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Indigenous Management Of Plant Genetic Resources In Nigeria-A Review.

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Abstract

Nigeria is rich in plant genetic resources (PGR) in natural habitats and diverse crop landraces/cultivars. The diversity of crops in Nigeria is reducing because diversity loss rate is more than collected and conserved. The participants in PGR preservation in Nigeria are Institutes of Research, Academic Institutes, NGOs, National Reserves, Wildlife Sanctuaries and National Centre for Genetic Resources and Biotechnology (NACGRAB). NACGRAB is the national centre of activity for PGR management in Nigeria. Nigeria, one of the gene-rich nations, faces the problem of preserving its natural history, while developing advantageous mechanisms for exchanging germplasm with other nations. The scheme of the Centre includes: exploration, collection and management of very important diversity of species. It also has the responsibility to carry out quarantine services, and has linkages with international organisations of the Consultative Group of International Agricultural Research (CGIAR), to accomplish its mandate. NACGRAB holds up to 10,000 genotypes of species conserved in its limited and durable germplasm, as live collections (*in situ* and *ex situ*). Copies of Guinea-Corn (*S. bicolor*) are reserved in the sectional seed repertoire of International Crops Research Institute of Semi-Arid Tropics (ICRISAT), and Sahelian Centre in Sadore, Niamey. Researchers, students and farmers from various parts of Nigeria access this germplasm. However, there is a wide gap in the knowledge of the genetic diversity of crops, owing to lack of up-to-date documentation. Only a fraction of the rich natural endowments of the nation's genetic resource is conserved at NACGRAB, and sister institute focuses on their mandate crops. The system has contributed immensely towards safeguarding the indigenous, and introducing useful exotic PGR for enhancing food and nutritional security. This paper focuses on PGR management strategies in Nigeria, the successes and pitfalls of NACGRAB, in comparison with global standards.

Key words: Indigenous, Germplasm, Management-strategies, Genetic-Resources, Biological-diversity

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1.Introduction

Plant Genetic Resources (PGR) is defined as the genetic material of plants having value as a resource for present and future generation (Singh *et al*., 2020). Plant Genetic Resources is the reproductive or vegetative propagating material of cultivated varieties (in use and newly developed varieties) obsolete, landraces, wild and weed species, special genetic stocks of elite and current breeder's lines and mutants (Salgotra *et al* 2019; Salgotra and Bhagirath 2023). The Convention for Biological Diversity (CBD) referred genetic resource to be any "genetic material of actual and potential value", and genetic material to be a"functional unit of heredity".

According to CBD (2019), PGR includes materials that are deemed to be of systematic value applicable to cytogenetic, phylogenetic, evolutionary, physiological, biochemical, pathological, and ecological research and breeding. PGR are the building blocks for the improvement of agricultural and industrial crops, and the agro-processing sector (Ogbu *et al*., 2019). PGR are the pillars upon which world food security depends, especially, with expanding global population (Ogwu *et al*. 2014; Salgotra *et al.*, 2019). It constitutes a rich combination of genes of agronomically important traits having potential for improving plant yields, and combating biotic and abiotic stresses to which plants are exposed under field condition during their life cycles (Abiwon, 2017). The environment for PGR development and bioresource production are shifting, due to the rising global need for food and bio-based renewable resources like biofuels.

The agricultural sector's Gross domestic product (GDP) of many developing countries, relies sustainably on the rich wealth of its plant genetic resources (Ogbu, 2014; Ogbu *et al*., 2019; Osuagwu *et al*., 2023). To Feed the constantly increasing population, is a great challenge militating against many parts of the world, and the problem is worst in sub-Saharan Africa, especially, in Nigeria, where there has been stagnation and reduction in the agricultural production of small-scale farmers (Anwadike, 2020). Plant Genetic Resource System is a complex system of dynamic interaction in Conserving, improving and sustaining the use of PGR, and components of a complex system is based on relationships among different types of representatives with specific functions within a system (Singh *et al.,* 2021). The various stakeholders in the PGR system, carry out their duties within a framework of legislative regulations, including indigenous groups, research institutes, breeders, private seed firms, curators, collectors, and farmers (Sonnino, 2017; Salgotra *et al*., 2019). New pathways for access to PGR and traditional knowledge (TK), have opened up as a result of international agreements and treaties, rapid advancements in bioscience, especially, biotechnology, and other factors (Anwadike, 2020). Strict controls on access to PGR, and the preservation of biological diversity have been made possible by the Convention on Biological Diversity (CBD) and the World Trade Organization (WTO)/Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The domestication of crop species, and the introduction of new crop varieties, have reduced genetic diversity among genotypes, which has resulted in genetic erosion (Abiwon, 2017; Anwadike, 2020).

1.2 Nigeria and its Plant Genetic Resources

Nigeria is endowed with substantial biological resources, and has a great deposit of genetic resources, and is known worldwide as a country that has great biodiversity of indigenous plants (Abiwon, 2017). The participants in PGR preservation in Nigeria are Institutes of research, academic institutes, NGOs, national reserves, wildlife sanctuaries and National Centre for Genetic Resources and Biotechnology (NACGRAB) (Ogbu, 2014; Abiwon, 2017). However, NACGRAB, established by the Federal Ministry of Science and Technology in 1987, is the national focal point for genetic resource management conservation, and relevant matters relating to research, data collection and dissemination of technological information on PGR in Nigeria (Ogbu, 2014; Abiwon, 2017). CGIAR is the largest consortium of crop-oriented research facilities in the world with 15 international centres (CIAT, CIMMYT, ICARDA, ICRISAT, IITA, IRRI) concentrating on major crops of importance to world food security (Singh *et al.,* 2021). In Nigeria, NACGRAB and other sister institutes, has been mandated to properly manage and conserve plant genetic resources. Being a big agrarian country, Nigeria has 18 National Agricultural Research Institutes, 12 of which have responsibility (mandate) for research on the agronomic and genetic improvement of specific crop plants (FAO, 2019).

1.3 Floristic and Economic Plant Diversity of Nigeria

Nigeria is one of the largest countries in West Africa, and has a land area of approximately 91.07 million ha. Nigeria's territorial area spans from latitude 4°14'N to 13°48'N, and from longitude 2°42'E to 14°40'E (Ogbu, 2014; Abiwon, 2017). The country is a physically, climatically and biologically diverse one. Reports by Federal Environmental Protection Agency (FEPA), showed that the floristic diversity in Nigeria comprised of 4903 species of angiosperms, 32 species of gymnosperms, 155 pteridophytes, 80 species of bryophytes, 784 species of algae, 3423 species of fungi and more than 500 species of viruses as reported by (Ogbu, 2014; Ogbu *et al*., 2019; Abiwon, 2017). According to Priyanka *et al*. (2021), reports also has it that 20 species of plants had become extinct since 1950, and 431 species are endangered, 45 species classified as rare, 20 species vulnerable, while 305 species are endemic.). Essentially the country encompasses three major ecological regions, *viz*: a humid tropical forest region, a sub-humid region with highland and a semi-arid region; with annual rainfall ranging from 250 mm in the Sahelian north to over 3000 mm in the southern coastal areas as reported by (Ogbu, 2014; Ogbu *et al*., 2019; Abiwon, 2017). Ogbu (2014), reported that in some areas of the country (Kano, Kaduna, Bauchi, Plateau and other similar states), the harmattan wind from Saharan desert results in a mild cold dry winter, and permits the growth of winter crops, such as, wheat and cold loving vegetables crops. Agriculture is strategic to the Nigerian economy supplying food and contributing to wealth creation and poverty alleviation (Abiwon, 2017). From a long time, it has been understood how important it was to preserve genetic material *in situ* in Nigeria. As such, a plan was devised that included: a) conservation areas/forest reserves; b) protected areas/wetlands; c) parks; d) natural reserves; and e) strict natural reserves; hence, the Forestry Management System, which contains numerous species with traditional culinary, medicinal, or cultural significance, provided the foundation for the majority of *in situ* conservation in Nigeria. Only about 10% of Nigeria's land area is still covered in forests, and despite the country's 3.0% population growth, 3.5% annual deforestation rate, and the increasing rate at which some State Governments are de-reserving forests, no serious efforts are being made to ensure *in situ* conservation. In the past twelve years, Nigeria has made some headway toward the *ex-situ* conservation of plant genetic resources for food and agriculture (Table 2).

Ogbu (2014), reported that out of the about 70 economic crop species grown across Nigerian arable lands, 35 food crop species account for most of the foodstuff that the people consume daily. In order to prevent vulnerability of crop species and genetic erosion, there is need to preserve and sustainably utilize these valuable collected germplasms. According to Scholarly Community Encyclopaedia (2019), in the process of domesticating crops, many plants have been selected for quantity or quality of their seed, while some have been cultivated for their roots, tubers, fruits, stems and leaves. Plant Genetic Resource Food and Agriculture special reserves popularly known gene banks that have been established since the middle of twentieth-century (FAO, 2019). There are more than 17,000 national, regional and international institutes and organizations dealing with the conservation and sustainable use of PGRFA (FAO, 2019). With over 5.4 million accessions from over 7051 genera currently held by 711 gene banks and 16 international/regional centres in 90 countries, crop species, including landraces and crop wild relatives, breeding materials, and cultivars, are the main focus of these organizations' conservation efforts (WIEWS, 2020). Cereals make up around 45% of the accessions preserved as seeds, i.e., wheat (*Triticum aestivum*), rice (*Oryza sativa*), Oat (*Avena sativa*), rye (*Secale cereale*), barley (*Hordeum vulgare*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), and beans (*Vigna unguiculata*) followed by food legumes (15%), forages (9%) and vegetables (7%) (FAO, 2019). On the other hand, a large number of food crops are not storable through seeds and therefore, needs an alternative method of conservation (Rajasekharan *et al*., 2015). This group of plants includes significant species that produce desiccation-sensitive, recalcitrant, or intermediate seeds, including edible banana (*Musa spp.),* garlic (*Allium sativum*), avocado

(*Persea americana*), coconut (*Cocos nucifera*), cacao (*Theobroma cacao*), and cacao (*Theobroma cacao*) (Rajasekharan *et al.,* 2015). This group also includes species with protracted life cycles that take years or decades to breed, such as yucca (Yucca sp.) and bamboo (*Bambuseae sp*.). Other species, such as root and tuber crops, such as potato (*Solanum tuberosum*), cassava (*Manihot esculenta*), yam (*Dioscorea spp*.), taro (*Colocasia esculenta*), and several fruit and nut trees, also produce orthodox seeds, but need to preserve specific gene combinations or genotypes.

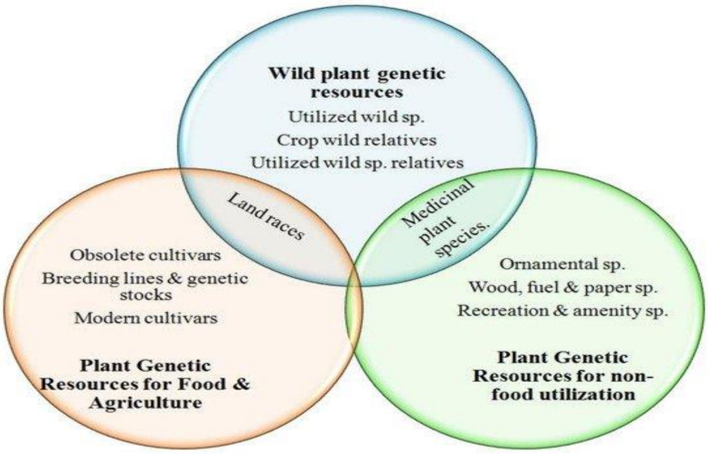

FIG. 1. Aspects of Plant genetic Diversity of Nigeria (Source: Ogbu, 2014)

1.4 Importance of Plant Genetic Resource

PGRFAs (plant genetic resources for food and agriculture) are crucial for ensuring sustainable crop production, wholesome food security for people, and increased economic prosperity for both the present and the future. They comprise the sum of genes, gene combinations or genotypes which serve as a reservoir for direct use in food production systems and for breeding new varieties (Panis *et al*., 2020) (figure 1). **Environmental problems and robust population growth, has made it very important that the left-over crop genetic resources are kept available to sustain the agricultural production systems, to feed a healthy diet and tackle future demanding challenges (Panis *et al*., 2020).** Plant genetic resources provides wealth, food, fibre, fuel, medicine, therapeutics, pharmaceuticals, phytoremediation, cosmetics, water regulation potential, soil erosion and degradation prevention, allows the development of sports, recreation, ecotourism and agriculture (FAOSTAT, 2015). According to Agrodiversity Index (2019), PGR can be categorized into 3 pillars of importance viz;

- 1) Markets and consumption plant genetic resource for healthy diets
- 2) Production for sustainable agriculture plant genetic resource and
- 3) Plant Genetic Resource in genetic resource management for future options(Figure 1).

Those who breed plants use genetic diversity to create improved crop varieties with important gene of interest, such as yield, resistance to pest, diseases and environmental stress (Osawaru, 2016). Plant Genetic Resources support the ability of agriculture to cope with changes, whether environmental or socio-economic, and provide the raw material for improving the production of better feed for livestock, fibres, textiles and energy (Bretting 2018). On the one hand, unanticipated changes in climatic parameters are likely to endanger the yield and efficiency of highly profitable plant species, especially, that of food crops, while on the other hand, agricultural productivity needs to be significantly increased to meet the anticipated increase in demand for food by the growing global population in the years ahead (Salgotra *et al*., 2015; Salgotra *et al.*, 2019). As reported by Bansal *et al*. (2014), efforts have been made since long to collect, conserve and evaluate plant genetic resources (PGRs), to support the plant breeders with diverse genetic materials, to widen the genetic base, and to create new crop varieties, although there are 240000 species of plants estimated to grow on earth, yet only 25–30% of them is used for human consumption, and of these, rice, wheat and maize together constitute about 75 percent of global grain production (Ajiboye and Atoyebi, 2020). Conservation, multiplication, management and sustainable utilization of the existing PGRs, which comprise traditional varieties and modern cultivars, landraces and crop wild relatives, are essential to combat not only food shortage but also to safeguard potentially vital traits that could be used as weapons against an unexpected future pest and climate change. (Abiwon, 2017). Greater emphasis will have to be placed on evaluation for resistance to biotic and abiotic stresses and on properties such as adaptability, plasticity, and resilience, which can help maintain productivity under changing environmental conditions (Abiwon, 2017). Despite the advancements in modern technologies, research strategies for developing climate-resilient cultivars are scanty though integrated strategy based on molecular breeding and genetic engineering approaches to manage PGR is gaining momentum (Salgotra *et al.,* 2015), hence, there is an urgent need to accelerate research efforts to harness the genetic potential of PGRs in general, and specifically, the wild or alien gene pool by pre-breeding and by modern genomics approaches to develop superior stress-tolerant cultivars (Salgotra *et al.,* 2019).

1.5 Aspects of Plant Diversity Depletion and Extinction in Nigeria

More than 90% of crop varieties have vanished from farmers' fields as a result of the expansion of industrial mono-cropping and the replacement of landraces by modern breeding varieties, as reported by (Ogbu, 2014; Ogwu *et al*., 2014; Ogbu *et al*., 2019; Salgotra *et al*., 2015). However, this loss of plant genetic diversity has resulted in the loss of 75% of plant genetic diversity (Figure 2).

The causes of these gradual but steady loss of native natural bioresources in general, and PGR in particular, have been identified to include overexploitation, massive deforestation and desertification, paucity of institutional frame work to engage in deliberate conservation of PGR of relevance to food and agriculture, neglect of useful indigenous plants and other factors. (Ogbu, 2014; Osawaru, 2016). According to (Abiwon, 2017; Bretting 2018; Salgotra *et al.,* 2019**),** Nigeria's PGR is seriously under the threat of depletion and extinction, as so many species are endangered (Figure 2), with the frequent increase in the prices of petroleum products, which have made a lot of people to resort to the use of the cheaper and more steady fuel-wood.

Depletion and extinction of Plant Genetic resources in Nigeria is due to:

- ✓ Industrialization, urbanization and economic development
- ✓ rapid deforestation
- ✓ Crude oil exploration and exploitation
- ✓ Climate change
- ✓ Bush burning, over hunting, road and residential building construction and uncontrolled search for food and other non-timber forest products.
- ✓ Land use act and Lack of implementation of government policies
- ✓ Impunity

As we cannot do without exploiting the available bioresources to our advantage, according to Bretting (2018) and Anwadike (2020), there has to be a balance between uses of resources and their conservation. Ajiboye and Atoyebi (2020) and Osuagwu *et al*.(2023), equally, reported that explosive decline of Africa's forests and bioresources is caused by a variety of factors, like civil war, bush burning, building of roads, bridges, and houses, the search for medicine, wildfires, poor management of the land currently available, unrestricted hunting for food, fuel wood, construction timber, overgrazing by cattle, the eradication and loss of landraces, lower yielding varieties, pests and diseases, pollution, acid rain, and incomplete understanding of the biology of many plants, especially, the propagation genetics aspect and adaptability of many forest plants, among many others (Figure 2).

FIG. 2: *Trichosantes cucumerina* (a genetic resource) seriously endangered (Osuagwu *et al*., 2023)

There must be a balance between resource use and conservation, because humans cannot survive without using the available bioresources to our advantage (Bretting 2018); and it is important to protect these naturally occurring resources, because they not only benefit humans, but also perform a number of ecological tasks like preventing floods, reducing soil erosion, preventing landslides and hurricanes, maintaining water quality, improving the climate, and preventing desertification (Osawaru, 2016; Salgotra *et al*., 2019; Aavik *et al*.,2021).The richness of plant and animal diversity in Nigeria is a major asset in agricultural development, hence, the conservation of such resources is fundamental to the progress and usefulness of biotechnology (Abiwon, 2017; Anwadike, 2020). Over the several millennia of human existence on earth, Plant Genetic Resources (PGR) had constituted the basis of development and sustainability of agricultural production systems. Biodiversity International (2019), reported that currently, only 30 cultivated plant species provide 90 % of all the human food obtained from plants, while 12 plant and 14 animal species together provide 70 % of the world human diet. Extinction of genetic resources and PGR, in particular, has been a naturally occurring phenomenon over millions of years, without any human involvement (Osawaru *et al*., 2013; Abiwon, 2017). According to a recent CTA report on agrobiodiversity, 75 % of all known crops have disappeared in the past century, but on the other hand, the United Nations FAO has projected that unless the spiral loss of genetic diversity is controlled, about 60,000 plant species (quarter of the world plant capital) might be lost by 2025 (Ogbu, 2014). This report on indigenous management of Plant Genetic Resources presents an awareness of the Nigerian situation and trends regarding the conservation and use of plant genetic resources (Ogbu, 2014; Ogbu *et al*., 2019).

2. Institutes for Indigenous management and Conservation of National Plant Genetic Resources

Plant genetic resources systems typically comprise of acquisition, maintenance, characterisation and evaluation of genetic resources; in addition to deliberate strategic conservation and documentation of the viability and genetic integrity of such materials, in order to facilitate their use by providing access to samples of the materials and associated information (Salgotra *et al* 2019). The collection, characterization, evaluation, conservation and use of PGR are enormous tasks, especially, in a country like Nigeria, (Figure 3) which has a vast heritage of these bioresources (Borokini *et al*., 2020; Ogbu, 2013; Abiwon, 2017). A large number of agronomic, horticultural and plantation plants are grown in the country due to different agro-climatic factors and socioeconomic cultural needs (Ogbu *et al*., 2019). These crops vary greatly in terms of their modes of reproduction (seed vs. vegetative propagation), seed storage habits (orthodox vs. recalcitrant), growth patterns (annual vs. perennial), adaptability, uses (as staple food crops, fruit, vegetables, ornamentals, plantation crops, medicinal and aromatic plants), agro-technology, and commercial value (like cash crops, staple food crops, minor and under-utilized), among other characteristics (Uyoh *et al.*, 2013).

Keeping in view the enormity and diversity of the task involved, networking approach is essentially required among the relevant National Agricultural Research System (NARS) with plant-based research and development mandates in the country (Ogbu *et al*., 2010) (Table 1).
Such networks include National Horticultural Research Institute—NIHORT, National Root Crops Research Institute—NRCRI [cocoyam, yam, potato, sweet potato, ginger, turmeric], Nigeria Institute for Oil Palm Research—NIFOR [coconut, oil palm, date, ornamental palms], National Centre for Genetic Resources and Biotechnology (NACGRAB), Forestry Research Institute of Nigeria (FRIN) [for inputs on conservation/domestication of certain important indigenous fruit trees, aromatic and medicinal plants, as well as the forest trees] and other organization that share similar interest in PGR and biodiversity management (Ogbu *et al* 2013; Ajiboye and Atoyebi 2020). With reference to organisations in Nigeria that have plant biotechnology activities (including conservation biotechnology of plant genetic resources), there are several of them ranging from government owned, CGIAR owned and privately owned institutions (Ogbu, 2014; Ogbu *et al*., 2019; Osawaru *et al*., 2016).

Table 1. Some National Agricultural Research Institutes with plant-based mandates and similar institutions relevant to PGR conservation

NACGRAB—National Centre for Genetic Resources and Biotechnology Ibadan
NIHORT—Nigerian Institute of Horticultural Research Ibadan
IART—Institute of Agricultural Research and Training Ibadan
NIFOR—Nigerian Institute for Oil Palm Research Benin City
NABDA—National Biotechnology Development Agency Abuja
NRCRI—National Root Crops Research Institute Umudike
NCCRI—National Cereal Crops Research Institute Badegi
CRIN—Cocoa Research Institute of Nigeria Ibadan
FRIN—Forestry Research Institute of Nigeria Ibadan
IAR—Institute of Agricultural Research Samaru Zaria
RRIN—Rubber Research Institute of Nigeria Benin City
NPQS—Nigerian Plant Quarantine Services Moor Plantation Ibadan
NISLT—Nigerian Institute of Science Laboratory Technology Ibadan

Source: Ogbu (2014)

2.1 Strategies for Conservation and management of Plant Genetic Resources

Intentional ex situ conservation of crop germplasm for food and agriculture began in Nigeria about 3 decades long with the establishment of the National Bureau for Plant Genetic Resources, Ibadan being established under the Federal ministry of Science and Technology. The naming of the centre was later exchanged to the National Centre for Genetic Resources and Biotechnology (NACGRAB) to catchup with the erupting problems in conservation of germplasm, particularly through in vitro means, DNA fingerprinting and cryopreservation (FAO, 2018). 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 carter in Nigeria for plant genetic resource management and relevant matters relating to research, data collection, conservation and dissemination of technological information (Abiwon, 2017). NACGRAB has a working relationship with NPQS and International Organisation like Biodiversity

International, FAO, UNDP, IPGRI, CGIAR, IITA, NARI etc. The national focal point for genetic resources, the National Centre for Genetic Resources and Biotechnology (NACGRAB), has commissioned many collection missions, undertook stock inventorization, viability monitoring, as well as evaluation and characterization of germplasms (Bako, 2022). In addition, National Agricultural Research Institutes (NARIs) were encouraged to have a genebank for collections of their specific mandate crops (FAO, 2020). Germplasm is exchanged freely within the National Agricultural Research System (NARs), as well as with the International Agricultural Research Centres present in the country, and the materials have been used almost exclusively in research to develop elite varieties that have been released (Smith *et al*., 2021). With the realization of the Government of Nigeria that plant genetic resources are valuable and makes up a major material having great capacity to yield dividends, it was to this effect that the parastatal called, NACGRAB was created to make sure that collating, conserving, preserving, utilizing and maintaining of valued traits for developing agriculture were carried out (Ogbu, 2014; Ajiboye and Atoyebi 2020) (Table 2). Genetic species under conservation in NACGRAB arena, could be grouped in accordance with the way and manner they are used (Ogbu, 2014; Ogwu, 2014; Ajiboye and Atoyebi 2020) (Table 3). In addition to regular PGR-related short-term training courses, efforts have been made to introduce PGR into the curriculum of selected Universities and Faculties of Agriculture (Begna, 2022). NACGRAB has a cordial working interplay with relevant multinational and Regional Organizations such as IITA, WARDA, CIMMYT, AVRDC, ICRAF and ICRISAT, where information is shared (Olajire, *et al*., 2015; Abiwon, 2017). However, a "National Environment (Conservation of Biodiversity and Resources), access to Genetic Resources and Benefit Sharing) Regulations within which access and benefit sharing is embedded, has been drafted, and efforts to pass it into law has reached an advanced stage (Borokini *et al* 2020; Olajire, *et al*., 2015; Abiwon, 2017; NACGRABS Review 2020)

Nigeria's various agroecosystems, from the humid south to the Sahel savanna region of the north, are home to a vast number of underdeveloped (but valuable) indigenous plant resources (Ogbu, 2014; Ogbu *et al*., 2019). In line with this assertion, (Ogbu, 2014) stated that there were about 95 fruit species belonging to 32 botanical families which are home to the flora of Nigeria. This is beside the array of traditional vegetables, medicinal plants, spices and condiment plants, field crops and forest trees that are almost being overshadowed by exotic species commonly cultivated alongside with these local species (Ogbu, 2014; Ogbu *et al*., 2019). However, many of these local species have not been substantially developed up to commercial scale cultivation, exploitation and deliberate conservation (Bako, 2022). The largest international organization in the world, the International Plant Genetic Resources Institute (IPGRI), was founded with the goal of advancing plant genetic resource conservation and utilization (Salgotra *et al*. 2019). According to Bretting (2018), it encourages, supports and undertakes activities to improve the management of genetic resources worldwide, so as to help eradicate poverty, increase food security, and protect the environment. IPGRI has a clear commitment to particular crops, and focuses on the protection and use of genetic resources that are significant for poor countries (Fowler *et al*. 2016; Bretting, 2018). The CGIAR is the largest consortium of crop-oriented research facilities in the world, concentrating on major crops of importance to world food security (Fowler *et al*. 2016).

By coordinating the operations and meetings of the National Committee on Registration and Release of Crop Varieties and Livestock Breeds in Nigeria, NACGRAB, supported by Decree No. 33 of 1987 (now Act of Parliament, 2016), also governs the seed and livestock sectors (NASCA, 2019). In January 2022, the National Crop Varieties and Livestock Breeds Registration and Release Committee (NVRC), released 49 high-yielding crop varieties of 11 crops, submitted for registration and release by Nigerian research institutes and seed companies. According to the report of Ajiboye and Atoyebi (2020), NACGRAB holds up to 10,000 genotypes of species conserved in its limited and durable germplasm, as live collections (in-situ and *ex-situ*), and copies of Guinea-Corn (*S. bicolor*) are reserved in the sectional seed repertoire of International Crops Research Institute of Semi-Arid Tropics (ICRISAT) Sahelian Centre in Sadore, Niamey (Table 3 & 4). Efficient conservation of plant genetic resources can best be achieved through an appropriate combination of *in situ* (in natural or original areas) and *ex situ* (in artificial habitat or habitat different from the original one) methods (Osawaru and Ogwu 2016), and Panis *et al*. (2020), two main *ex situ* conservation approaches can be distinguished for these crops: the conservation of plants in field gene banks, and the maintenance of propagules in tissue culture, either (i) as active growing cultures in short- and medium-term storage (i.e., in vitro storage), or (ii) in frozen state at ultra-low temperature in liquid nitrogen for long-term storage (cryopreservation).

Table 2. Institutions Involved in Plant Genetic Resources Biotechnology in Nigeria

Institutions/funding agent	Main activities
International Institute of Tropical Agriculture (IITA)—Tissue Culture Laboratory: CGIAR funded	Conservation, micro propagation and distribution of banana/plantain, cassava, and yam; training.
National Centre for Genetic Resources and Biotechnology (NACGRAB): Federal Government	Research, training and consultancy on PGR and their *in vitro* multiplication and Conservation.
National Root Crops Research Institute (NRCRI)—Plant Tissue Culture and Molecular Biology Laboratory: Federal Government	Micropropagation of root and tuber crops; Training and extensions.
Nigerian Institute of Horticultural Research (NIHORT)—Tissue Culture Laboratory: Federal Government	Micropropagation and distribution of improved horticultural crops planting materials
Institute of Agricultural Research and Training (IAR&T)—Tissue Culture Laboratory: Federal Government	Tissue culture of some crops including cassava, fluted pumpkin and yams
Forestry Research Institute of Nigeria (FRIN)—Biotechnology unit: Federal Government	Development and distribution of improved vegetatively propagated cuttings of economic forest species
University of Ibadan (UI)—Department of Agronomy: Federal Government	Protocol development for *in vitro* propagation of selected crops
Nigerian Institute for Oil Palm Research (NIFOR)—Tissue Culture Laboratory: Federal Government	Development of improved planting materials of mandate research crops and provision of extension and consultant services
University of Jos (UJ)—Tissue Culture Laboratory: Federal Government	Development of protocol for *in vitro* propagation of selected crops
Ahmadu Bello University (ABU)—Biotechnology Centre: Federal Government	Protocol development for *in vitro* propagation of selected crops
Sheda Science and Technology Complex (SHESTCO)—Biotechnology Advanced Laboratory: Federal Government and International Donor agencies	Development of protocols for genetic transformation of some indigenous plants; Micropropagation and distribution of acacias banana/plantain, cassava, pineapple
Jigawa Research Institute (JRI)—Tissue Culture Laboratory: State Government	Production and distribution of improved planting materials of banana/plantain, cactus, date palm, pineapple and sugarcane; Agricultural extension services
Biocrops Biotechnology Limited (BIOCROPS): Private funding	Contract micropropagation of planting materials of plantation crops
Molecular Bioscience Limited (BIOSCIENCE): Private funding	Micropropagation of plantation crops and medicinal plants
University of Nigeria, Nsukka (UNN)—Tissue Culture Laboratory: Federal Government	Protocol development for *in vitro* propagation of selected crops
University of Maiduguri (UNIMAID): Federal Government	Protocol development for *in vitro* propagation of selected crops
University of Port Harcourt (UNIPORT): Federal Government	Protocol development for *in vitro* propagation of selected crops

Source: Ogbu (2014)

There is the risk of losing some of these plants due to industrialization and urbanization, characterized by rapid deforestation, uncontrolled logging, burning and uncontrolled search for food and other non-timber forest products (Bretting, 2018) Many of these plants constitute an important component of the diet in many West African countries (Eg. *Gnetum africanum,* *Treculia africana* (breadfruit), *Irvingia gabonensis*) and costly timbers (eg. *Diospyros mespiliformis* (iroko), *Entandrophragma cylindrical* (mahogany) and *Chlorophora excelsa*) (Borokini *et al* 2020; Olajire, *et al*., 2015; Ogbu, 2014; Abiwon, 2017; Ogbu *et al*., 2019). However, Plant tissue culture provides a method for mass clonal propagation of such materials, as well as serving as a tool for their germplasm conservation. (Panis *et al*., 2020; Priyanka *et al*., 2021).

2.2 Conservation Strategies by NACGRAB In Nigeria

Seeds hold the genetic potential of every crop plant, as it is critical for increasing agricultural productivity, reducing food insecurity and poverty (Abiwon 2017)
NACGRAB has three (3) germplasm conservation facilities

1. Seed germplasm
2. Field germplasm
3. *In Vitro* germplasm

The Seed Genebank unit of NACGRAB is where the acquiring, managing, regeneration, characterising, conserving and utilisation of orthodox seeds occur. i.e seeds that can be dried to low levels of moisture content and stored at low temperature over a long period of time without losing viability. Eg rice, maize, sorghum, millet etc. (Olajire, *et al*., 2015; Abiwon, 2017).

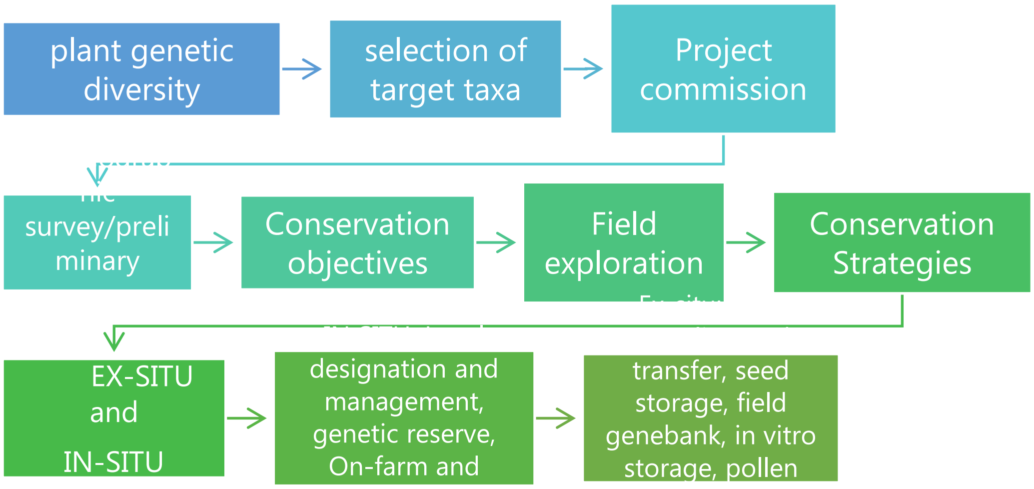

FIG. 3: A Model of General pipeline of Plant Genetic Conservation program **(**Source: Priyanka *et al*., 2021**)**

The Seedbank area has 2 instruments of storage: i. A synthetic long time storage room maintained at -20˚C and relative humidity of 10%. **ii.** A modified room for short time storage maintained at 15˚C and 30% relative humidity**.** The Field Gene bank is responsible for conserving recalcitrant seeds (i.e seeds that cannot be preserved over a long period) and vegetatively propagated seeds (Olajire, *et al*., 2015; Abiwon, 2017). The *in vitro* Gene bank is under the Biotechnology unit of NACGRAB. The unit was established in 1999 to handle issues relating to R&D in micropropagation, multiplication and authentication of plant genetic resources (Abiwon, 2017; Bako, 2022).

The *in vitro* gene bank arena is split into 2 laboratory compartments:

i. **Tissue culture LAB** where propagation and conservation of indigenous and exotic plant species using their organ, seed, buds, meristem and shoot tip culture takes place. (Abiwon, 2017).The objectives of tissue culture laboratory at NACGRAB are: ---Germplasm conservation, storage and production of disease-free plantlets ---Multiplication of PGR and development of protocols for the conservation maintenance and commercial propagation of selected cultivars, superior hybrid of indigenous agronomic plants and tree crops. --Training of personnel and students (Abiwon, 2017).

ii. The molecular biology lab: At the Molecular Biology Laboratory NACGRAB enhances characterisation by introducing DNA extraction and finger printing. The procedure includes Sample collection, DNA isolation, Cleansing/purification, Quantification using Nanodrops, Gel Electrophoresis and Application by polymerase Chain Reaction (PCR) (Abiwon, 2017).

Legend:

Target: Series 1→ Characterisation/identification.
Series 2→ Conservation/multiplication.
Series 3→ Evaluation/enhancement

Applications: Series 1→ Protein analysis, DNA analysis, diversity assessment.

Series 2 → Clonal multiplication, artificial seed production, distribution of materials, exchange of materials, plant health screening.

Series 3 → Cryopreservation, DNA Genebank, *in vitro* conservation, micropropagation, virus indexing.

Relevant techniques: Series 1 → Genetic, fingerprinting, isozymes, AFLP, RAPD, RFPD, SSR, and so on. Series 2 → Cryopreservation, DNA Genebank, *in-vitro* conservation, micropropagation, indexing. Series 3 → Anther culture, embryo rescue, genetic map, QTL mapping.

Table 3. Selected Crop collections according to utilization potentials

Utilisation potential	Crop species
Indigenous vegetables	*Talinum triangulare, Telfairia occidentalis, Occimum gratissimum, Vernonia amygdalina* etc.
Indigenous and lesser exploited fruit trees	*Tamarindus indica Spondia mombin, Treculia africana, Tetrapleura tetraptera* etc.
Medicinal herbs	*occimum gratissimum, Neem(Azacdirachta indica) etc.*
Invasive Aliens	*Tithonia diversifolia, Chromolaena odorata* etc.
Endemic	*Aspilia africana, ageratum conyzoide* etc.
Mysterious and superstitious	*Adansonia digitata, Crotons zambesicus, Erythrophleum suaveoliens.*

Source: (Ajiboye and Atoyebi, 2020)

Table 4. SUMMARY OF THE COTYLEDONS' PRESENCE IN NACGRAB'S FIELD GENEBANK

S/N	Cotyledons	Total Number	Percentage
1	Monocotyledonous	62	17. 2%
2	Dicotyledonous	292	80.9%
3	Pteridophyte	4	1.1%
4	Gymnosperm	3	0.8%
5	Total	361	100%

0)

Source: (Ajiboye and Atoyebi, 2020

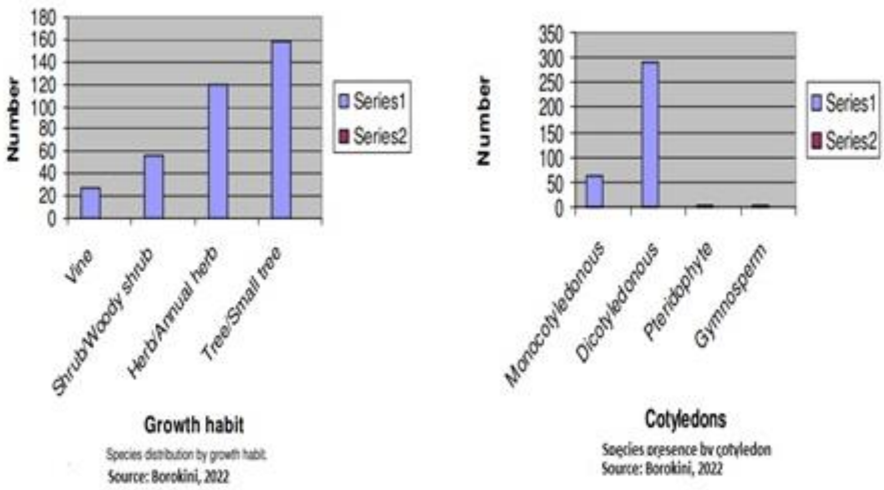

Figure 4: Growth habit and cotyledons presence

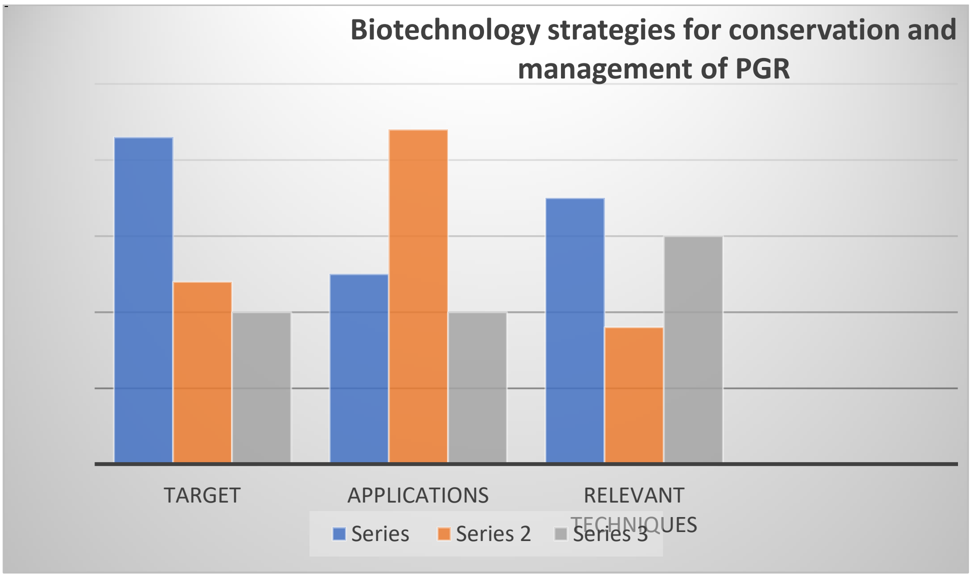

FIG. 5: Strategies for conservation and management of PGR (Source: Salgotra and Bhagirath 2023)

2.3 NACGRB'S Biotechnology Approach for Indigenous Management of Plant Genetic Resources

The development of *in vitro* culture technology, cryopreservation, and molecular markers technology, as well as traditional understanding of germplasm and their useful utilization in an efficient manner, have all significantly improved methods of conserving rare and endangered plant genetic resources (Table 3). Players involved in PGR conservation argue that the best way to conserve plant genetic resources is by combining traditional *ex situ* and *in situ* techniques with contemporary biotechnological applications, to get a comprehensive managerial outcome (figure 5). Given the variety and complexity of threats to biodiversity, a single approach, such as seed bank, legal protection for species or the acquisition of land for field gene bank, is unlikely to be successful (Panis *et al*., 2020; Priyanka *et al*., 2021).

Generally, plants with orthodox seeds (high tolerance of low temperature storage conditions) are best preserved *ex situ* under medium- or long-term conditions, as comparatively dry seeds stored at low temperatures (Panis *et al*., 2020; Singh *et al*., 2021). Plants that produce recalcitrant seeds (intolerant of desiccation and low temperatures) could be preserved as *ex situ* live-gene banks (or gene libraries) or by *in vitro* conservation methods of enforced reduced

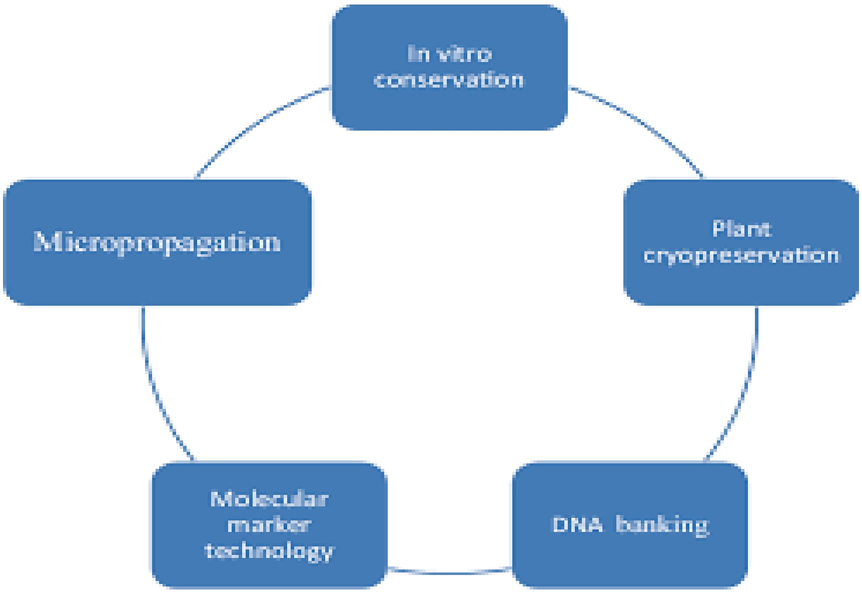

FIG. 6: NACGRAB'S Tools for Conservation and Use of PGR (Source: Abiwon, 2017).

growth storage (Abiwon 2017; Singh *et al.*, 2021; Priyanka *et al*., 2021). Essentially, modern conservation biotechnology approach is an off-shoot of *ex situ* conservation techniques, although in Nigeria, it is presently been given special detailed attention because of its versatility, economy of space and wide range applications (Osawaru and Ogwu 2016). According to (Nnamani *et al*., 2017; Ogbu *et al*., 2019: Tanwy *et al*., 2022), however, conservation biotechnology should not be seen as a substitute to conventional conservation techniques, but a complementary tool. Conservation biotechnology studies the use and management of biodiversity present in natural and manipulated ecosystems (including agroecosystem) (Table 4) by biotechnology logical applications, in order to guarantee their renewal, conservation and productivity, provide benefits and opportunities for present generation and posterity (Anwadike, 2020; Smith *et al*., 2021). There are a wide range of technologies offered in conservation biotechnology for use in plant genetic resources, and biodiversity management for food and agriculture, which included *in vitro* conservation, cryopreservation, DNA banking, micropropagation and molecular marker technology (Figure 6) (Abiwon 2017; Ogbu *et al*., 2019; Anwadike, 2020; Smith *et al*., 2021). The various biotechnology tools can be used to achieve plant genetic resources objectives, such as, conservation and clonal multiplication, characterisation and identification, as well as evaluation, selection, enhancement and distribution among others (Ogbu, 2014; Ogbu *et al*., 2019; Anwadike, 2020).

2.3.1 *In Vitro* Conservation Techniques

To tackle the challenges faced by vegetatively propagated plant and recalcitrant seeds, *in vitro* conservation techniques have been increasingly used by NACGRAB, NIHORT, NRCRI BIOCROP Biotechnology and institutes such as UNIJOS, UNN, UNIPORT, UI etc. for conservation and its related activities like collecting and exchange of germplasm of these problem species (Ogbu 2014; Ogwu *et al* 2014; Ajiboye and Atoyebi 2020). *In vitro* meristem culture technique offers the possibility of eliminating viruses and thus, exchange of virus-free germplasm. By using *in vitro* slow/normal growth procedures, it is possible to store genetic material for up to a few years without running the danger of losing it to pests, nematodes, disease, or natural disasters. It is commonly used for vegetatively propagated species, nonorthodox seeded species and wild species which produce little or no seeds (Ogbu 2014; Panis *et al*., 2020), while cryopreservation at ultra-low temperature, usually that of liquid nitrogen (− 196 °C) is the only option currently available for the long-term conservation of these PGR, avoiding exogenous contamination, requiring small space and minimum maintenance. Both *in vitro* conservation and cryopreservation techniques use tissue culture principles for conservation (Panis *et al*., 2020). Subsequently, the technique has progressed from mere speculation to development, and today, it is routinely being used for conservation of vegetatively propagated crops and perennial species. When tissue techniques are employed for conservation, the aim is to devise a medium that would decrease the growth rate of explants to the minimum, thereby increasing the subculture intervals (Salgotra *et al* 2019). The various methods used to achieve this include the following: use of growth retardants, use of minimal growth media, use of osmotic regulators, reduction in oxygen concentration, size and type of culture vessels, type of enclosures, maintenance under reduced temperature and for reduced light intensity and combination of more than one treatment (Ogbu, 2014; Ajiboye and Atoyebi 2020; Panis *et al*., 2020). The apical and auxiliary meristems of very small size being at the right physiological stage are the preferred explants for *in vitro* storage (Ogbu, 2014).

2.3.2. Cryopreservation

Preservation through Cryo means is known as the non-lethal storage of biological tissues at ultra-low ambient in a liquid nitrogen (LN) at − 196 °C (Ogbu, 2014; Salgotra *et al* 2019; Panis *et al*., 2020; Salgotra and Bhagirath 2023). Cryopreservation is a current alternative for long-term conservation of germplasm of vegetatively propagated and recalcitrant seed plants. Due to storage at the temperature of the vapour phase (− 150 to − 180 °C) or liquid phase (− 196 °C) of LN, cell divisions and metabolic activities are arrested and thus, plant material can be stored for unlimited periods of time (Ogbu, 2013; Salgotra *et al* 2019). According to Dhan *et al* (2021), conservation of germplasm using cryogenic approach, required very limited space, and the plant material stored is protected from exogenous contamination, and needs very limited maintenance. It causes no change in viability, vigour and genetic make-up of the conserved materials, and equally eliminates the need to test stored materials frequently, thus making storage cost-effective (Nnamani *et al*., 2017; Dhan *et al*., 2021; Singh *et al.*, 2021), and the explants can include shoot apices, auxiliary buds, dormant buds, somatic embryos, seeds, zygotic embryos, embryonic axes or pollen and the various techniques currently under investigation or in use include: the classical freezing method, encapsulation-dehydration, vitrification, encapsulation–vitrification, desiccation, pre-growth droplet freezing, and pre-growth desiccation (Ogbu 2014).

2.3.3. DNA Bank/Library

In NACGRAB'S Molecular Biology Lab, DNA from the nucleus, mitochondria and chloroplasts, are now routinely extracted and immobilized into nitrocellulose sheets where the DNA can be probed with numerous cloned genes (Ogbu 2014; Panis *et al*., 2020; Salgotra and Bhagirath 2023). With the development of PCR (polymerase chain reaction), one can now amplify specific genes or oligonucleotides from the entire mixture of genomic DNA, and this approach is very simple and cheap (Abiwon 2017; Anwadike, 2020). The exchange of germplasm through DNA sequences is safe, since infestations with pathogens can be easily avoided (Osawaru and Ogwu, 2016; Omonhimin *et al*., 2021).

2.3.4. Micropropagation

The technique of micropropagation involves, *in vitro* micrografting, artificial seed production, somatic embryogenesis, adventitious regeneration, single node culture, meristems culture, anther culture, and axillary branching (Sonnino *et al*., 2017). This technique is utilized in the commercial production of improved virus free planting materials of some economically important crops for distribution to farmers globally (Olajire, *et al*., 2015; Sonnino, *et al*., 2017; Salgotra *et al.*, 2019; Begna, 2022).

In Nigeria, it has also been used by (IITA, NACGRAB, NRCRI, NIHORT FRIN, NIFOR, SHESTCO) to rescue endangered rare plant species from going on extinct due to over exploitation, poor natural regeneration and environmental conditions that are not favourable (Ogbu, 2013; Nnamani *et al*., 2017; Ajiboye and Atoyebi 2020).

2.3.5. Molecular Markers

Molecular markers are used in molecular biology and biotechnology to identify a particular sequence of DNA in a pool of unknown DNA, and it is a fragment of DNA that is associated with a certain location within the genome (Kocaman *et al*., 2020). According to (Salgotra *et al* 2019; Kocaman *et al*., 2020; Panis *et al*., 2020), the technology relies mostly on DNA assay, and there are various kinds of molecular marker systems available for use at present, such as Polymerase Chain Reaction (PCR), Amplified fragment length polymorphisms (AFLPs), random amplified polymorphic DNAs (RAPDs), restriction fragment length polymorphism (RFLP), microsatellites and single nucleotide polymorphisms (SNPs). Guimaraes *et al*. (2018), has fairly treated in detail, the molecular marker biotechnology currently used in PGR as well as livestock and fisheries genetic resources conservation, management and exploitation. Molecular markers are adopted by NACGRAB and other sister institutes in Nigeria to achieve a variety of PGR materialisation (Ogbu, 2014; Edagbo *et al*., 2011), thus, they are used to characterise and conserve genetic resources, for example in the estimation of genetic relationships between populations within a species, measuring genetic diversity of accessions, verifying genetic identity of individuals among provenances; to identify duplicate accessions in crop genebanks; to carry out biological studies of pollen movement and seed dispersal in forest tree populations (Kocaman *et al*., 2020). They are also used in disease diagnosis to characterise and detect pathogens in crops and forest trees. Moreover, they are used widely in modern crop breeding programme through the so-called marker-assisted selection (MAS) (Kushanov *et al*., 2021).

3. NACGRAB's success, prospects and challenges

According to Ajiboye and Atoyebi, (2020) NACGRAB has succeeded in acquiring a large array of indigenous crops across Nigeria, and her germplasm exploration, collection, management and exchanging of same by introduction from other countries has brought about a tremendous availability of genetic materials for breeders, students and farmers to work with in different crop species. There is an event called "Fascination of Plants Day" (FoPD), which comes up every two years, when various biodiversity conservation organizations exhibit plants (Ajiboye, 2020). NACGRAB came first in plant exhibition in the 2019 event that took place at the Federal University of Agriculture, Abeokuta, Nigeria (NACGRAB, 2020).

In his brief review, Ajiboye (2020), reported that the Fascination of Plants Day is a global occasion, consisting of over 1000 events held every two years across the globe. This program is coordinated by EPSO (European Plant Science Organization). The latest collection is 400 lost lines of *Vigna unguiculata* (cowpea) from IITA, with initial evaluation of these lines showing tremendous and promising of variations (Ajiboye and Atoyebi 2020).- As part of the collaborative efforts between the Centre, the National Research Council, and other research institutes, duplicate samples of the germplasm of some of the mandate crops and released varieties collected from the International Institute of Tropical Agriculture (IITA), Ibadan; National Cereals Research Institutes (NCRI), Badeggi; Institutes of Agriculture and Training (I.A.R. T), Ibadan; Cocoa Research Institutes of Nigeria (CRIN), Ibadan; and other research institutes are being maintained accordingly. Plant germplasm has been collected from the International Centre for Research in Agroforestry (ICRAF) and the plant species maintained either as seeds in the storage rooms or in the field as field Environment, Renewable

Natural Resources Management, Research and Development (CENRAD); an NGO located in Ibadan. To date the Centre has a total collection of about 10, genebanks (Ogbu *et al*., 2019; Bako, 2022). The conservation activities of field genebanks on various plant species are being complemented and enhanced through tissue culture techniques, which are methods such as meristem, nodal cuttings, shoot-tip and embryo cultures used often for micro-propagation, rapid multiplication of endangered/under-utilized, exotic and indigenous plant species, root and tuber crops (Olajire, *et al*., 2015; Sonnino, *et al*., 2017; Salgotra *et al.*, 2019; Begna, 2022). Methodologies for disease elimination by meristem culture, micro-propagation, rapid propagation and conservation of endangered plant species, under-utilized crops, indigenous plant species, exotic fruits, root and tuber crops have been developed in the last few months in NACGRAB (Edagbo *et al*., 2011; Ajiboye and Atoyebi 2020).

Among the plants conserved in NACGRAB field with ethnoveterinary uses are A*zadirachta indica, Khaya senegalensis, Vernonia amygdalina, Pilostigma thonningii, Psidium guajava, Zingiber officinale, Carica papaya, Kigelia africana, Citrus aurantifolia, Aspilia africana*, and *Ricinus communis* (Ogbu, 2014; Bako, 2022). Plants conserved in NACGRAB field has potential as recalcitrant, homeostatic, antiseptics, stimulant, tonic, dermal eruptions, inflaming, ulcers, control of parasites, bones, limbs, deformity, rickets, paralysis, epilepsy, spasm, blood disorders, anaemia, pain killers, arthritis, eye and ear treatments, naso-pharyngeal, oral, pulmonary, cholera, liver, gallbladder, spleen, kidneys, anus, menstrual cycle, conception, lactation stimulants, abortifacients, parturition stimulants, venereal diseases, malaria (Edagbo *et al*., 2011; Salgotra and Bhagirath 2023).

3.1. Prospects and Challenges

Conservation and management of PGR for food and agricultural production via biotechnology procedure in Nigeria at present, prove to be a knotty issue among the policy makers and ruling class as the immediate economic gain for such venture is not always readily felt (Abiwon, 2017). The major and daunting challenges for the *ex-situ* conservation efforts in Nigeria are primarily inadequate infrastructure and human capacity (Abiwon, 2017; Ogbu *et al*., 2019 Ajiboye and Atoyebi 2020). Often, the hype and hot debate about genetically modified (GM) crops/food have tended to becloud the potential rich benefits from non-transgenic biotechnologies that can be exploited to boost food production, enhance nutritional security as well as conserve biodiversity, without compromising wholesomeness of the environment now and in the future (Priyanka *et al*., 2021). Granted that the initial capital outlays for acquiring and establishing functional plant biotechnology laboratory, with full complement of personnel and materials resources for conservation of PGR may be rather enormous, in the long run such investment mostly pays off. Moreover, in view of the vagaries of climate change phenomenon and human induced environmental degradation, *vis a vis* the unprecedented negative impacts on biodiversity in general, and PGR in particular, the need for biotechnology approach to conservation of biological resources cannot be regarded as optional or expensive (Ogbu, 2014; Abiwon 2017; Ogbu *et al*., 2019).

3.2 Recommendation

According to Country Report on the state of the world's plant genetic resource for food and agriculture, Nigeria do not have a well organised computerized documentation system (FAO, 2019). Thus, PGR Informatics is hereby recommended**.**

3.2.3. PGR Informatics:

PGR Informatics is the management (creation, storage, retrieval and presentation) and analyses (di scovery, exploration and extraction) of diverse information (facts, figures, statistics, knowledge and news) (Bretting, 2018). Development of mobile apps in PGR Informatics enhances access to PGR information, and help generate routine and updated genebank reports (Figure 7). India, China, Japan and Germany have developed two mobile apps (Genebank and PGR Map) (Singh *et al*., 2020). The genebank app provides a dashboard view of indigenous and exotic collections, while the PGR Map helps users to obtain quickly, the accessions that has been collected and conserved in the gene bank from a particular location. The two apps are first of its kind for anywhere in the world, and is highly recommended for Nigeria in her PGR management system (Singh *et al*., 2020).

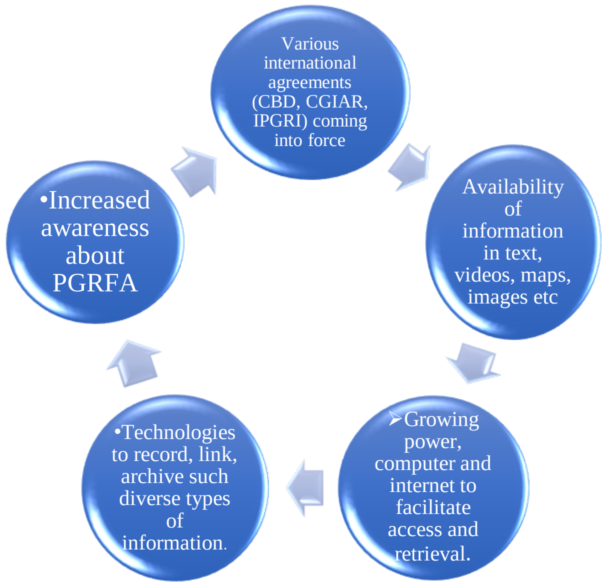

FIG. 7: Factors that necessitates PGR Informatics (Tanwy *et al*., 2022**)**

Conclusion

According to statistics and the 2022 hunger map of the world food programme, the highest level of hunger occurs in Sub-Saharan Africa (SSA), with Nigeria facing a high hunger situation, and with 10-24.9% of the population being undernourished. Ubi (2022), reported in his inaugural lecture 20th series, that important genetic resources in terms of plants, particularly that of food crops, at the same time agriculture productivity requires significant increase to meet the expected growth in demand for food by the ever-increasing Nigerian populace in the next few decades. We must understand that plant genetic resource preservation, management and utilization, is one of the most neglected weapons of food safety, bioresources extraction and disease control. Its neglect has led to extinction, threatened, endangered species and many other harms, already, few institutions in the country (as earlier mentioned) are engaged in some conservation biotechnological activities of certain economic crops like banana/plantain, cassava, ginger, yams and others (Ubi, 2022). However, there is need for the institutions to expand their scope to accommodate more indigenous plant species which are actually cherished by the local people, although such plants are not commercially grown in large scale production systems. The issue of biodiversity is essentially summed up thus: value it, conserve and use it, or regard it (Abiwon 2017). Nigeria, in her PGR management has not conserved enough, and therefore, should create more institutes to carter for other PGR going on extinct, and which are not captured by the present mandate crop institutes.

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