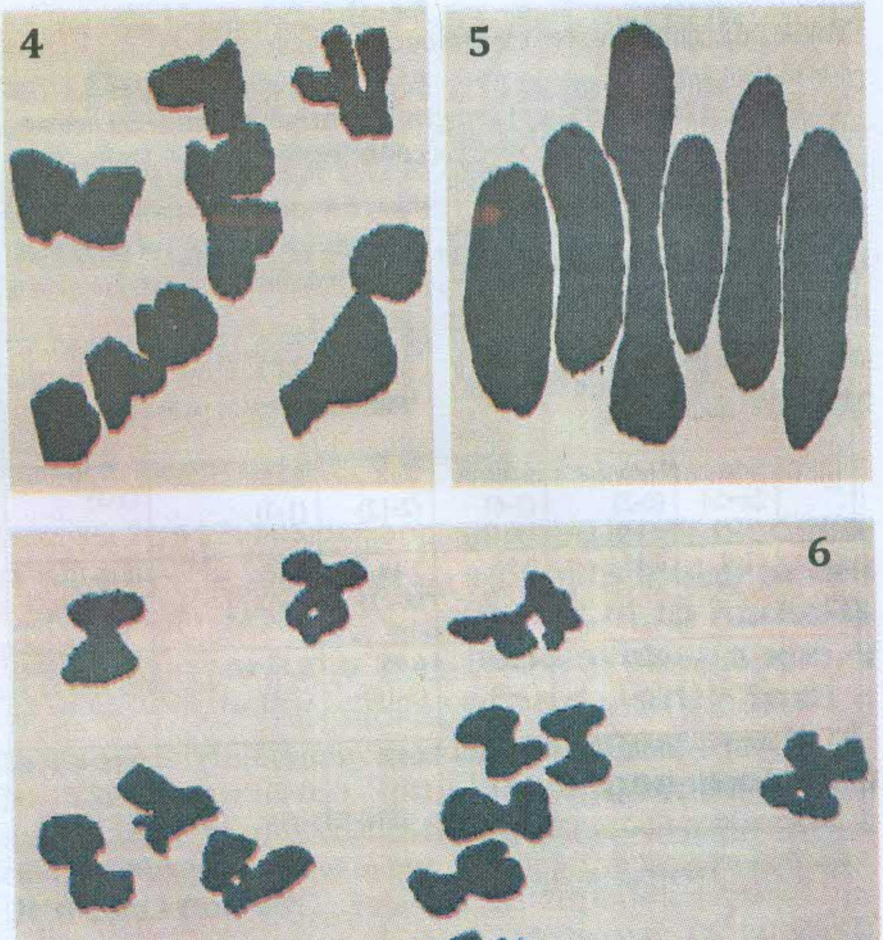
The results of our studies on the meiotic chromosome behavior in Pepper showed that Chromosome associations at diakinesis were characterized by varying frequencies of univalents, bivalents, quadrivalent and hexavalents (Table 6: Plates 35:7-9). Figure 4 is a diakinesis cell in 'TAI' showing 2 IV + 8 II (two quadrivalents and eight bivalents). Figure 5 is a metaphase 1 cell in 'TAI' showing 6 IV (six quadrivalents) while Figure 6 is a diakinesis cell in 'WEI' showing 1211 (twelve bivalents).

Table 6: Diakinesis chromosome association in Pepper collections

Ranges per cell (number) are given in brackets from 30 cells per plant and averages are based on counting.

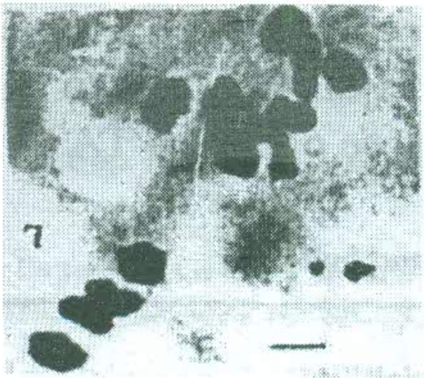
S/No	Plant	Univalent	Ring Bivalent II	Rod Bivalent II	Rod Quadrivalent IV	Rod Hexavalent VI
1.	TA1 2n=24	0.46 (2-4)	3.33 (3-7)	4.26 (1-10)	1.60 (1-6)	0.33 - (1-2) 0.30
2.	TA2 2n=24	0.13 (0-2)	3.50 (1-6)	7.18 (2-12)	0.16 (1-3)	(1-3)
3.	1101 2n=24	0.13 (0-2)	2.96 (1-9)	5.13 (1-12)	1.20 (1-5)	0.46 (1-3)
4.	SQI 2n=24	0.20 (0-2)	4.26 (2-8)	6.96 (3-10)	0.16 (2-3)	(1-2)
5.	WE1 2n = 24	0.26 (0-2)	4.56 (2-6)	4.63 (2-9)	0.63 (1-3)	0.46 (1-2)

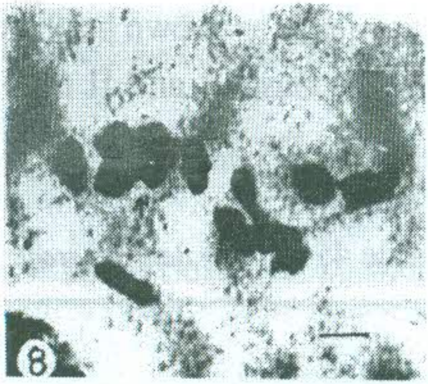
Source: Falusi (2003a)



Figures 4-6: Meiotic chromosomes in collections of *C. annum* and C. *frutescens.* (4) Diakinesis cell in collection "TA1" showing 2 IV + 8 II (two quadrivalents and eight Bivalents) (5) Metaphase 1 in collection "TAl" showing 6 IV (six quadrivalents), (6) Diakinesis cell in collection WE1 showing 1211 (twelve bivalent).

Source: Falusi and Morakinyo (1998)





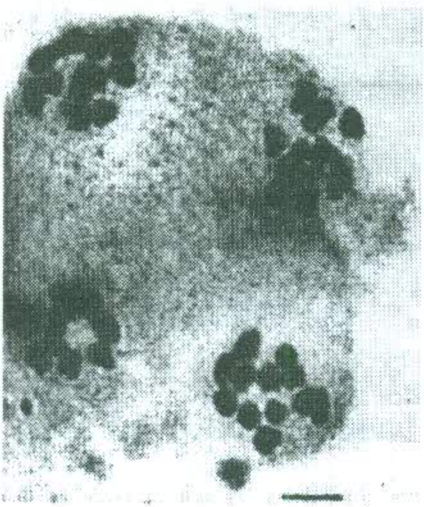


Plate35: 7-9: Meiotic chromosomes in collections of *Capsicum annuum: (7)* Metaphase 1 in collection TA3 showing 12II. (8) Metaphase 1 in TA3 showing clumped chromosomes (arrowed). (9) Anaphase II cell in TA3 showing normal chromosome distribution to the anaphase II poles. N.B. Scale line represents one micron.

Source: Morakinyo and Falusi (1992)

The occurrence of univalents, bivalents, quadrivalents and other multivalent associations is indicative of reciprocal translocations involving non-homologous chromosomes. This kind of chromosomal association and interchange of segments suggests hybrid origin for the plants and homoeology of the ancestral parental genomes. The occurrence of 61V (six quadrivalents) in 'TAl' on the other hand suggest that the basic chromosome number in these peppers is 6 and that they are therefore segmental allotetraploids.

ii: Studies on Chromosomes Interconnections in Peppers

The Chromosomes, during cell division, usually occur as separate entities, but sometimes they occur as chromatin threads connecting the individual chromosomes (Falusi, 2006d). Often these interconnections are so thin that they cannot be detected with the light microscope. Generally, the occurrence or existence of these interconnections has been overlooked, thus their functions are not understood (Falusi *et al.*, 2005). We have observed cells showing interconnections and clumping in *Capsicum* species (Plate36:1-4). Mr. Vice-Chancellor sir, it is important to let you know that this finding is novel. The report is the first of the occurrence of interconnections in the genus *Capsicum*. The interconnections were more visible at diplonema and diakinesis stages. They were also more in *C. frutescence* which *had* the widest distribution than in *C.annuum*. This suggests that chromosomal interconnections are possibly useful ecological adaptation for Capsicum species in Nigeria rather than aberrations.

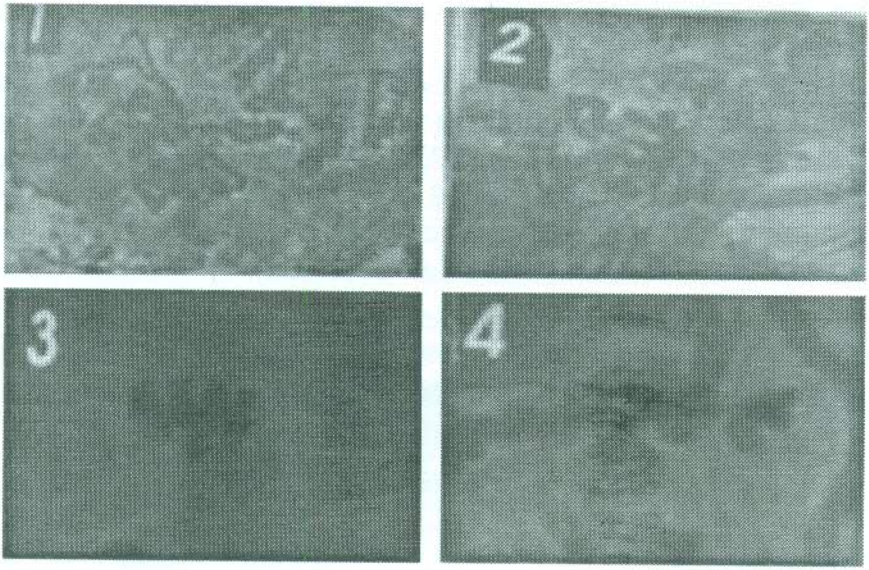


Plate 36:1-4: Chromosome interconnections and clumping in *C. annuum* and *C. frutescence*
1: Chromosome interconnections at diplonema in *C. frutescence* 2: Chromosome interconnections at diplonema in *C. annuum* 3: Metaphase 1 in *C. frutescence* showing clumped chromosomes. 4: Metaphase 1 in *C. annuum* showing clumped chromosomes and interchromatin connections.

Source: Falusi (2006d)

Table7: Frequencies of interchromosomal connections at diplonema and diakinesis, and clumped metaphase 1 in two species of C*apsicum*

Species	Chromosome Number	No. of cells	% of cells with bivalents linked in Diplonema			Number of cells	% of cells with bivalents linked in Diakinesis			% Clumping at Metaphase 1
			2	3	4		2	3	4	
TA3	2n=24	100	12.5	3.2	11.2	90	10.6	6.8	5.5	16.8
RO2	2n=24	100	11.2	12.6	13.8	90	12.8	10.5	8.1	25.8
SO1	2n=24	100	15.5	14.5	13.2	90	12.4	9.3	5.3	27.5
WE1	2n=24	100	40.2	27.5	20.9	90	30.6	25.3	18.5	30.4

Source: Falusi (2006d)

iii: Meiotic Chromosome Behavior in the F1 Hybrids of Pepper

Mr. Chairman sir, the behaviour of chromosomes during meiosis is an important area of study when the fertility of the individual is concerned (Falusi, 2006a). When we studied the meiotic chromosomes in F1 hybrids of Pepper, we observed extensive chromosome clumping and non disjunction bridges at both anaphase 1 and anaphase 11 (Plate 37:10-14)

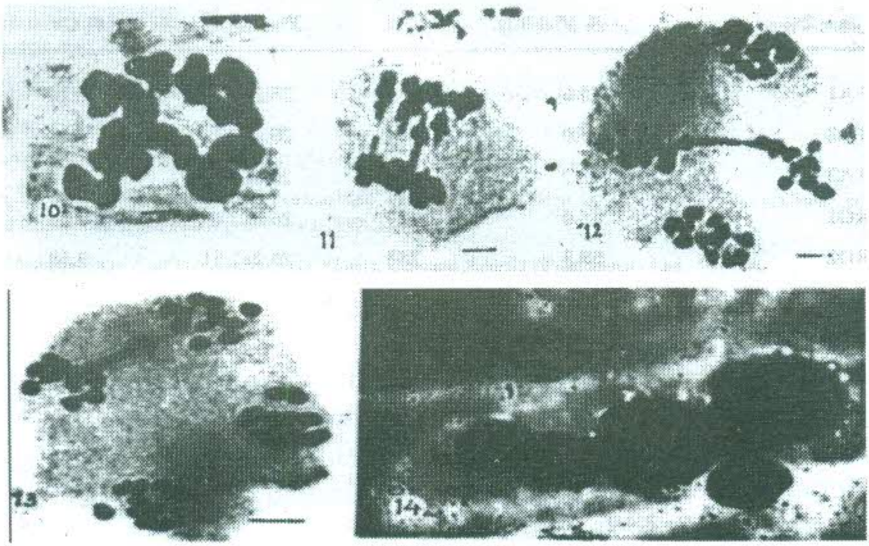


Plate37: 10-14 Meiotic Chromosomes in the F1 hybrids of Pepper: (10) Metaphase 1 cell in SOI x RO2 showing the entire chromosome complement clumped together. (11) Anaphase 1 non-disjunction bridge in WE1 x RO2 interspecific hybrid plant. (12) Anaphase 11 non-disjunction bridge in SO1 x RO2 intraspecific hybrid plant (13) Anaphase 11 non-disjunction bridge in TA1 x SO1 intraspecific hybrid. (14) Pollen grains in WE1 x RO2 interspecific hybrid plant showing small sized non-viable and big sized viable pollen grains. N.B. Scale line represents one micron.

Source: Morakinyo and Falusi (1992)

iv: Meiotic Chromosome Behavior in the F1 Hybrids of Sesame

Mr. Chairman sir, Sterility is a commonly observed phenotype in interspecific hybrids. This may results from chromosomal or genic incompatibilities (Falusi, 2006be). When the meiotic chromosomes of the F1 hybrids between *Sesamum indicum* and *Ceratotheca sesamoids* (a very close wild relative of *S. indicum*), were studied, we observed meiotic abnormalities such as multivalent association and non-disjunction bridges (Plate 38: 1-4). These meiotic abnormalities affected the fertility of the hybrids as demonstrated by pollen with two sized classes in Plate 38:1 below.

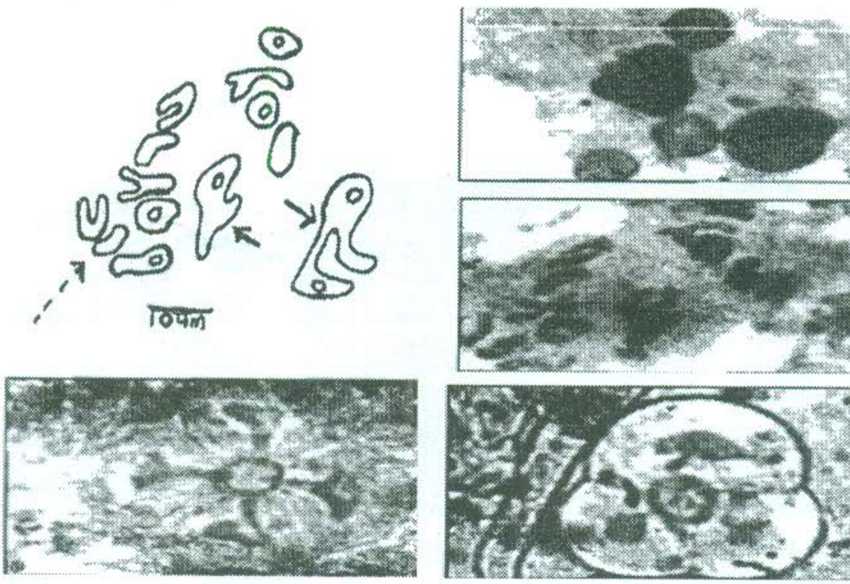


Plate38: 1-4 and Figure 7: Pollen and meiotic chromosomes in hybrids between *Sesamum indicum* and *Ceratotheca sesamoids*. 1: Pollen grains in NG-OI x KD-04 plant with two sized classes. 2 and Figure 7: Diakinesis cell in NG-01 x KD-04 plant with 2IV + 10II + 1I. 3: Non disjunction bridge in NG-01 x KD-04 plant. 4: Triad in KN-02 x KD-02 plant. (Arrows indicate quadrivalent chromosomes while dotted arrow indicates a univalent chromosome)
Source: Falusi et al. (2001a)

E: Studies on the inheritance of characters: Mr. Vice-Chancellor sir, many indigenous plant species in Nigeria exhibit different characteristics and few of these differences have been genetically investigated (Falusi *et al.*, 2012b). The following are the studies we carried out on the inheritance of character differences.

i: Inheritance studies in wild and cultivated *'Sesamum'* **species in Nigeria**

Our studies on the inheritance of character differences between cultivated *Sesamum indicum* and wild species *Sesamum radiatum* showed that inheritance of resistance to leaf curl disease and lodging was controlled by two independently assorting genes with both dominant alleles F' and L' producing plants that are resistant to leaf curl disease and lodging, while their recessive alleles t" and 1' produced plants that are not resistant to leaf curl disease and lodging, respectively (Falusi, 2006c) (Plate 39 and Table 8).

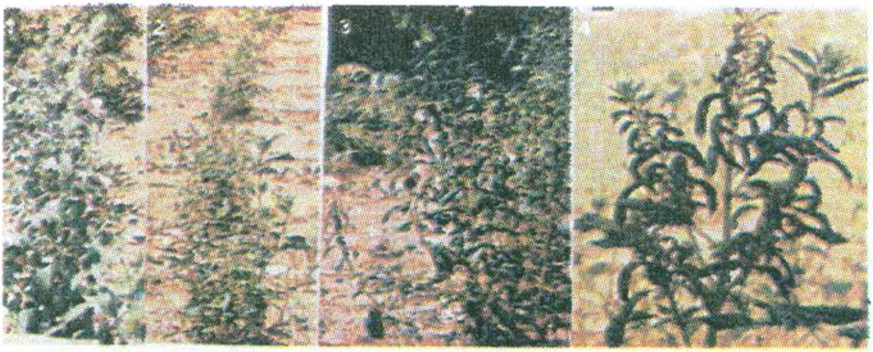


Plate 39: (1:1-1:4). *Sesamum radiatum* and *Sesamum indicum* and their hybrid. (1:1) *Sesamum radiatum* plants show resistance to leaf curl disease and plant lodging (1:2) Hybrid plants showing resistance to leaf curl disease and plant lodging. (1:3) *Sesamum indicum* plants showing susceptibility to leaf curl disease and plant lodging (1:4) Shoot of *Sesamum indicum* plant showing the effect of leaf curl disease.

Source: (Falusi, 2006c)

Table 8: *Inheritance of Resistance to Lodging and Leaf curl in a cross between KG-01 and NG-01*

CROSS	EXPERIMENTAL				THEORETICAL				X^2	P	RATIO
	LF	Lf	lF	lf	lF	Lf	lF	Lf			
KG-01xNG-01(self ed)	63	30	22	5	67.5	22.5	22.5	7.5	3.64	50-.3	9:3:3:1
(KG-01xNG-01)xNG-01	41	0	0	0	41	0	0	0	0.00	0.000	All &F
(KG-01xNG-01)xKG-01	8	7	5	4	6	6	6	6	1.67	.70-5	1:1:1:1

Source: (Falusi, 2006c)

This is a digenic inheritance with complimentary gene action. It strongly suggests the involvement of gene mutations in the evolution of cultivated Sesame in Nigeria. From these studies, the possibility of utilizing desirable genes in the wild relatives for the development of new cultivars has been enhanced.

ii: Inheritance of Stem Pigmentation in Two Local Varieties of *Hibiscus sabdariffa* in Nigeria

Mr. Vice-Chancellor sir, despite the promising prospects that Roselle enjoys, there has been no proportionate effort in research on the crop. Our studies on the inheritance of pigmentation in a cross between Red and Green Roselle varieties showed that the expression of red pigment on stem and calyces was due to the presence of the dominant allele (R--) i.e., RR or Rr, while the presence of the recessive allele (rr) produced green pigment on the stem and calyces. This is an indication that character difference between the two local varieties of *H. sabdariffa* was inherited simply (Plate 40: A, B, and C: Table 9). This result also shed more light on the role of gene mutation on the development of character difference between the two varieties. The change from Red variety to the Green variety could have been caused by the mutation of R to r suggesting that the Green variety plants were derived through gene mutation.

Plate 40: Shoots of two local varieties of *Hibiscus sabdariffa* and their hybrid. (**A**) Shoot of the variety with red pigment on stem and calyces. (**B**) Shoot of the hybrid with Red pigment on stem and calyces. (**C**) Shoot of the variety with green pigment on stem and calyces.

Source: Falusi (2008a)

Table 9: Inheritance of pigmentation in a cross between two varieties of *Hibiscus sabdariffa* L.

Cross Ratio	*Experimental Theoretical*				X^2	*P Ratio*
	R	rr	R-	rr		
NRG-NG-R7XNRG-NG-R8 (selfed)	72	28	75	25	0.48	0.90-0.8 3:1
NRG-NG-R7XNRG-NG-R8XNRG-NG-R7	44	0	44	0	0	0.00 All R
NRG-NG-R7XNRG-NG-R8XNRG-NG-R8	16	12	14	14	0.57	0.70-0.50 1:1

R- = red pigmentation; rr = green pigmentation

Source: (Falusi, 2008a)

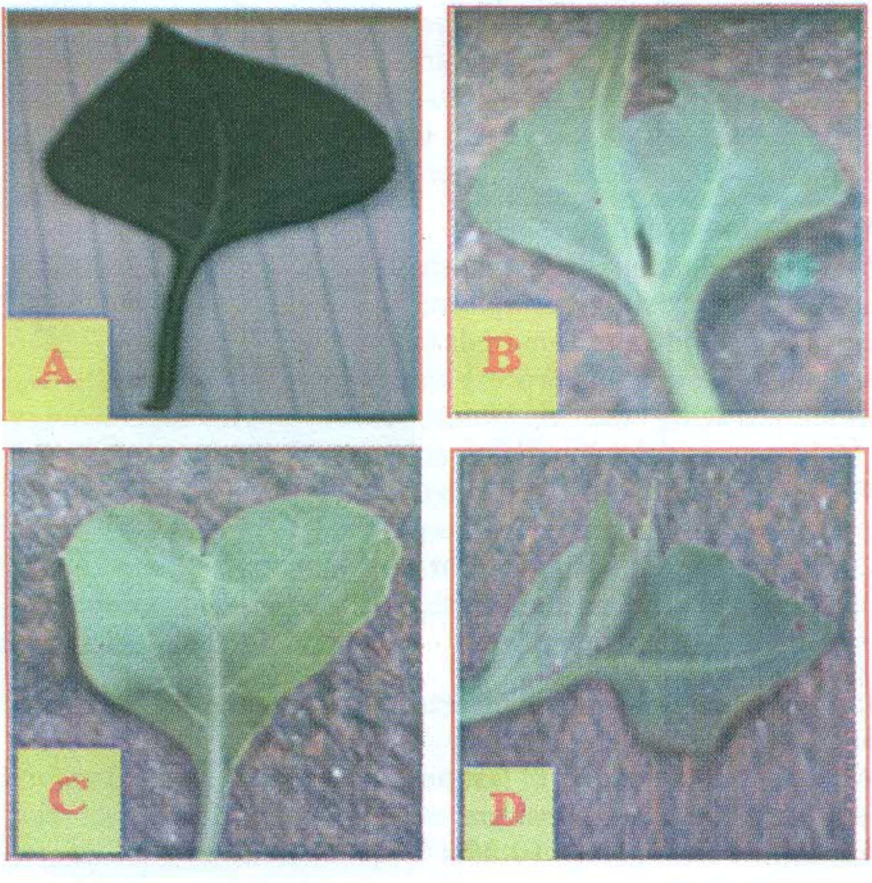
The ease of gene exchange between these two local varieties of *H. sabdariffa* confirms that they are very closely related (Falusi, 2006c; Falusi, 2008c). Mr. Chairman sir, the existence and knowledge of these genes will go a long way to assist in the improvement of Roselle for better productivity in Nigeria.

F: Mutation Breeding.

Mutation induction is an established tool in crop improvement to supplement existing germplasm and to improve cultivars in certain specific traits. Hundreds of improved varieties have been obtained through this process and released to farmers thereby demonstrating the economic value of the technology (Muhammad *et al.*, 2013: Falusi *et al.*, 2014a: Yahaya *et al.*, 2014). We have just initiated a research on mutation breeding targeting traits such as improved agronomic characters (Falusi *et al.*, 2013abc). The studies are still at the preliminary stages and we are hoping to produce mutants that will be released as improved varieties.

i: The effects of fast neutron irradiation on the leaf morphology of *Capsicum*

We assessed the effects of fast neutron irradiation (FNI) on the leaf morphology of *Capsicum annuum*) using five irradiation treatments on the seeds, (0, 30, 60, 90, and 120 min). The results obtained showed that all irradiation treatments caused leaf morphological abnormalities, such as leaves with reduced size, leaves with invaginated or inverted margins, or with a blunt or bifurcated apex, when compared with control plants(Plates41: A-J). There was an increase in leaf abnormalities with increase in the duration of FNI (Table 1). 120 min was identified as the most effective irradiation period to induce leaf morphological abnormality in the plants (Falusi *et al.*, 2014a) .This information could be used by breeders to produce useful mutations for yield and other parameters in pepper.



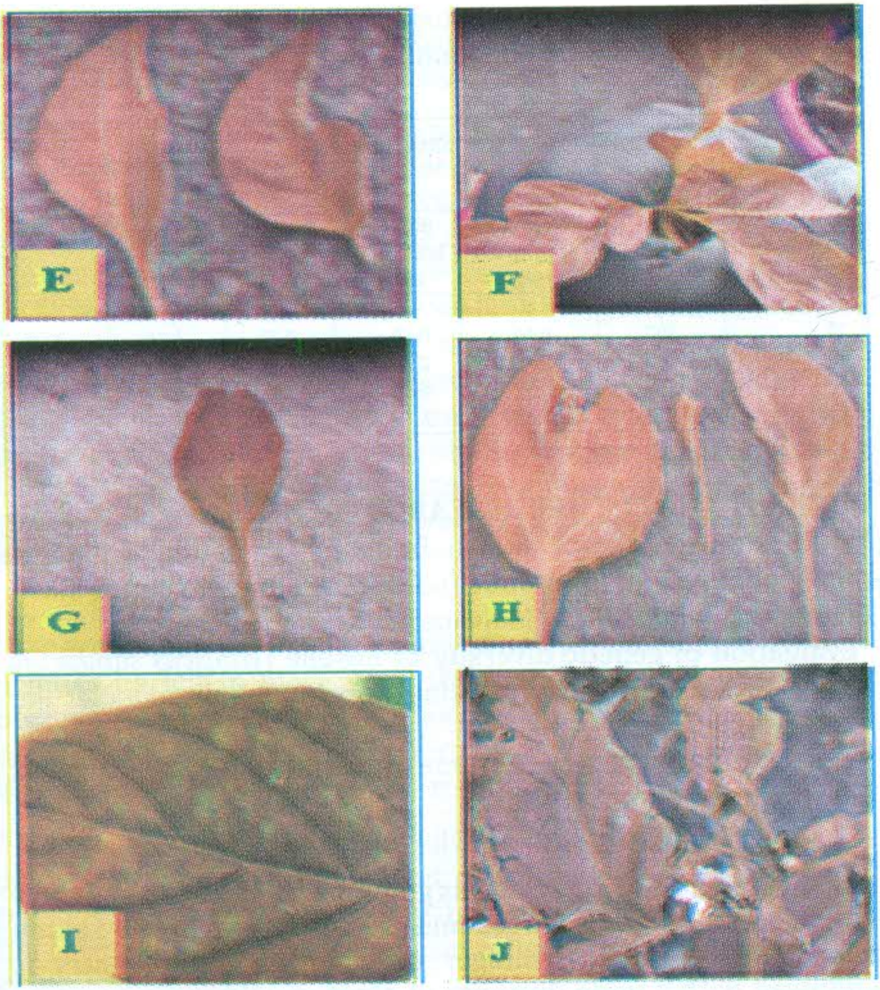


Plate 41: A-J; Leaf Morphological abnormalities: A. Normal leaf of *C. annum var accuminatum*, B. The leaf that turned bifoliage (30 min IEP), C. Leaf with bifurcated apex, D. A leaf with another leafy outgrowth at the petiole (90 min IEP), E. Leaves showing invaginated margins (120 min IEP), F. Leaves with dented margin, G. Leaf with bifurcated apex (60 min IEP), H. Leaf with curved apex, the middle leaf is small with dented margin, the third leaf has invaginated margin. (60 minutes irradiation exposure). I. Leaf showing chlorophyll mosaic. J. Leaves showing necrotic margins.
(Source: Falusi and Daudu, (2014a)

Table 10: Induced leaf morphological abnormalities expressed as percentages in *Capsicum annuum* with different irradiation treatments.

Treatments Irradiation periods/min	No of leaves Observed	Shape of leaves				
		Invaginated or inverted margins	Blunt or bifurcated apex	Reduced size	Deformed	Bifoliage
0 (control)	300	-	-	-	-	-
30	300	0.14	0.18	0.22	0.10	0.05
60	300	0.46	0.38	0.40	0.24	0.27
90	300	0.52	0.66	0.55	0.42	0.36
120	300	1.02	1.22	1.04	0.66	0.53

Source: Falusi et al., (2012a)

CURRENT AND FUTURE RESEARCH FOCUS

*Studies on the effects of radiofrequency radiations from 900 mhz global system for mobile (GSM) telecommunications masts on *Hibiscus sabdariffa L.* (Malvaceae).

*Evaluation of genetic diversity of Roselle (*Hibiscus sabdariffa* Linn.) germplasm in Nigeria, using morphological and molecular characterization.

*Genetic improvement of Sesame (*Sesamum indicum*) using fast neutron irradiation.

5.0 CONCLUSION

Mr. Vice-Chancellor sir, God has generously blessed our country with a lot of plant resources and we certainly have no reason whatsoever to live in hunger or suffering. Our country is endowed with a wide diversity of plant resources that we can harness to ensure food security. This magnanimity, to me is an incredible generosity of Mother Nature. It also carries with it an equally incredible responsibility. Therefore the scientific research community needs to wake up to this reality and be engaged in not just knowing these heritage but also engaged in preserving it to ensure food security for this generation and the unborn generations. I have highlighted my modest contributions to alleviate hunger and food insecurity in Nigeria. The knowledge we have gathered over these years will surely continue to assist in the improvement of our crops for better productivity.

Mr. Vice-Chancellor, sir, Ladies and Gentlemen, let me conclude this lecture by telling us that, what evolution does naturally is the same thing we do in Plant genetics. The more we look into plants, the more we see characters. The more we look into characters, the more we see genetics. The more we look into genetics, the more we see genomes. The more we look into genomes, the more we see genes. The more we manipulate genes, the more biotechnology develops. The more biotechnology develops the more improved productivity and yield, disease resistance drought tolerant and environmentally stable organisms emerge Osuji(2012). The more these outputs of biotechnology emerge, the more food insecurity and poverty disappear and the happier we become.

6.0 RECOMMENDATIONS

If we are to enjoy all God has endowed us with, a number of things need to be put in place. Mr. Vice-Chancellor, sir, since it has become customary in lectures of this nature to proffer recommendations to Government, I should not disappoint this audience. Let me therefore make the following:

* Nigeria should be actively involved in the IBPGR coordinated plant germplasm collection and conservation efforts through persons, NGOs and governmental bodies. This will enable us take full advantage of world germplasm collections in our crop plant development efforts.

* Our government should sign into law, the Biosafety law to promote and boost research activities on GM crops in our country.

* Nigeria should invest more on research into various areas of crop improvement to make us self reliant, sufficient and truly independent. The present paltry sum allocated to research and education does not portray us as a nation desiring to grow and develop.

7.0 ACKNOWLEDGEMENTS

Almighty God

I will like to start by thanking the Almighty God who gave me life and the good health without which there would have been no career and of course nothing to celebrate. As a child He was with me, as a youth He did not allow me to waste and as a scholar He helped me to choose and attain the zenith of a rewarding career. To Him alone is all the Glory.

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I will ever remain grateful to my parents, Mr. and Mrs. Olowokere Falusi who sacrificed so much for my education. You have all it takes to be addressed as parents. Unfortunately, both of you are not alive to witness today's event. Your labour has not been vain. To my parents in-law, Rev. and Mrs. Oshayomi David, I say thank you. Your prayers have sustained me and seen me through rough times.

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I am very grateful to all the members of my nuclear family. To my wife, Mrs. F. M. Falusi, I say thank you. I cherish the kindness, endurance and support you have given me in these past (23) years we have lived together. Your faithfulness and commitment to God is exemplary. These are the impetus towards achieving success in my carrier. I want to thank you for always being there as my source of encouragement and a pillar of support behind the scene both during good and hard times. I also want to thank my children, Olamide Joseph and Oluwafunmilayo Jemima for their cool headedness and obedient spirit. These attributes have enabled me to concentrate and make meaningful progress in my chosen career.

FUT, Minna Authorities

I am grateful to the Vice-Chancellor, Professor M. A. Akanji and his Management Team, for making it possible for me to give this

lecture, and for the work they have been doing looking after us all. I will like to thank you specially sir for your leadership and for your encouragement. May God continue to guide and reward you for everything. The solid support and the wise counsel of your two Deputy Vice-Chancellors, Professor A. Bala and Professor S. O. E. Sadiku are greatly acknowledged. May God also reward them and their families. I thank the entire Board of School of Life Sciences, the administrative and technical staff, the students, the cleaners and security personnel, for their support and love. I am grateful to God for making me part of the history of the new School. In the same way, I thank my academic nuclear family in FUT, Minna, the Department of Biological Sciences, ably headed by Dr. I. K. Olayemi, for their love, care, friendship, warmth, and ever-present support. It has been a delight working with you these many years. Your prayers and words of encouragements have always been a propeller to me particularly at difficult times. I also thank all our colleagues in the School of Physical Sciences with whom we fraternized for so many years.

I wish to specially thank the Chairman and the entire members of the FUT, Minna Seminar and Colloquium Committee for making this day a reality. To my senior colleagues (i.e. the older Professors in the University I bow and doff my cap for all of you. Your encouragements are highly appreciated. God bless you all.

NCRI, Badeggi and the Federal Polytechnic, Bida Authorities
I remain indebted to the Management and staff of NCRI, Badeggi and the Federal Polytechnic, Bida. They encouraged me when I was on my PhD programme. God bless you.

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Words are not enough to express my gratitude to my supervisors, Prof. J. A. Morakinyo and Prof. S. A. Salako. The rigours you took me through during training have paid off. I will ever remain grateful to both of you. God bless you.

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I thank my students at all levels, especially all my postgraduate students. We have worked as a team and your contributions at the different stages of my research are highly acknowledged. This gathering will continue to remind you that every effort has a reward

My Friends, Colleagues and Associates

I thank my friends and colleagues everywhere, far too numerous to mention by name, who have made my life so far an enjoyable experience, those who were able to make it here and those who could not. May God bless you all. I am grateful to all who were able to come here today, for the sacrifice they made to make it possible. I thank Prof. E. H. Kwon-ndung, Prof. B. Mantur, Prof. S. O. Alonge, Dr. A. T. Mustapha, Dr. (Mrs.) H. Idris, Dr. A. A. Aliero, Dr. T. Ogunkunle, Dr. M. A. Adelanwa, Dr. M. N. Ishaq, etc. May the angels of God lead everyone safely home IJN.

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