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Plant Genetic Resources (PGR) in Nigeria and the Reality of Climate Change - A Review

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Since the beginning of time, nature has fed us, cured and protected us. Today, the roles have been reversed, we need to feed nature and protect it if we must secure a healthy and prosperous future for generations to come. Worldwide analysis shows that biodiversity is threatened by climate change resulting mostly from anthropogenic causes. In Nigeria, there are serious concerns about the rate of biodiversity loss through outright neglect and many manifestations of the challenges posed by the ongoing climate change. Plant genetic resources are fundamental to the establishment of resilient, sustainable agriculture and food security. They provide the raw materials for many medicines and are the genetic stock from which adaptable crop varieties/strains are developed. Therefore, proper conservation and maintenance of the nation's biodiversity is very important. This paper discourses climate change in Nigeria in relation to plant genetic resources as a specific issue of interest and threat to agriculture and food security. Adaptation strategies are also herein prescribed.

Keywords: Climate change; plant genetic resources; biodiversity; flood; agriculture; Nigeria.

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ACRONYMS

ADP : Agricultural Development Program
AGRA : Alliance for Green Revolution in Africa
ATA : Agricultural Transformation Agenda
BBC : British Broadcasting Corporation
CGIAR : Consultative Group on International Agricultural Research
CWR : Crop Wild Relative
DNA : Deoxyribonucleic Acid
FAO : Food and Agricultural Organization
GDP : Gross Domestic Product
GMO : Genetically Modified Organism
IITA : International Institute for Tropical Agriculture
NACGRAB : National Centre for Genetic Resources and Biotechnology
NAFPP : National Accelerated Food Production Programme
NIRSAL : Nigeria Incentive- Based Risk-Sharing system for Agricultural lending
NPQS : Nigerian Plant Quarantine Service
OFN : Operation Feed the Nation
PCR : Polymerase Chain Reaction
PGR : Plant Genetic Resources
SAP : Structural Adjustment Programme
UNDP : United Nation Development Programme

1. INTRODUCTION

The challenges of climate change are increasingly threatening the existence of insitu Plant Genetic Resources in Nigeria, and like other developing countries, Nigeria is generally inadequately equipped to meet the challenges related to conservation and sustainable use of PGR in the context of climate change. Nigeria is believed to be vulnerable to the effects of climate change because of existing little capacity to adjust and adapt as a result of low level of awareness, limited human and financial resources and also inadequate institutional and technological capability. Before going further with this review, there is need to first define climate change, green house effect, global warming and plant genetic resources (PGR).

Climate change is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer. Weather on the other hand is the state of the atmosphere, its temperature, humidity, wind, rainfall and so on over hours to weeks [1]. The earth's climate is mostly affected by latitude, the tilt of the Earth's axis, the movements of the Earth's wind belts, and the difference in temperatures of land and sea, and topography.

Green house effect is the blanketing effect in the lower strata of the earth's atmosphere that occur when the earth's atmosphere traps solar radiation as a result of the presence of gases such as Carbon dioxide (CO_2), Water vapour (H_2O), Nitrous oxide (N_2O) and Methane (CH_4), allowing incoming sunlight to pass through but absorb heat radiated back from the earth surface [2].

Global warming is the increase in the average temperature of the earth's atmosphere resulting from an enhanced green house effect as a result of sustained increase in the amount of green house gases in the earth's atmosphere leading to entrapment of more solar radiations and thus increasing the overall temperature of the earth [3].

And finally, Plant genetic resources (PGR) which is the main focus of this paper are a strategic resource to sustainable crop production. They are the raw materials utilized in selection and crop improvement through breeding to ensure that the food security needs of the world's rapidly increasing population is met [4]. PGR as a vital segment of biodiversity in general and agro biodiversity in particular constitute the genetic material of plants having value as a resource for present and future generations [5]. As a genetic resource, PGR may be of reproductive or vegetative propagule such as seeds, shoots, tissues, cells, pollen, DNA molecule etc, containing the functional unit of heredity in addition to corresponding information and knowledge about their use that can be applied in crop improvement program and other products development. The categories of PGR range from landraces and farmers' varieties, absolute cultivars, modern cultivars, breeding lines and genetic stocks, wild relative, weedy races and potential domesticate species, exotic and indigenous species [6,7,8].

2. CAUSES OF CLIMATE CHANGE

Decades of scientific research have shown that climate can change from both natural and anthropogenic causes. The climate becomes warm in response to increasing concentrations of carbon dioxide (CO_2) and other greenhouse

gases. The concentrations of greenhouse gases in the atmosphere are now higher than they were thousands of years back. Human activities (mainly greenhouse-gas emissions) are the dominant cause of the rapid warming since mid 1900s [9]. Natural causes include changes in the Earth's orbit, the sun's intensity, the circulation of the ocean and the atmosphere, and volcanic activity. The rapid warming seen today cannot be explained by natural processes alone as human activities are increasing the amount of greenhouse gases in the atmosphere. Some amounts of greenhouse gases are necessary for life to exist on Earth—they trap heat in the atmosphere, keeping the planet warm and in a state of equilibrium. But this natural greenhouse effect is being strengthened by human activities, resulting in a shift in the Earth's equilibrium.

One must first acknowledge that most of our economy is based on fossil fuels (Coal, Oil and Natural gas), all our modes of transportation, the way we produce our food etc, almost everything we do releases greenhouse gases into the atmosphere having significant effect on the climate. Greenhouse gases comprise less than 1% of the atmosphere, their levels are determined by a balance between "SOURCES" and "SINKS" [10]. Sources and Sinks are processes that generate and destroy greenhouse gasses respectively. The major greenhouse gases in the atmosphere are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (NO_2), Chlorofluorocarbons (CFC_s) and Ozone (O_3). Atmospheric water vapour (H_2O) also makes a large contribution to natural greenhouse effect but its presence is not directly influenced by human activities. The flux of several greenhouse gases in the atmosphere is also influenced by agriculture. For instance, the removal of natural vegetation in most cases for agricultural purpose is the second largest source of CO_2 emissions after fossil fuel combustion, accounting for 10 to 30% of net global CO_2 emissions [11]. The level ofCO_2 emission in Nigeria (96,513 million metric tons) is the highest in sub-Saharan Africa. Emissions from flared gas alone is reported to have accounted for more than half of this figure [12]. Forests, grasslands, and soils store large quantities of carbon per unit area than most crops and when they are cleared for cultivation, much of this carbon is released to the atmosphere. The rain forest helps to absorb carbon from the atmosphere over several years of photosynthetic activities and stores it in the leaves, trunks and organic matter. The carbon are held safe until the forest is cleared and set on fire releasing massive carbon into the atmosphere and the ecosystem that helps absorb the carbon is taken away. Mean estimates of carbon loss from the conversion of terrestrial ecosystems to agriculture range from 21 to 46% [13]. Just like the rain forest the ocean is like a big buffer in nature, it absorbs 1/3 of the CO_2 that we dump into the atmosphere and because of that, they are a stabilizing force in climate. The fact is that the ocean cannot do its job with the absurd rate of carbon emission. Different agricultural practices have different consequences for greenhouse gas emissions. In intensive agriculture, large quantities of fossil fuel are used for tilling and harvesting and soil carbon can be depleted.

Methane (CH_4) is a very impactful greenhouse gas and a significant amount of emission comes from livestock production [14]. When livestock (Cattle, Sheep and Goats) remove vegetation by grazing they produce methane. They eat grasses and other cellulose forages as much as they can and in the process of digestion there is a build up of fermentation gas in the rumen (one of the stomach compartment) which is voided out from time to time. Some of the CH_4 molecule in the atmosphere are from livestock expulsions and about 75% of the total livestock CH_4 expulsion is from cattle [15]. Paddy rice cultivation also contributes to CH_4 concentration in the atmosphere. In flooded rice paddies, microbial decomposition of high organic aquatic sediments under low oxygen conditions release CH_4 gas to the atmosphere. These concentrations in the atmosphere will continue to increase particularly in Nigeria where lowland rice cultivation is increasing at a fast rate [14].

Nitrous oxide (N_2O) is another greenhouse gas released from agricultural activities. Like carbon, Nitrogen in vegetation and soils is lost to the atmosphere during land clearing. Nitrogen fertilizers are applied to crops to generally enhance growth and when in excess, it is leached into the soil and converted to volatile N_2O through microbial dentrification and released into the atmosphere. Estimates of N_2O release from agricultural fertilizers range from 0.1 to 1.5% of applied nitrogen [15].

3. THE CLIMATIC PROFILE OF NIGERIA

Nigeria is in western Africa and has a climate and weather that are not largely dependent on topographical features but varies by the interaction between the moist, northern air

coming from the Atlantic Ocean and the drier air arriving from the south. The interaction between these two air masses play a distinct role in the country's seasons and temperatures [16].

3.1 Rainy Season

The Nigerian climate produces an extensive rainy season across the country, with rains beginning in the southern, coastal areas of the country in late February to early March and travelling north, reaching most areas by early summer, with rain lasting through September. While the northern part of the country typically sees the highest rainfall during August, the coastal areas see the most precipitation in May, June and October [16].

3.2 Dry Season

Northern Nigeria has a dry season lasting from October to April, with high temperatures and low humidity. The coastal regions see a shorter dry season from December to February, being closer to the damp ocean winds. A second little dry season occurs in the southern region between July and September [17]. The break in rainfall during late summer rarely results in a complete dry season but gives farmers a brief period especially in the country's southwest region in which to harvest their crops [16].

3.3 Harmattan Winds

The harmattan winds or trade winds from the northeast accompanied by a fine dust of sand from the Sahara permeate the country during the dry season of December through February. The winds are most prevalent in the country's north and nearly undetectable on the south western coast most years. The harmattan winds bring higher temperatures, low humidity and a coating of fine, sandy particles as they travel across the country [16].

Table 1. Characteristics of some major greenhouse gases

Greenhouse gas	Sources	Sinks	Importance for climate
Carbon Dioxide (CO_2)	1)Burning of fossil fuel 2) Land use change (deforestation)	1)Ocean Uptake 2)Plants' photosynthesis	Absorbs infrared radiation; affects stratospheric O_3
Methane (CH_4)	1)Biomass burning 2)Enteric fermentation 3)Rice paddies	1) Reactions with OH 2) Microorganisms uptake by soils	Absorbs infrared radiation; affects tropospheric O_3 and OH; affects stratospheric O_3 and H_2O; produces CO_2
Nitrous Oxide (N_2O)	1) Biomass burning 2) Fossil fuel combustion 3) Fertilizers	1)Removal by soils 2) Stratospheric photolysis and reaction with O	Absorbs infrared radiation; affects stratospheric O_3
Ozone (O_3)	Photochemical reactions involving O_2	Catalytic chemical reactions involving NO_x, ClO_x and HO_x Species.	Absorbs ultraviolet and infrared radiation
Carbon Monoxide (CO)	1)Plant emissions 2) Manmade release (transport, industrial)	1)Soil uptake 2) Reactions with OH	Affects stratospheric O_3 and OH cycles produces CO_2
Chlorofluorocarbons (CFCs)	Industrial production	Insignificant in troposphere, dissociated in stratosphere (photolysis and reaction with O)	Absorbs infrared radiation; affects stratospheric O_3
Sulphur Dioxide (SO_2)	1)Volcanoes 2) Coal and Biomass Burning	1)Dry and wet Deposition 2) Reactions with OH	Forms aerosols, which scatter solar radiation

Source: Climatological information services > climate change > green house effect.2001

Given this climatological cycle and the size of the country, there is a considerable range in total annual rainfall across Nigeria, both from south to north and, in some regions, from east to west. The greatest total precipitations is generally in the south east, along the coast around Bonny (south of Port Harcourt) and east of Calabar, where mean annual rainfall is more than 4,000 millimetres. Most of the rest of the south east receive between 2,000 and 3,000 millimetres of rain per year, and the south west (lying towards north) receives lower total rainfall, generally between 1,250 and 2,500 millimetres per year. Mean annual precipitation at Lagos is about 1,900 millimetres; at Ibadan, only about 140 kilometres north of Lagos, mean annual rainfall drops to around 1,250 millimetres. Moving north from Ibadan in the south west, mean annual rainfall is in the range of 1,200 to 1,300 millimetres. North of Kaduna, through the northern Guinea savannah and then the Sudan savannah zones, the total rainfall and the length of the rainy season decline steadily [18].

The Guinea savannah starts in the middle belt, or southern part of northern Nigeria. It is distinguished from the Sudan savannah because it has more trees whereas the Sudan savannah has few trees. Rainy seasons decline correspondingly in length as one moves north, with Kano having an average rainy period of 120 to 130 days, and Katsina and Sokoto having rainy seasons 10 to 20 days shorter [18]. Average annual rainfall in the north is in the range of 500 to 750 millimetres. Temperatures throughout Nigeria are generally high; diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season while rains are moderate during afternoons in the wet season. Average highs and lows for Lagos are 31°C and 23°C in January and 28°C and 23°C in June. Although average temperatures vary little from coastal to inland areas, inland areas, especially in the northeast, have greater extremes. There, temperatures reach as high as 44°C before the onset of the rains or drop as low as 6°C during an intrusion of cool air from the north from December to February [18].

4. FLOOD INCIDENCE IN NIGERIA

One of the most severe evidences of climate change in Nigeria in recent times are flood incidences, i.e. rising of water body and its overflow into normally dry land. It is an extreme weather event naturally caused by rising global temperature, heavy down pour, thermal expansion of ocean water and glacier melt, in turn resulting in rise in sea level. Flooding is one of the most common of all environmental hazards. In Nigeria, the pattern is similar with the rest of the world. Flash floods from torrential rains wash away thousands of hectares of farm lands. Dam bursts are common following such floods. In august of 1988 for instance, 142 people died, 1800 houses were destroyed and 14000 farms were swept away when Bagauda dam in Kano collapsed following a flash flood [19].

Urban flooding such as the Ogunpa disaster of 1980 in Ibadan the headquarters of old western region, Nigeria (now the capital of Oyo State) which claimed over 200 lives and damaged properties worth millions of Naira is another case in history. In august of 2011, a torrential down pour of close to ten (10) hours over Ibadan, Oyo state, Nigeria brought back the memories of Ogunpa flood disaster of 1980 as it left a tale of woes on the residents of virtually every part of the city.

Table 2 vividly reveals that flood has become a major problem in Nigerian cities. The first flood hit Ibadan, the headquarters of old western region, Nigeria (now the capital of Oyo State) in 1948.and since then, serious flood disasters had occurred in Ibadan, occurring in 1963, 1978, April 30, 1980, 1985, 1987, 1990 and 2001. Lagos recorded the first flood menace in early 1970s and till date, floods have become a perennial event in the state. The table also reveals the flood history of some other states in the country.

While floods impact the country each year, the damage and losses from the 2012 floods were unprecedented. Heavy rains between July and October 2012 combined with rising water levels resulting from the runoff contributed to the flooding of human settlements located downstream of the Kainji, Shiroro, and Jebba dams on the Niger River; the Lagdo dam in Cameroun on the Benue River; the Kiri dam on the Gongola River; and several other irrigation dams. In some cases, the dams were damaged; in others, water had to be released at full force to avert an overflow. 363 people were killed, 5,851 injured, 3,891,314 affected, and 3, 871, 53 displaced due to the resulting floods [20].

Plate 1. Aerial view of houses submerged in 2012 flood in Ibadan, Oyo state, Nigeria

Plate 2. Streets covered by flood water in Ibadan, Oyo state, Nigeria

Plate 3. Home made inhabitable by flood water in Ibadan

Plate 4. People wailing at the loss of loved ones in after the 2012 flood incidence in Ibadan, Oyo state, Nigeria

Plate 5. Ajegunle-Ikorodu flood in Lagos state, Nigeria

Table 2. Some flood disaster cases in Nigeria

State	Disaster	Associated hazards	Number of people affected	Year
Oyo	Ogunpa Flood	500 Houses demolished, properties destroyed & bridges collapsed	50,000 affected	1948,1963,1978,1980,1985,1987,1990 and 2011
Lagos	Flood	Buildings collapsed, markets submerged, properties destroyed.	Over 300,000 affected	Early 1970's Till Date
Kano	Flood and wind storm	Schools, Houses, Farmlands & Animals destroyed	300,000 displaced in 1988, 20,445 in 2001	1988, 2001
Zamfara	Flood	Building submerged, Farmlands destroyed, properties damaged	12,398 Affected	July 2001
Yobe	Flood, Fire & Drought	Houses & Farmlands submerged, Houses razed, animals affected	100,000 affected	April & September, 2001
Sokoto	Flood, Fire, Windstorm	Houses & Farmlands Destroyed	16,000 affected	July 2001
Taraba	Flood	80 Houses totally swept off. 410 houses extensively destroyed	More than 50,000 displaced	August 2005
Osun	Rain storm	Houses & schools Destroyed	17000 affected	April 2001
Ondo	Rain storm	Houses & schools Destroyed	800 affected	April 2001
Niger	Flood & Rainstorm	Houses, Schools, animals & farmland affected	200,000 displaced	1999 & 2000
Kogi	Flood & Rainstorm	Houses, Schools & Farmland destroyed	1500 displaced	March, May 2001
Jigawa	Flood & Windstorm	Houses, farmlands & animals destroyed	35,500 displaced in 1988; 450,150 displaced in 2001	1988, March, April & August 2001
Imo	Flood & Windstorm	1000 houses, 150 electric poles & 40,000,oil palm Destroyed	Over 10,000 displaced	April 2001
Ekiti	Flood & Rainstorm	Public Schools & 890 houses	2100 affected	April 2001

State	Disaster	Associated hazards	Number of people affected	Year
		Destroyed		
Edo	Flood & Rainstorm	560 Houses Destroyed	820 affected	March 2001
Delta	Flood & Rainstorm	Houses, Schools, Markets & Farmlands Submerged	Over 425,839.5 affected in the incidences between March 1999 and April 2001	1999, March/April 2001
Bayelsa	Flood	Houses, Schools, Markets & Farmlands Submerged	Over 273,266 people affected 1999, 382,000 people affected in the devastation of march 2001	1999 & March 2001
Akwa-Ibom		367 houses washed away	4000	March 2001
Adamawa	Flood & Rainstorm	Houses & Farmlands Destroyed	500	April 2001

Source: TS06J - Hydrography and the environment, 2011

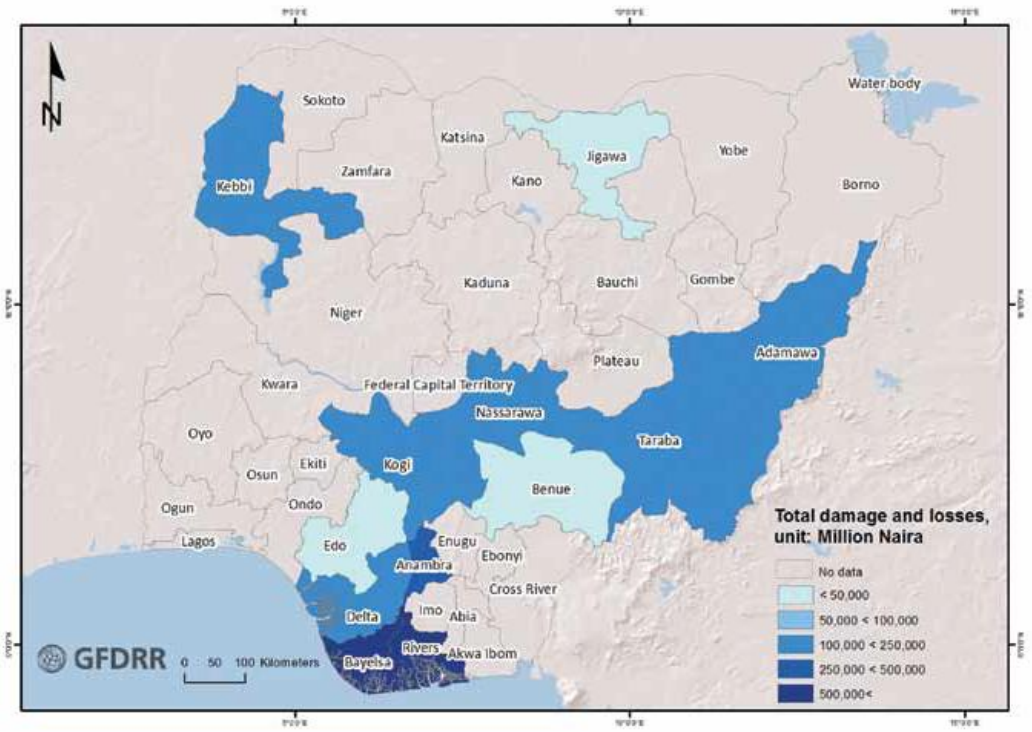

Fig. 1. Map of Nigeria showing states most affected by flood

Source: Estimations by the assessment Team on the basis of official information, 2013

Most of the agricultural and livestock-raising activities take place in low-relief areas of the major river flood plains, taking advantage of the proximity to water. It is precisely for that reason, combined with the widespread absence of flood control works and of effective flood

warning schemes, that production in this very important sector of the economy is highly vulnerable to floods. Worse yet, the extraordinary 2012 floods occurred in the last quarter of the calendar year, near the time of harvest for many food crops, which went submerged for several days and caused the massive loss of production.

It is evident that floods had forced millions of people out of their homes while thousands of people lost their lives to flooding at different time and locations of the Federation. The effect of climate change can be seen with the incessant flood disaster witnessed almost every year all over the country, several farm lands get destroyed and farmers experience terminal drought on the same production field where flood had occurred. The soil in these regions are also seriously leached after these incidences, there is also the serious problems of weed competition with crops which if left uncontrolled leads to a total loss of crops on the farm land. The control of these weeds leads to increased production cost and crop yield are reduced drastically as a result of delayed weeding due to competition for labour at the early stage of crop growth.

Floods are among the most devastating natural disasters in the world, claiming more lives and causing more property damage than anyone would imagine. In Nigeria, though not leading in terms of claiming lives, flood affects and displaces more people than any other disaster; it also causes more damage to properties. At least 20 per cent of the population is at risk from one form of flooding or another. The federal government and States adopt remedial reaction, that is, a post-disaster reaction where relief materials are supplied to the affected victims.

5. DISASTER MANAGEMENT PROCESS

Disaster management involves many diverse activities. These activities can be grouped into five main stages viz: assessment, mitigation, preparedness, response, and recovery**.** [21]The first three activities are performed before the occurrence of disaster, while the fourth and fifth take place during and after the occurrence of disasters respectively.

Plate 6. Cultivated farm land covered with water

Plate 7. Cultivated farm land covered with flood water

Plate 8. Inundated cassava farm

Plate 9. Herds men displaced by flood in northern Nigeria

Plate 10. Inundated maize farm

Plate 11. Inundated sorghum farm in northern Nigeria

5.1 Assessment

This involves inventorying (identification and recording) the sensitivity and vulnerability of a region to certain types of hazards. At this stage the levels of risks, the danger to human life, environment and structures are considered and determined. The assessment will provide identification of development that increase them, thus establishing the culture of prevention [21].

5.2 Mitigation

This entails making necessary provisions to ensure that the region is less vulnerable to risks and danger. Mitigation activities may include; land use and planning; moving settlement away from areas susceptible to such risks and dangers such as flood and storm areas; and the establishment and enforcement of building code etc. [21].

5.3 Preparedness

This involves planning of emergency aid, development of scenarios and monitoring systems, and establishment of early warning system, public information and awareness of likely hazards, community involvement in disaster management programmes, establishment of disaster management and reduction at local, state and national levels and establishment of proper communication channels [21].

5.4 Response

This happens after the occurrence of the disaster which would have caused untold human suffering and damages to the environment. At this stage rescue teams will attempt to save lives, injured people will be treated and relief materials will be supplied to traumatized survivors. This is the most sensational stage of disaster reduction and management system [21].

5.5 Recovery

This stage involves assessment of damages, rehabilitation, cleaning of the environment and social and economic reconstruction. It also entails the first three stages of management process which are; assessment, mitigation and preparedness, all of which are central to strategic development aimed at preventing or minimizing the effect of future disasters.

6. NIGERIAN AGRICULTURAL SECTOR BACKGROUND

Nigeria covers an area of 923 768 square km enclosed within longitudes 3° and 14° East of the Greenwich meridian and latitudes 4° and 14° North of the Equator. About 98.6% of the total area is land and the rest is water. It shares a common boundary with the Republic of Benin to the West, Chad and Cameroun to the East and Niger Republic to the North. The Atlantic Ocean with a 960 km coastline borders the south and is indented by lagoons and by the immense Niger River Delta. The River Niger with its tributary, the Benue, forms a large 'Y' across Nigeria. The country is a physically and climatically diverse country that is endowed with substantial natural resources. There are nine distinct ecological zones which can be streamlined into five, namely (i) Sahel/Sudan savannah, (ii) Guinea savannah, (iii) Derived savannah, (iv) Lowland rain forest/montane forest and (v) Freshwater swamp forest/mangrove forest and Coastal vegetation. The physical and climatic diversity permits the growth of a wide variety of crops [22].

The Nigerian agricultural sector has remained a resilient sustainer of the economy and the Nigerian people in terms of food supply, employment, national income generation and industrialization. It has also struggled to perform the above functions over the years in spite of declining effectiveness of policy attention since the 1980s. The eleven major crops grown in Nigeria are yams, cassava, sorghum, millet, rice, maize, beans, dried cowpeas, groundnuts, cocoyam, and sweet potatoes. These major crops, which account for roughly 75 percent of total production, increased from 81,276 tons in 2004 to 95,556 tons in 2007. Other main crops include plantains/bananas, ginger, cocoa, rubber, oil palm, gum Arabic, cashews, mangos, citrus ,pulses, and pineapples[23]. The exploitation of the agricultural sector since the 1960s provided the main source of employment, income and foreign exchange earnings for Nigeria. This was due to focused regional policies based on commodity comparative advantage. The sector employed over 70 percent of the labour force [24], fed the population estimated at 55million and 60million in 1963 and 1965 respectively, guaranteeing the greater percentage of the food security of the average household. In the same period, export of cash crops earned 70 and 62.2 percent respectively, of Nigeria's total foreign exchange and contributed 56.7 and 66.4 percent of GDP in 1960 and 1965 respectively [25].

The dominant position of the agricultural sector in this period of the Nigerian economy was therefore not in doubt. The advent of commercial exploitation of oil resources, however, turned the trend against agriculture and its downstream industries from the rest of seventies onwards. The oil boom heralded an era of decay and decline in agricultural output and in the overall contribution of the sector to the economy, evidenced by the Dutch Disease. It lost its foreign exchange earning capacity, domestic revenue importance, and attracted policy neglect. This neglect turned a threat to national food security leading to massive and continuous food importation with an erosion of value addition gains of the sector as agricultural raw commodities were exported only for finished goods to be imported [25].

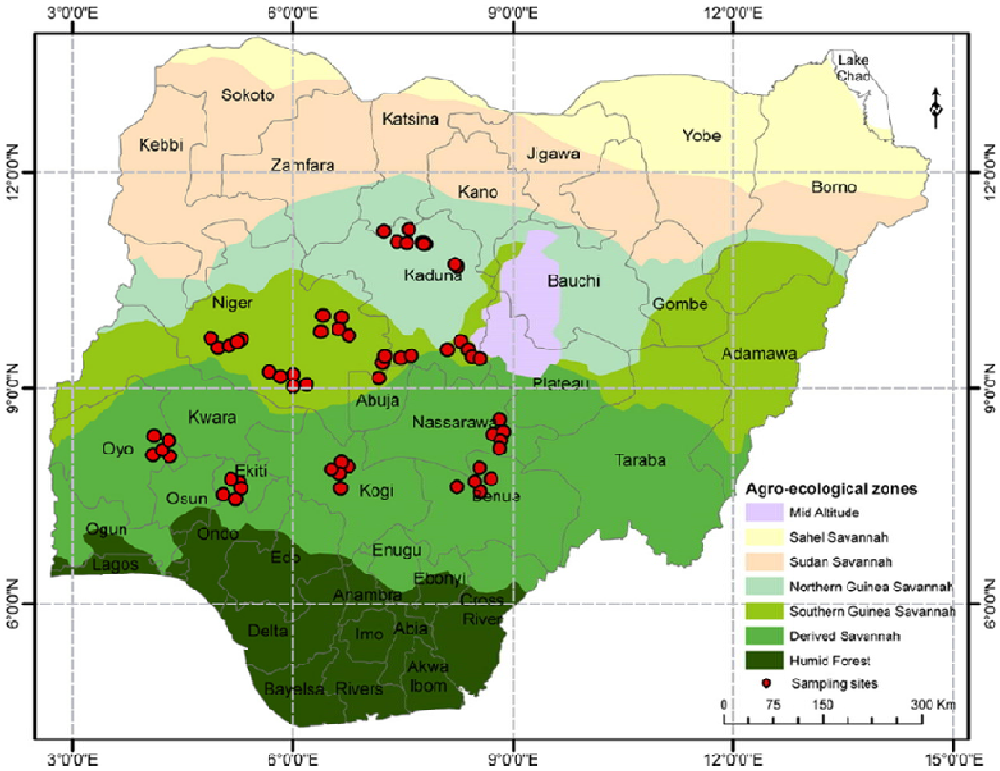

Fig. 2. Map of Nigeria showing the ecological zones
Source: Country pastures/ forage resource profiles.2009

Policy neglect affected key indicators of agricultural sector performance, gross domestic product (GDP), amount of guaranteed loan received by farmers under the agricultural credit guarantee scheme fund (ACGSF), total bank credit to the agricultural sector and the economy as a whole, capital expenditure of federal government on agriculture and all sectors of the economy and the share of labour force employed in agriculture. In spite of this, the sector still showed some resilience. Its share in both aggregate GDP and non-oil GDP continued to increase. Credit flow to the agricultural sector (an indicator of the sector's capacity to invest and grow) measured by the amount of guaranteed loan that flowed to the sector under the agricultural credit guarantee scheme fund and the total bank credit to the sector. The nominal flow of guaranteed credit increased but sharply declined in real terms over the sub-periods, from about N44.2 million in the 1981 – 85 sub-periods to about 36.5 million in the 1986-90 sub-periods and to only about 5.6 million in the 1996-2000 sub-period [25].

Between 1960 and 1970, Nigerian agricultural development was fully decentralized with the states and regions as centres of activity, while the federal government provided support. This enabled a region/state-specific strategy or approach, but which generally involved a combination of private-sector/small farmer and government direct production approaches. The strategies were highly successful within this period, making agriculture Nigeria's economic mainstay, providing the greatest employment opportunities, bulk of the raw materials for growing industries and as main source of foreign exchange earning while remaining the food security foundation. However, within the 1970s, a national neglect set in [25].

Earlier public policy instruments included the series of ***National Development Plans*** coordinated at the National level from the first (1962-68), the second (1970-74), the third (1975-80) and the fourth (1981-85) National Development Plans. This was followed by the ***Structural Adjustment Plan (SAP)*** in 1986 which made efforts at making the sector commercially competitive and remunerative and tried to redress Nigeria's defective mono-economic imbalance through a diversification programme to reduce dependence on the oil sector and on imports. The policy package, focused on rapid improvement of domestic food production, domestic supply of agricultural raw materials, production of exportable cash crops and rural employment. It only succeeded in creating the awareness to diversify the economy through agriculture and the catalytic leading role the private sector must play in agricultural development, which renewed a general interest in agriculture .Pre-SAP policies were generally public sector-driven, and mainly targeted initiatives at improving agricultural production. Some of the specific policies within this period include:

6.1 The National Accelerated Food Production Programme

(NAFPP) started in 1972 primarily to raise farmers' income, accelerate the rate of diffusion of new agricultural technology and serve as a medium for testing and adopting agricultural research findings in on-farm conditions. The objectives of this programme were not achieved.

6.2 Agricultural Development Projects

(ADPs) were set up in various parts of the country starting from 1975. Partly financed by the World Bank, these projects were to promote integrated rural development by providing facilities for intensive extension services, modern input supplies and distribution system and rural infrastructures, especially feeder roads.

6.3 Livestock Development Projects

Livestock Development Projects were started in 1976 to commercialize beef production by the establishment of large scale public breeding ranches to encourage small scale private ranches development of grazing reserves and the provision of supervised credit for small holder fattening Schemes.

6.4 Operation Feed the Nation

(OFN), which started in 1976, was aimed at curtailing massive food importation into the country. The stated objectives of the programme were to meet the acute shortage in food supply, and restore some respectability to farming with the view to stemming the movement of youths from the rural areas to the cities. Urban dwellers were also encouraged, through the programme, to engage in backyard farming. The operations also attempted raising production and productivity by distributing inorganic fertilizers and improved seedlings.

6.5 Agricultural Credit Guarantee Scheme

The Agricultural Credit Guarantee Scheme was set up, under the Central Bank to mobilize funds from the banking sector for rural development to guarantee loans by the commercial banks for investment in agriculture in order to minimize the risk involved in financing the sector. The implementation of this policy was too slow to reach all applying farmers.

6.6 The Land Use Act

The act was meant to facilitate an effective utilization and exploitation of the land resources for agricultural purposes. The law sought to bring the existing land tenure system under one common law. This law was largely abused as public officials with authority for land use approval have expropriated large portions for self-based compromises. Besides the law became a key bottleneck to land access and alienation for investment uses, necessitating the call for its amendment.

6.7 Green Revolution

The Green Revolution was launched in 1980, was essentially a reformulation of "Operation Feed the Nation" Programme but focused on the small farmer and the development of the rural areas. The Green Revolution intended to address agricultural production from a fully mechanized and capacity upgrading perspective. To this effect, the government supported the policy with deliberate program of procuring machineries for full mechanized farming. It also established the universities of Agriculture to enhance the nurturing of young, educated population of modern farmers learned in mechanized production. A new Green Revolution effort has been launched continentally championed by the Alliance for Green Revolution in Africa (AGRA).

Although agriculture grew substantially over the last few years, this growth is attributable to an Increase in land under cultivation. Even as Nigeria contains 79 million hectares of fertile land, only 32 million hectares (46 percent) are cultivated. Productivity has been consistently low; households with less than two hectares under cultivation account for more than 90 percent of the Country's agricultural output [26]. Typical farm sizes range from 0.5 hectares in the south to four hectares in the north. In fact, 80 percent of farm holdings are small in scale and hardly produce enough to sustain their owners for eight months. During bad crop years resulting from poor or poorly distributed rain fall and other natural calamities (e.g., floods, bird and insect infestations, outbreaks of plant diseases), the capacity of small-scale farmers to cope is further reduced and many may go hungry. The supply of agricultural inputs has also generally been suboptimal. Nigerian fertilizer consumption at 7kg/hectare is one of the lowest in Sub-Saharan Africa .Less than 10 percent of irrigable land is actually under irrigation. Furthermore, farmers have limited access to credit and the existing extension services are inadequate. There is currently one extension worker per 25,000 farm families in Nigeria, compared to a best practice that would have 1 worker available for every400-1,000 families [27]. Mechanized assistance is also insufficient. There are only about 30,000tractors available to roughly 14 million groups/families in Nigeria. On the processing front, Nigeria loses between15 and 40 percent of its agricultural produce due to its inability to process it in a timely fashion. In the livestock subsector, local supplies are inadequate. The daily animal protein intake per head per day is currently at 10 grams, compared to the FAO recommended 36 grams.

Despite this gloomy picture of Nigeria's agricultural sector, the federal government, through the Agricultural Transformation Agenda (ATA), has made some advances, especially in the areas of food processing and value addition, and has thus given some hope to the sector. For example, to stimulate domestic production and the processing of cassava, bakeries will enjoy a corporate tax rebate of 12 percent if they attain 40 percent blending of wheat flour with cassava flour within a period of 18 months. Additionally, to facilitate farmer's access to credit, the government is guaranteeing70 percent of the principal of all loans made for the supply of seeds and fertilizer by the private sector. Also, under the Nigeria Incentive-Based Risk-Sharing System for Agriculture Lending (NIRSAL), N450 billion was set aside to serve as a credit portfolio to support the federal government's Agricultural Transformation Agenda. In an effort to enhance the production of oil palm, the Federal Ministry of Agriculture and Rural Development secured 4 million improved *tenera* oil palm nuts from the Nigerian Institute for Oil Palm Research; these was raised into mature seedlings by 70 public and private sector nursery operators, and then distributed to farmers for field planting in 2013.

This initiative will cover 26,666 hectares of oil palm plantations [27].

7. HOW CLIMATE HAS CHANGED IN NIGERIA

The humid tropical zone of southern Nigeria, which is already too hot and too wet, is expected to be characterized by increase in both precipitation (especially at the peak of the rainy season) and temperature [28]. Already, temperature increases of about 0.2°C - 0.3°C per decade have been observed in the various ecological zones of the country, while drought persistence has characterized the Sudan-Sahel regions, particularly since the late 1960s [28]. For the tropic humid zones of Nigeria, precipitation increases of about 2-3% for each degree of global warming may be expected. Thus, it is reasonable to expect that the precipitation would probably increase by approximately 5 -20% in the very humid areas of the forest regions and southern savannah areas. The increase in temperature in these areas would also possibly increase evaporation, reducing the effectiveness of the increase in precipitation. According to IPCC projections, rainfall in the very humid regions of southern Nigeria is expected to increase. This may be accompanied by increase in cloudiness and rainfall intensity, particularly during severe storms. It could also result in shifts in geographical patterns of precipitation and changes in the sustainability of the environment and management of resources. However, since the increase in temperature could increase evaporation and potential evapo-transpiration, there would be tendency towards “droughts” in parts of these humid areas of the country. In fact, recent studies have shown that precipitation decrease in the humid regions of West Africa, including southern Nigeria, since the beginning of the century is about 10-25% or about 2-5% per decade. If this trend persists, rainfall in the humid regions of southern Nigeria may be about 50% to 80% of the 1900 values by 2100 [28]. With increase in ocean temperatures, however, there could be increase in the frequency of storms in the coastal zone of the country. In contrast to the humid areas of southern Nigeria, the savannah areas of northern Nigeria would probably have less rainfall, which, coupled with the temperature increases, would reduce soil moisture availability. Recent studies have indicated that the Sudan Sahel zone of Nigeria has suffered a decrease in rainfall in the range of about 30-40% or about 3%-4% per decade since the beginning of the nineteenth century [28]. Already, these savannah and semi-arid areas suffer from seasonal and inter annual climatic variability, and there have been droughts and effective desertification processes, particularly, since the 1960s. This situation may be worsened by the expected decrease in rainfall with greater drought probabilities and more rainfall variability and unreliability. Part of the conclusions of IPCC’s third assessment report is that during the 21st Century, some extreme climatic events will increase in frequency and/or severity due to changes in the mean and/or variability of climate. Some of these events will have negative impacts on PGR and in turn- Agricultural production and food security of the country.

8. IMPACT OF CLIMATE CHANGE ON CROP PRODUCTION

The location of Nigeria in Sub Saharan Africa is characteristically high in temperature. An increase in the mean temperature and varying extremes of precipitation due to warming resulting from climate change has detrimental effects on crop production. Agricultural activities in Nigeria are rain-fed and farmers are engaged in crop production. The crops planted in Nigeria include: annual crops such as cassava, melon, yam, rice, groundnuts, peppers, onion, plantain, vegetables, etc. The cash crops are: cocoa, oil palm, cashew, mango, coconut rubber, cotton and other fruit crops like pineapple, guava, pawpaw, etc [29]. All these crops depend on rainfall. Where rain is abundant especially in the southern parts of the country, crops that require much rain are planted and in the northern part of the country, crops that do not require much rain are cultivated.

The effect of climate change on crops in Nigeria has manifested in a number of ways. For example, Pest and disease incidence have become varied and uncontrollable under these extreme weather. Uncertainty and variation in the distribution of rainfall has caused pest and disease vectors to migrate in response to the changing climate making the breeding season of these insects coincide with cropping season. In some cases, disease vectors migrate and become endemic in areas that they were not initially noticed causing serious devastation and economic losses in crop production. Irregular rainfall and sunshine hours (Albedo and Photoperiods) impose a serious setback. Under reduced photoperiods, flowers and fruits of crops gets aborted leading to a serious decline in harvest per annum [30].

Droughts and floods occur mostly in the northern part of the country, destroying a lot of farms in the event. The feed of livestock are mostly from crops and the drought condition causes a significant decrease in pasture grasses and water [31] so herdsmen migrate toward the southern part of the country and tend to destroy farms by allowing the cattle to graze on cropped areas as they enter the south during these migrations causing tensions and conflicts between the farmers and the herdsmen. A lot of farmers have suffered great economic losses in the clashes that result from such conflicts and lives have been lost in the process.

9. THE NATIONAL CENTER FOR GENETIC RESOURCES AND BIOTECHNOLOGY- FUNCTION

Deliberate ex situ conservation of crop germplasm for food and agriculture started in Nigeria about three decades ago with the establishment of the National Bureau for Plant Genetic Resources, Ibadan under the Federal ministry of Science and Technology. The name was later changed to the National Centre for Genetic Resources and Biotechnology (NACGRAB) to meet the emerging challenges in germplasm conservation, especially in the area of in vitro conservation, DNA fingerprinting and cryopreservation.

The National Centre for Genetic Resources and Biotechnology (NACGRAB – present name) was established by the federal ministry of science and technology in 1987 through the active support of the Food and Agricultural Organization (FAO) IPGRI/UNDP, following the promulgation of decree 33 of 1987. To be the lead canter in Nigeria for plant genetic resource management and relevant matters relating to research, data collection, conservation and dissemination of technological information [32].

Before the promulgation of Decree 33 of 1987, there was no national institutional mechanism for the validation of claims by individuals or institutions on the development of new crop varieties and livestock breeds. There was no centralized documentation of the distinguishing features of such plants and animals nor was there any harmony in the confusion. It was against this background that Decree 33 of 1987 that established the national crop varieties and livestock breeds registration and release committee was promulgated to inject sanity into the system of naming, release and registration of crop varieties and livestock breeds and consequently checkmate the seed industries. The decree spelt out the responsibilities of members and functions of the national committee, the committee was charged with receiving and processing applications for the registration, naming and release of old and new crop varieties and livestock breeds: officially releasing the list of superior crop varieties and livestock breeds recommended by the sub-committee established for that purpose [33].

Activities of NACGRAB include:

- Acquisition,Conservation,Preservation and Maintenance of the nations valuable plant genetic resources for future use and the encouragement of the immediate utilization of these genetic resources to rapidly transform our agriculture and industry, improve the local sourcing of drugs that are of plant origin and to help in the amelioration of harsh environments.
- Networking and coordinating activities in the development of capabilities in genetic engineering and biotechnology.
- The identification of national research needs and priorities, the conduction of research in conservation and utilization of genetic resources, genetic engineering and biotechnology.
- Collaboration with relevant national research institutes, tertiary institutions and Non-Governmental organizations within Nigeria and outside the country.

The Centre operates as the central organ of the country for liaison with international organizations like Bioversity International, FAO, UNDP and IITA on plant genetic resources. It also advises government on matters concerning plant genetic resources and conservation of vegetation. Similarly, the Centre has working relationship with National Agricultural Research Institutes [34]. The acquisition of germplasm through collection of indigenous diversity across Nigeria and germplasm exchange through introduction from other countries has contributed tremendously to available gene pool for breeders to work with in different crop species. Introductions are generally carried out by the National Centre for Genetic Resources and Biotechnology (NACGRAB) in collaboration with Nigerian Plant Quarantine Service (NPQS). In some exceptional cases private seed companies and Agricultural Universities are also permitted to make some introductions from other countries but with the knowledge of NACGRAB and NPQS

to ensure no GMO or alien pathogens are imported into the country and for proper documentation. The rich diversity of different crop species in Nigeria has made it easy and fast to develop new varieties of crop.

10. CONSERVATION STRATEGIES

Climate change has put substantial stress on traditional crops and as such the need to collect and conserve crop and plant germplasm is critical. Nigeria is diverse in its climate and vegetation and is very rich in floristic composition. Over the years, there has unfortunately been intensive deforestation resulting from forest exploitation, and land clearance for agriculture including other uses even in fragile ecosystem resulting in the loss of vital under-explored vegetation and their gene pool as habitats were changed.

The National Centre for Genetic Resources and Biotechnology (NACGRAB) has three germplasm conservation facilities – Seed gene bank, field gene bank and in vitro gene bank'.

10.1 Seed Genebank

Seeds are critical inputs for increasing agricultural productivity, reducing food insecurity and easing the effect of poverty. It exerts the most profound influence on crop yield as it holds the genetic potentials of the crop plant. A seed gene bank is very crucial in the conservation and utilization of plant genetic resource.

The seed gene bank is one of the core units of the National Centre For Genetic Resources and Biotechnology (NACGRAB) and it is responsible for acquiring, managing, regenerating, characterizing, conserving and the utilization of orthodox seeds i.e. seeds that can be dried to low levels of moisture content and stored at low temperatures over a long period of time without losing viability e.g. Rice, Maize, Sorghum, Millet etc. The unit has two storage facilities in its gene bank, a prefabricated long-term storage room maintained at -20°C, and relative humidity of 10% and a modified room for short term storage is maintained at 15°C and 30% R.H. The two storage facilities have dehumidifiers [35].

10.2 Field Genebank

The field gene bank is one of the units under the technical department. The unit is responsible for conserving recalcitrant seeds i.e. seeds that cannot be preserved over a long period) and vegetatively propagated seeds.

10.3 *In-vitro* Genebank

Biotechnology is a science that has holds solution to the practical problems in many areas of agriculture. The biotechnology unit in NACGRAB was established 1999 to handle issues relating to research and development in micro propagation, multiplication and authentication of plant genetic resources. The unit is divided into two sections namely:

10.3.1 Tissue culture (Tc) laboratory

The tissue culture laboratory is where propagation and conservation of indigenous and exotic plant species using in-vitro techniques which include organ, seed, meristem and shoot tip culture takes place. One of the objectives of the tissue culture laboratory is the multiplication of plant genetic resources. Since inception there has been continuous research on the development of protocols for the conservation, maintenance and commercial propagation of selected cultivars, superior hybrids of indigenous agronomic and tree crops.

10.3.2 Molecular biology laboratory

In order to enhance characterization in NACGRAB, molecular characterization was introduced for DNA extraction and fingerprinting. The procedure includes sample collection, DNA isolation, cleaning/purification. Quantification using Nanodrop, Gel-electrophoresis and amplification by Polymerase Chain Reaction (PCR) [35].

11. PLANT GENETIC RESOURCE (PGR) IN NIGERIA

The strength of Nigeria as a nation as it is the case with any other nation in the world lies in its natural resources including the genetic resources that are the foundation for growth and stability in agriculture, forestry and environment[36]. In the light of the above, the country's ability to integrate itself into the evolving global system to a large extent depends on agricultural transformation that is based on PGR[36].A large portion of the Nigerian population reside in the rural community and derive subsistence and income principally from agricultural resources, yet the economic policies, programs and practices as well as the political institutions of the

nation have not fully maximized the socio-economic potentials of these PGR.

Nigeria is rich in PGR which exists in wild forms in plants natural habitats and in diverse crop landraces/cultivars [37]. The country is an epicentre of diversity for many taxa.However, there is a wide gap in the knowledge of the genetic diversity of crops owing to lack of up to date documentation of crop's genetic resource for food and agriculture [38], only a small fraction of the rich natural endowments of the nation's crop genetic resource is properly documented and profitably exploited for food and agriculture [39]. The diversity of crops in Nigeria is decreasing because the rate at which diversity is lost is far more than the rate at which collection and conservation are done in spite of how Small holder farms and local communities in a wide range of agro ecosystem within different regions have developed viable agricultural practices and maintained numerous traditional plant varieties over thousands of years [40].

Successful adaptation of agricultural production system to climate change depends on improved access to and use of PGR [41] including crop wild relatives. Such access is important for the discovery and use of climate resilient traits. Climate change stresses prevailing in Nigeria include severe drought, flooding, extreme temperature, high level of salinity and severe outbreak of insects and disease occurrence. Collection and characterization and conservation of crop wild relatives hold the hope of finding useful and so far undiscovered traits with particular climate change adaptation potential e.g. Tolerance to extreme heat or cold. Priority species and regions need to be first identified as wild species are the most exposed to stress that derives from climate change [42]. Consolidation of national germplasm collections of wild species, crop wild relatives, biological control species, underutilized and wild harvested species must be a high priority. Collection of crop wild relatives is deficient and in need for further work to complete the collections that exists which should cover all taxonomic species of relevance to crop improvement and full geographic distribution of species [43]. In 2015, the crop trust, an established independent organization under international law, founded by the food and agricultural organization (FAO) and Bioversity international on behalf of the Consultative Group on International Agricultural Research (CGIAR) set out on a three (3) year mission to collect crop wild relatives in Nigeria for its crop of interest. A team was put together for the collection mission. The National Centre for Genetic Resources and Biotechnology (NACGRAB) being the focal point for genetic resource management and conservation coordinated the mission with members of the team drawn from tertiary academic institutions.

Growing research interests in crop wild relatives (CWR) has highlighted their value for crop improvement, particularly to mitigate the impact of climate change and contribute to global food security. As most conservation programs are implemented at national level, there is a requirement for Nigeria to develop a national crop wild relative conservation strategy. The strategy should be one that raises the importance of agricultural biodiversity, utilization and maintenance of PGR for crop improvement and diversification of agricultural and food systems in the context of significant climate change. Crop wild relatives (CWRs) are a key resource for climate change adaptation, providing researchers with genes and traits for biotic and abiotic resistance [44,45]. Crop wild relatives have saved agriculture millions of dollars, both directly and indirectly, by improving crop resilience to biotic and abiotic stresses [46]. A number of crops, such as sugar cane, tomatoes and tobacco, could not be grown on substantial commercial scales were it not for the contribution to disease resistance made by wild relatives of those crops [47].

However, CWR themselves are now under threat of extinction due to climate change. Under elevated CO_2 levels, CWR produce relatively less fruit and seed than domesticated crops [48], increasing their risk of extinction. Moreover, CWRs remain a relatively low priority in germplasm collection due to financial and political impediments. Increasing threats to natural habitats and farming systems make it imperative to collect, conserve and characterize traditional varieties (landraces) and wild relatives in order to have them available for use in mitigating the effects of biotic and abiotic stresses caused by climate change [49]. The importance of crop wild relatives as an important source of genetic diversity for breeding is underestimated [50]. CWR are taxa closely related to crops and are defined by their potential ability to contribute beneficial traits for crop improvement; for example, to confer resistance to pests and diseases, improve tolerance to environmental conditions such as extreme temperatures, drought and flooding, and to

improve nutrition, flavour, colour, texture and handling qualities and agro technical advantage such as ability to hibernate [51]. The practical use of crop wild relatives is affected by little awareness of their diversity and differences from cultivated species.

Nigeria like most other African countries has been a cheap source of PGR for industrial change in the western world, contributing greatly to the promotion of agriculture and production of pharmaceutical products in industrialized countries. [52] In the recent past up till date, valuable chemical compounds have been extracted from Nigerian plants and trees for use in the pharmaceutical and personal care product industries. Natural products play a key role in the health care delivery program in the country as traditional medicine depends entirely on plant genetic resources as the source of base materials and products. The system, practices and products depended on by a large portion of Nigerian community for ages are facing great threats from climate change, and internal neglect.

12. ROLE OF PLANT GENETIC RESOURCES IN SUSTAINABLE AGRICULTURE AND FOOD SECURITY

Sustainable agriculture is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the natural resource base and avoiding environmental degradation [53], While food security is achieved when all people at all times have physical, social and economic access to sufficient safe and nutritious food to meet their dietary needs and food preference for an active and healthy life [54].

The role of PGR is mostly seen as a source of specific useful genes for crop improvement. Such perception is far too restrictive and diminutive, considering the great potential they retain for progress in agriculture, particularly under unfavourable conditions [55] such as what is witnessed presently with climate change. Biotic and abiotic stresses can set in with different intensity at different times during the growing season and for a variable period of time. In Nigeria for example stress results from sudden seizure of rains during active period of rain for extended period, unexpected cold during pollination and seed setting, high temperature, lack of water and hot winds during seed grain filling or from different combinations of these factors. PGR comes into play in the face of these challenges as yield increase and stability under these circumstances cannot be derived from a single trait no matter their complexity, but rather from a combination of different traits and with each combination, the role of individual traits can change with the type, intensity and timing of the stress.

13. GENETIC EROSSION AND GRADUAL DISAPPEARANCE OF CROP WILD RELATIVES IN NIGERIA

Genetic erosion is the loss of genetic diversity; both the loss of specific traits within a variety as well as the loss of the entire variety and specie [56].As the response of landraces to improvements in farming system began to reduce, it became important to consider more reactive materials. Selection first started among and within landraces and then in variation brought about by crossbreeding. Farmers adopted the high yielding varieties over large areas, making the crops more uniform and exposed to risk of serious attacks by pests and diseases [57].

During the era of ‘Green Revolution’ – many traditional crop varieties were replaced by modern improved varieties. In combination with industrial fertilizers and pesticides, these improved varieties brought about the significantly higher crop yields that were urgently needed at that time [58]. The replacement of traditional crop varieties by modern varieties is one of the major factors affecting crop diversity in production systems. Genetic erosion did indeed take place at the time of the shift from traditional to more intensified production. Unlike the traditional farming systems in which agricultural inputs were mainly produced by farmers, farmers had to purchase improved seeds under the modern production system, fertilizers and pesticides as external inputs and so the practice of saving seed for subsequent cultivation was completely abandoned and many locally adapted varieties were lost [58]. In the decades that followed, other factors directly and indirectly linked to the Green Revolution further contributed to the loss of diversity between and within crops. The seed market competition further contributed to the erosion as they only promoted the introduced high yielding elite varieties. Consumers in turn preferred these varieties further making plant breeding narrow the genetic bases of crops to its success [58]. Other factors included the mechanization of production processes, the

increasing corporate concentration in the seed industry, the opening of agricultural markets to international trade, uniformity requirements set by the food industry and a growing homogenization of food cultures worldwide.

14. ROLE OF GENE BANKS IN PLANT GENETIC RESOURCE MANAGEMENT

The challenges of climate change are increasingly threatening the existence of PGR in Nigeria. The country like any other developing country is generally not well equipped to meet the challenges related to the conservation and sustainable use of PGR in the context of climate change.

PGR are a strategic resource to sustainable crop production. Their efficient conservation and use is critical to safeguard food and nutrition security now and in the future. Meeting this challenge will require a continued availability of improved crops and varieties adapted to particular agro-ecosystem condition. Sustainable management of a thriving agriculture under adverse environmental and fluctuating meteorological conditions is made difficult by the loss of genetic diversity. Well managed genebanks both safeguard genetic diversity and make it available to breeders [59].

The value of conserved PGR is realized only through its effective use. This requires a strong linkage along the chain from in situ resource conservation and collection, to storage in genebanks, through research and breeding and to farmers, their communities and ultimately the consumers [59]. Genebanks play a key role in the conservation, availability and use of a wide range of plant genetic diversity for crop improvement for food and nutrition security, they bridge the gap between the past and the future by ensuring the continued availability of genetic resources for research, breeding and improved seed delivery for a sustainable and resilient agricultural system.

Sustainable conservation of PGR depends to a great extent on the efficient management of genebanks through the application of standards and procedures that ensure the continued survival and availability of the plant genetic resources. Such standards relate to;

- Accession identity
- Maintenance of viability
- Availability of information on the germplasm
- Maintenance of genetic integrity of the acquired or collected samples
- Physical security of germplasm/Safety duplication of the samples
- Maintenance of germplasm health
- Availability and use of germplasm

15. ADAPTATION STRATEGIES

As the temperature of the climate continues to increase, more changes are expected to occur, and the effects will become more severe as time goes on, heat waves are expected to become more common, severe, and longer lasting. Storms are likely to become stronger and more frequent, increasing the chances of flooding followed by severe drought in the flooded area [60]. There is also the chance of increased damage to crops by pests and diseases. Climate change has affected different regions in the country, ecosystems, and sectors of the economy in many ways, depending not only on the sensitivity of these systems to climate change, but also on their ability to adapt to risks and changing conditions. The effects of climate change have already been observed in Nigeria, and the rate of warming is increasing.

For this reason, human-caused climate change represents a serious challenge, one that require approaches and ways of thinking that ensure the continued health, welfare, productivity of the society, sustainable agricultural productivity for food security and efficient conservation and utilization of the country's PGR for food and agriculture. The following approach could be considered in achieving these;

- The government should embark on a wide spread public awareness mission to educate the public and improve existing knowledge and understanding of the causes and how climate change affects our society on both local and regional scale
- There are a number of influences that could reduce the effect of climate change on PGR regeneration and crop production capacity in Nigeria; options to consider include the possibility of synchronizing metrological data with planting by altering dates of planting and harvesting.
- Farmers can adapt by making appropriate change in planting date and varietal selection,

- The federal government should embark on mass reconstruction of dams and irrigation channels across the country, especially in the north.
- Considerable efforts should be put into restoration of lost trees in the country and deforestation should in turn be discouraged.
- Regeneration of collected PGR in gene banks is the most serious aspect of gene bank management because of the possibility of compromise of genetic integrity of the accessions as a result of out crossing, selection pressure and mechanical mixtures of seeds. Giving these possibilities and the biotic and abiotic stress the ongoing climate change impose, seed generation should be done in the post rainy season under controlled irrigation provisions. There is the advantage of low relative humidity, low incidence of pest and diseases and consequently the quality of seeds produced is high. The flowering of photosensitive accessions is induced by the short days during post rainy season, enabling their seed production.
- The sighting facilities and infrastructures in areas identified to be likely affected by flood should be discouraged and already existing ones should be pulled down and/or relocated where possible.
- The federal government should shift focus from post disaster reaction/response to pre disaster reactions. In other words considerable energy and attention should be put into prevention/or mitigation and not handing out of relief materials.

16. THE FUTURE OF NIGERIAN PLANT GENETIC RESOURCES

A proper knowledge and proper management of genetic diversity is very important in breeding and sustainable crop production, Nigeria has a great deposit of genetic resources which can contribute to the expansion of the genetic base of crop varieties grown on farmer's field to make them better adapted to the multiple biotic and abiotic stresses in the country.

As collection missions are organized and properly executed by mandated institutions in Nigeria in collaboration with national partners to collect crop wild relatives and land races from different areas and underrepresented regions in the national gene bank, the hope for the future of the nation's PGR for use to attain food security in the face of the ongoing climate change experienced in the country is held in the proper conservation and increased sustainable use of the nation's PGR. A very good option to focus on is ex situ method of conservation of PGR.

Ex situ conservation is the conservation of biological components outside their natural habitat. Seed gene banks, field gene banks tissue culture, and cryopreservation are forms of ex situ conservation [61]. This conservation method makes possible the reintroduction of crops in areas where they have been lost through environmental degradation or any form of disaster. Out of all forms of ex situ conservation methods, seed storage in seed gene banks is the most convenient approach for long term conservation of PGR because in this form of conservation, seeds are desiccated and stored at low temperature and low moisture content.

Therefore serious attention should be given to proactive management of gene banks in the country by establishing a balance between the scientific aspect of the task, the personnel on ground, and the infrastructural and financial resources available in the face of the prevailing challenges imposed by climate change.

17. SUSTAINABLE USE OF PLANT GENETIC RESOURCES

The primary aim for conserving PGR is for use by people as food and medicine among other reasons. It will be pointless to conserve these plant genetic resources without use and also the genetic diversity required by breeders to improve on existing varieties for better productivity is neglected if plant genetic resources are used without being conserved.

To facilitate sustainable use, PGR conserved in gene banks must be properly documented by maintaining a passport data giving location of collection, site characteristics, specie, cultivar name, characterization data, documenting heritable characteristics that can be used as basis to distinguish an accession from the other and evaluation data e.g. yield and reaction to pest and diseases.

18. CONCLUSION

Climate change is having a significant negative impact on the environment and on PGR distribution and most likely alters their

physiognomy. Future progress in crop improvement is to a very large extent dependent on immediate and proper conservation of the nation's PGR for effective and sustainable utilization towards achieving food security as many of these PGR are threatened/endangered by the prevailing conditions and challenges brought about by the change in climate while some have already been lost, i.e. extinct.

Climate change is a real and urgent challenge that is already affecting people in Nigeria and the environment worldwide. In Nigeria, there are significant and notable alterations of seasons manifesting as (a) Late arrival of rains, (b) Unusual rainfall pattern, (c) Increase in flood occurrence followed by severe drought, (d) Harmattern being hardly noticed in some years while it is prolonged and sever in some other years. There is also a shift in the breeding periods of some insects and pest in response to the change in climate, making it coincide with the reproductive phase of crops in cropping season resulting in significant economic damage and loss in crop production. Diseases are also more prevalent.

To cope with the challenges imposed by the change in climate, measures to reduce anthropogenic contribution to climate change must be put in place and strictly adhered to. The worst thing that a nation can face is not economic collapse or conquest by a totalitarian government. As catastrophic as these may be, the nation can recover within not too many years. Loss of genetic and species diversity as a result of anthropogenic activities will take several generations to recover from and however much we try, nature is always steps ahead of us ,in other words every time we try to alter nature, the backlash will manifest in other forms. To this end, conservation of the country's plant genetic resources and biodiversity is a national concern that involves the entire population, organizations, communities, private companies and the various government outfits across the country.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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