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SEED BANKS AS CONSERVATION TOOL FOR ENDANGERED WILD PLANT SPECIES IN ECOZONES OF NIGERIA

***Dau, J. H.[1]; Donald-Amaeshi, U.A.[2] and Chukwu, O.[3]**
[1.] Department of Forest Production and Products, University of Agriculture, Makurdi, Nigeria
[2.] Department of Forest Production and Products, University of Ibadan, Nigeria
[3.] Department of Social and Environmental Forestry, University of Ibadan, Nigeria
***Corresponding author:** *daujaph@gmail.com;* +2348068347777

ABSTRACT
Seed banks have played the largest role in the conservation of endangered wild plant species in the world. The potential role of seed in the regeneration of plant species is threatened by a rapid decline in the longevity and viability of the seeds in their natural habitats. This study addresses the key role of seed banks in the conservation of floristic diversity. The increasing popularity of the seed bank as a tool in the conservation of wild plant species can be attributed to different significance, including; provision of immediate access to plant samples, allowing researchers and conservation biologists to evaluate them for properties such as new sources of medicines, nutrition, and genes. Also, wild plant seeds conserved in seed banks are immune to habitat destruction, diseases, and predators. The stored seeds can be used to reinstate species into existing, suitable habitats where they were once present, or to augment the diversity of small, genetically depleted populations. Conservation efforts, as sources for population reintroduction and restoration, have been cited as an important justification for seed banks. Thus, it is recommended that seed banks with state-of-the-art storage facilities should be established at the national and local levels; and all of such banks should be networked so that materials, knowledge, and expertise on particular wild plant species is available on a global scale.

Key words: Conservation, Endangered, Floristic diversity, Plant species, Seeds bank, Storage

INTRODUCTION

Seed banks as 'off-site' or ex-situ conservation storehouses focus on safe-guarding seed species by storing them in a controlled environment or room (Plate 1a-b); to prolong seed viability and thereby preserves plants for future use. Seed banking conserves seeds which are a source of genetic regeneration. The main aim is to conserve the genetic purity and viability of seeds of endangered tree species for the regeneration of seedlings in the nursery (Agera and Dau, 2012).

Seed banks have played the greatest role in the conservation of domesticated plant varieties (Daniel and Anthony, 2001). For the past two decades, many botanical gardens began to establish seed banks for the purpose of conservation; this including the Millennium Seed Bank Project at the Royal Botanic Gardens, Kew, in Great Britain (Smith *et al.*, 1998). They aimed to stockpile 10% of the world's plant diversity, targeting species of the dry tropics, including Great Britain.

Endangered tree species that have direct and indirect economic uses to mankind are conserved in seed banks (Plate 1 and 2). The increasing popularity of the seed bank as a tool in the conservation of wild tree species can be attributed to a number of factors: seed banks provide immediate access to plant samples, allowing researchers and conservation biologists to evaluate them for properties (such as new sources of medicines, nutrition, and genes). The availability of plant germ-plasm in seed banks facilitates research that could provide helpful information for conserving the remaining natural populations of the species. Perhaps, most important, plants conserved in seed banks are immune to habitat destruction, diseases, and predators. They can be used to reinstate species into existing, suitable habitats where they were once present, or to augment the diversity of small, genetically depleted populations (Daniel and Anthony, 2001).

Strict Nature Reserve (SNR) is prominent among the methods for *in situ* conservation of biodiversity in Nigeria in particular and the world in general. Other common methods in Nigeria include Biosphere Reserves, Game Reserves, Regeneration Plots, Permanent Sample Plots, and Sacred Groves (Adekunle *et al.*, 2013). SNRs are created to protect representative samples of natural ecosystems for the preservation of biodiversity and ecological processes, scientific study, environmental monitoring, education and the maintenance of genetic resources in a dynamic and evolutionary state (Isichei 1995; Adekunle *et al.*, 2013).

Fewer efforts are underway in Nigeria and Africa as a whole, to consider some of the problems and challenges that mankind may face if endangered tree species seeds are not conserved in modern seed banks. In Nigeria, most of the Universities and research institutes concerned with tree plants lack storage facilities for proper seed conservation. This could be as a result of death information on the level of seed storage (seed banks). Thus, the aim of this article is to review the potential role of seed banks and to improve our knowledge on the need for establishing seed banks for endangered species in the eco-zones of Nigeria for biodiversity conservation and genetic regeneration.

Plate 1a: Seeds Conserved in Labeled/sealed Bottle

Plate 1b: Seeds Stored in Iron & Plastic Containers in Modern Seed Bank

Plate 1c: Seeds Conserved in Labeled/sealed Envelop
Source: Millennium Seed Bank Project, U.K (FAO, 2012)

Plate 2: Local Seed Bank Use by Gwari People in Niger State, Northern Nigeria
Source: Field Surveyed (2011).

BIODIVERSITY AND ECOSYSTEMS DESTRUCTION

There is abundant evidence that environments have shifted dramatically in biotic makeup and climatic conditions during the recent geological past (Davis, 1983; Pitelka, 1997). There is also widespread concern that global climate change is causing directional shifts in temperature and moisture regimes in many natural habitats (Sala *et al.,* 2000). Gene frequencies and gene combinations in natural populations are expected to change in response. Also, many plant species are threatened with extinction because of the gradual disappearance of the terrestrial natural ecosystems due to anthropogenic factor; often, resulting to erosion, salinization and invasion of alien species, but more recently climate change is looming as a significant new threat (Reed *et al.,* 2011).

But seed bank collections are stored and regenerated outside the natural habitat, typically in such a way as to minimize genetic change (Daniel and Anthony, 2001). More than 50% of the world's plant species are endemic to 34 global biodiversity hotspots (GBH), which once covered 15.7% of the earth's land surface and which are now reduced to 2.3%. These areas include large numbers of endemic species, which face an increasing threat of extinction (Reed *et al,* 2011). In-situ conservation alone is not sufficient to meet the challenges of saving endangered species. While seed banking can be utilized for ex situ conservation of the majority of endangered species, there are a significant number of species for which seed banking is not an option. Conserving the genetic diversity of species and populations is highly important in these situations, and micro-propagation can provide large numbers of propagules from a cross-section of the genetic diversity of a region (Rogers, 2003).

Information on biodiversity of wild tree species and species-rich communities is of primary importance in the planning and implementation of biodiversity conservation efforts among developing countries. Also, the diversity of native trees is fundamental to African nations as trees provide resources and habitat structure for almost wildlife species. According to Singh (2002), biodiversity is essential for human survival and economic well being and ecosystem function and stability. UNEP (2001) reported that, habitat destruction, over-exploitation, pollution and species alien are identified as major causes of biodiversity loss. Disturbances created by these factors determine forest dynamics and tree diversity at the local and regional scales (Hubbell *et al*., 1999). These disturbances have been considered as an important factor structuring communities (Sumina, 1994).

It appears that intact old growth forests, where biodiversity is conserved for posterity are restricted only to the strict nature reserves, biosphere reserve and the sacred groves and community forests. These now serve as refuges for animals driven by human disturbances from other forests and free areas, and home for so many endangered indigenous plant species (Adekunle *et al.*, 2013).

FLORISTIC CONSERVATION TREND IN NIGERIA

The degradation, fragmentation and conversion of the forests to other forms of land uses in Nigeria, are currently progressing at alarming rates. Between 1990 and 2000, Nigeria lost about 2.7% of its natural forests to deforestation which increased to about 18.56% (about 2.06 million ha) between 2000 and 2010 (FRA, 2010). A cumulative 47.5% of Nigeria's natural forests were lost to deforestation between 1990 and 2010 (FRA, 2010). Recent global forest resources assessment revealed that Nigeria is one of the five countries in the world with the highest annual rate of deforestation for the period 2000 –2010 (FRA, 2010). These changes have caused the loss of some plant species and a decline in the biodiversity conservation status of the forest and environmental quality. The sustainable management and use of these resources is essential for the nation's economic and environmental security (Humphrey and Godwin, 2015).

The conservation of wild plant species has become less important in our society due to high interest attached to farming, fuel wood extraction, settlement and industrial development as a result of increasing human population. Al-min (2013), reported that the decline in tree cover affect aspects of daily life of the people. Neelo *et al*. (2015), reported that excessive anthropogenic disturbances, such as logging or cutting trees, usually result in an immediate decline in species diversity.

High rate of deforestation in Nigeria showed clear evidence of desert encroachment, soil erosion and degradation of areas in Sudan savanna of Nigeria. This could be the cause of great decrease in the availability of trees species in some areas in the Northern Nigeria. This observation agrees with McCarty (2001) that rapid human population growth rate is the major cause of wild plant species loss. These population growths pose a serious threat on plant species due to anthropogenic activities. This implies that endanger of economic tree species and soil degradation in the area are inevitable.

The conservation status of the 27 species enlisted (Table 1) was checked and confirmed on the IUCN red list of threatened species. Out of the 27 species, two species (*Rauvolfia sp* and *Sterculia sp*) were reported to be threatened with extinction, *Khaya senegalensis* was reported vulnerable while 5 species (*Acacia sp, Albizia sp, Allophylus africana, Strychonos spinosa,Vetellaria paradoxa* and *Vitex donianna)* were endangered**.** Some species were reported least concern in North eastern part of Nigeria, while *Anogeissus leiocarpa, Strombosia postulate, Rytigniaum bellatum, Uapa catogoensis* and *Pterocarpus erinaceus* were not found on the IUCN catalogue.

Table 1: Economic Wild Plant Species and their Conservation Trend in Nigeria

Species	Frequencies		Species Status
	Decreasing in Availability	Increasing Availability	
Acacia sp	26	18	Decreasing
Afzelia africana	32	1	Decreasing
Albizia gummifera	26	4	Decreasing
Allophylus africana	4	0	Decreasing
Anogeissus leiocarpa	11	39	Increasing
Bambax cosveolens	5	0	Decreasing
Borassusa ethiapum	23	0	Decreasing
Deinbolia pinnata	2	8	Increasing
Garcinias mithmanii	0	10	Increasing
Hymenocardia acida	9	39	Increasing
Khaya senegalensis	19	12	Decreasing
Pleiocarp apycnantha	2	10	Increasing
Prosopis africana	7	18	Decreasing
Psychotria sp	7	1	Decreasing
Pterocarpus erinaceus	53	0	Decreasing
Rauvolfiavo miteria	8	0	Decreasing
Rytigniaum bellatum	0	10	Decreasing
Schefflera abyssinica	9	1	Increasing
Sterculia setijera	16	1	Decreasing
Strombosia postulate	0	17	Decreasing
Strychonos spinosa	11	3	Increasing
Terminalia species	24	20	Decreasing
Uapacatogoensis	0	56	Increasing
Vetellaria paradoxa	19	8	Decreasing
Vitex donianna	14	5	Decreasing
Ziziphus sp	7	5	Decreasing
Total	**336**	**286**	

Source: field survey, (2017)

SOME INTERNATIONAL SEED BANKS

According to Rao (2008), there are several seed banks in different countries, at the national, regional and local levels. Some of the best seed banks in the world are in Peru, Colombia, Syria, India, Ethiopia, and the Philippines. These include: The Millennium Seed Bank Project, The Svalbard Global Seed Vault, Seed Banks of Global Network of Agricultural Research Institutions, The National Bureau of Plant Genetic Resources (NBGPR), New Delhi, India (Rao, 2008).

The Millennium Seed Bank Project: The Millennium Seed Bank Project (MSBP) at the Royal Botanic Garden, Kew, England, is one of the largest conservation projects. MSBP's 47 partner organizations in 17 countries intend to store 25 per cent of the world's plant species by 2020. The Seed Information Database (SID) at Kew is an ongoing compilation of seed characteristics and traits world-wide, targeted at >24,000 species. As the largest seed bank in the world, the Millennium Seed Bank housed at the Welcome Trust Millennium Building (WTMB), located in the grounds of Wakehurst Place in West Sussex, near London (Drori, 2009).

The Svalbard Global Seed Vault: On February 26, 2008, the Svalbard Global Seed Vault (SGSV) opened near Long-year-byen (Norway), 600 miles from the North Pole. SGSV is designed to hold 4.5 billion batches of seeds of the world's main crops. The SGSV is a glazed cave-like structure, drilled 500 ft below permafrost, in the middle of a frozen Arctic mountain topped with snow, with the goal to store and protect samples from every seed collection in the world, which will stay frozen. An automated digital monitoring system controls temperature and humidity and provides high security. The SGSV is an insurance against natural disasters such as earthquakes and tsunamis, or deliberate attacks like bomb blasts or human errors such as nuclear disasters or failure of refrigeration that may erase the seeds of any important species in the other seed banks or in the wild, in the other countries.

Seed Banks of Global Network of Agricultural Research Institutions: Ten international agricultural research institutions, co-ordinated by the Consultative Group on International Agricultural Research (CGIAR), Washington, are focused on crops and have extensive seed collections for such crops as rice, maize, wheat, barley, millets, pulses, oil seeds, tuber crops, banana, tropical forage and fruits. The collections in these seed banks are well documented and the institutions are networked among themselves and with several other institutions.

THE IMPORTANCE OF SEED BANKS IN BIODIVERSITY CONSERVATION

i. Conservation of Plant Species Seeds

There is an urgent need for the conservation of wild plant genetic resources, but it is largely impractical to conserve the very large number of plant species and their wild relatives in their natural habitats. A viable alternative is to conserve whole seed in seed banks (Plate 1a-d). The seeds are germinated to raise plants from them for use in plant improvement. The important role seed banks play in the conservation of wild plant genetic resources is now globallyrecognized.Various techniques have been developed for preserving seeds of wild plant species; retaining their viability for longer periods. As temperature and humidity are very critical factors, cleaned seeds are stored at around -20^{o} C, often using silica gel in the seed containers to reduce humidity (Table 2). Seeds in the seed banks need to be protected from pests and pathogens while in storage. The viability loss at varying moisture content and temperature for selected forest tree species were presented in Table 2.

Table 2: Viability Loss at varying Moisture Content and Temperature for Selected Forest Tree species

Species	Temperature (°C)	Moisture Content (%)	Period (Years.)	Viability loss (%)
Casurina spp	-3	6-16	2	0-5
Eucalyptus spp	3-5	4-8	5-20	-
Tectona grandis	0-4	-	7	None
Grevillea robusta	-6	6	2	Less than 5
Acer saccharum	-10	10	5.5	6
Acacia mongnium	4-8	-	1.2	6
Azadirachta indica	26	10-18	-	-
Dipterocarpus spp	16	41-44	-	47

Source: Agera and Dau (2012)

Plates 2a to 2f showed some modern seed banks

Plate 2a **Plate 2b**

Plate 2c **Plate 2d**

Plate 2 (a-d): Seeds Stored in Different Forms of Containers in Modern Seed Banks (Svalbard Global Seed Vault**)**

Plate 2e

Plate 2f

Plate 2 (e-f): Seeds Store in Labeled/Sealed Plastic Containers and Stacked on Shelves in as Seed Banks at National Center for Genetic Resources and Biotechnology (NACGRAB)
Source: (https://en.wikipedia.org/wiki/Gene_bank/ 2018).

ii. Conservation of Endangered Wild Plant Species Seeds

Seed banks serves to conserve species that otherwise might be lost. It also stores seeds of regional populations so that regionaldiversity is conserved and restoration oflocal populations can be achieved in future. It serves to conserve species that otherwise might be lost. It also stores seeds of regional populations so that regional diversity is conserved and restoration of local populations can be achieved in future. The storage and sub-freezing temperature for some Orthodox and Recalcitrant Seeds are presented in Table 3.

Table 3: Storage and sub-freezing Temperature for some Orthodox and Recalcitrant Seeds

Species	Storage type (bank)	Temp.	Duration (Years)
Pinus caribea	Closed container	0-5 ^oC	5
Pinus oocarpa	Closed container	,,	5
Pinus resinosa	Closed container	1.1-2.2 ^oC	30
Tectona grandis	Closed container	6 ^oC	-
Triplochiton spp	Closed container	-	1.9
Azadirachta indica	Closed container	-	-
Eucalyptus spp	Closed container	3-5 ^oC	10

Source: Foliot and Thames (1983)

iii. Conservation of Genetic Stocks

Gene banks are type of biorepository which preserve genetic material. For plants, this could be by freezing cuttings from the plant, or stocking the seeds (e.g. in a seed bank). For animals, this is the freezing of sperm and eggs in zoological freezers until further need. Plant genetic material in a 'gene bank' is preserved at -196° Celsius in Liquid Nitrogen as mature seed (dry). Seed banks can be used for a range of purposes, including the following: 'Species bank' – to conserve species (generally back-up to *in situ* measures); 'Population bank' – to conserve genetic diversity within species (this sometimes includes population restoration); 'Genome bank' or 'gene-pool bank' – to conserve sets of related species that may be able to share genomes in a single gene-pool; 'Breeding bank' – to conserve selected families of interbreeding genotypes.

iv. Source of Plant Samples for Researchers

The increasing popularity of the seed bank as a tool in the conservation of wild plant species can be attributed to numbers of factors which include: seed banks provide immediate access to plant samples, allowing researchers and conservation biologists to evaluate them for properties such as new sources of medicines, nutrition, and genes. Also, the availability of plant germplasm in seed banks facilitates scientific study that could provide helpful information for conserving the remaining natural populations of the species. Third, and perhaps most important, plants conserved in seed banks are immune to habitat destruction, diseases, and predators. They can be used to reinstate species into existing, suitable habitats where they were once present, or to augment the diversity of small, genetically depleted populations.

CONCLUSION AND RECOMMENDATIONS

Seed banks play vital roles in ensuring the future of wild plants diversity. They provide the necessary protection for indigenous economic seed plant biodiversity as well as continuing access to the plant's biodiversity required for economic development of the biological export economy. The key purpose of Seed banks is to have a viable supply of seed whenever it may be needed. Seed banks ensure that seed tissues are available to bridge the gap between intermittent seed plants; ensure ease of storage, economy of space, and consequently, the capacity to maintain large samples at an economically viable cost. Conservation can be important for preserving the biodiversity of many endangered habitats. Thus, it is recommended that seed banks with state-of-the-art storage facilities should be established at the national and local levels; and all of such banks should be networked so that materials, knowledge and expertise on particular wild plant species is available on a global scale.

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