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THE ROLE OF PLANT RESOURCES IN NIGERIA'S ECONOMIC RECOVERY AGENDA

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INTRODUCTION

My training as an ecologist has in the last thirty years kept me engaged in the scientific study of the factors that determine the distribution and abundance of plants. I have come to learn that you could accurately predict environmental conditions when you know the vegetation the area can support and that it is also true that plants are the most important indicators of environmental health. I also know that growth medium chemistry determines, to a large extent, the performance of plants and their chemical composition. Basically, it is the performance of plants and chemical composition that we exploit for economic and cultural purposes. Our human world has been so closely tied to plants that it is difficult to imagine human existence without them. In all life on earth, plants are the only producers and all consumers are dependent upon plants for food, fibre, wood, energy and oxygen. Knowledge of plants, their habitats, structure, metabolism and inheritance is thus the basic foundation for human survival. Plants form the bedrock of life, being the first generator of oxygen in a reducing atmosphere that characterized the early earth. Plants are thus the roots of life and human material culture depends on them. The way a people incorporate plants into their cultural traditions, religions and even cosmologies reveals much about the people themselves. People rely on plants for much more than food and shelter and people use plants in so many ways that there are a few areas of human endeavour in which they do not play an important role. Plants have determined the course of human civilization – America was discovered during the course of the search for spices! Few societies can ignore the pivotal role of agriculture and forestry, both based essentially on plants. Several environmental crises such as global warming and biodiversity loss at their core, involve plants. It could indeed be that we are so closely linked that humans often take plants for granted, something to be left to the background and not worthy of serious economic consideration. But we met plants on our planet and they have defined our 'life zones'. The late appearance of humans on the evolutionary scene laid open to us a large variety of natural resources to exploit for food and plants were the natural choice, being the only organisms that had the capability to convert solar energy to chemical energy. From them we have learnt about life and it now looks as if we still have to depend on them to sort out our environmental crisis. And while relying on them, humankind could dig deeper than ever before into plants to, as we are wont to say, 'make ends meet'. Botanists in Nigeria should lead this beneficial interaction between humankind and plants for economic recovery in our country.

Broadly defined, plants are organisms that are capable of synthesizing organic molecules from inorganic elements. They usually possess chlorophyll that enables them to synthesize carbohydrate from carbon dioxide and water in the presence of solar radiation. Vegetation is the totality of plants in the waters, land and air in a given area.

Plants arose from the oceans. Phytoplanktons of oceans are the remnants of this early evolution. They depend on phosphate and nitrate on the surface waters of the sea. Phytoplankton gave rise to diatoms, peridineans

and coccolithophores which are flagellate. It is believed that seaweeds arose from plankton that settled on rocks. Seaweed size depends on their position on the shore. They (seaweeds) pioneered plant form by sending from a fixed base, filaments, branches and fronds against the forces of the environment and so established vegetation. They have holdfast, a body made up of layers of cells. The colonization of the continental land areas took place about 400 million years ago (Corner, 1964).

NIGERIAN PLANTS, THEIR DIVERSITY AND UTILIZATION

Nigeria has over 700 species of algae, 80 lower plants (bryophytes, etc.), 150 ferns and 5,000 higher plants, about 205 of them endemic (Federal Environmental Protection Agency, FEPA, 1992).

Plants as food

Edible wild plants which could be used as leafy vegetables, edible fruits and seeds and starchy roots and tubers include leafy vegetables, fresh fruits and juices, soup condiments, edible seeds, sweeteners and those used to wrap foods (Appendix I). (See Ola-Adams and Onyeachusim, 1993; Isawumi, 1993; Morakinyo, 1994; a long list of usable plants is also given in Spore, 1994).

These are the crops that would ensure our food security. Okafor (1993) has observed that there are over 300 edible plants in the Nigerian flora. Unfortunately, 484 plants in 112 families have already gone extinct and several are threatened with extinction (Tables 1, 2 & 3). Okojie (1993) has defined food security as access by all people at all times to enough food for an active, healthy life. Such security depends on both food availability and the ability to acquire it. If plants that should form the basis of such security are going extinct or are threatened then our food security is indeed shaky.

Table 1. ENDANGERED SPECIES OF THE NIGERIAN FLORA

Distribution Of Endangered Plant Species Within The Different Families (From FMAWR&RD, 1986)

Family	No of Endangered Plant species	Family	No of Endangered Plant species
ACANTHACEAE	26	LORANTHACEAE	1
ADIANTACEAE	5	LYCOPODIACEAE	1
AGAVACEAE	2	MALVACEAE	1
AMARANTACEAE	1	MARANTACEAE	1
ANACARDIACEAE	7	MELASTOMATACEAE	10
ANNONACEAE	15	MENISPERMACEAE	2
APOCYNACEAE	19	MIMOSACEAE	3
ARACEAE	3	MONIMIAIACEAE	2
ARALIACEAE	1	MORACEAE	9
ARISTOLOCHIACEAE	3	MYRISTICACEAE	2
ASCLEPIADACEAE	2	MYRTACEAE	1
ASPIDIACEAE	7	NAJADACEAE	1
ASPLENIACEAE	6	OCHNACEAE	1
ATWYRIACEAE	2	OCTOKNEMATACEAE	1

BALSAMINACEAE	1	OLACACEAE	1
BEGONIACEAE	2	OLEACEAE	1
BORAGINACAE	4	ONAGRACEAE	1
BURSERACEAE	1	OPILIACEAE	2
BUTAMACEAE	1	ORCHIDACEAE	23
CAESALPINIACEAE	13	OROBANCHACEAE	1
CAPPARIDACEAE	2	OXALIDACEAE	2
CARYOPHYCEAE	2	PAPILIONACEAE	8
CELASTRACEAE	6	PEDALIACEAE	1
COMBRETACEAE	9	PITTOSPORACEAE	2
COMMELINACEAE	3	PLANTAGINACEAE	1
COMPOSITAE	36	PODOSTEMACEAE	2
CONNARACEAE	6	PROTACEAE	1
CONVOLVULACEAE	3	RANUNCULACEAE	2
CRUCIFERAE	1	ROSACEAE	3
CUCURBITACEAE	6	RUBIACEAE	16
CYTHEACEAE	1	RUTACEAE	3
CYPERACEAE	21	SALVADORACEAE	1
DENNSTAEDTIACEAE	1	SANTALACEAE	1
DICHAPETALACEAE	11	SAPINDACEAE	8
EBENACAEAE	7	SAPOTACEAE	2
ERICACEAE	2	SCROPHULARIACEAE	2
ERIOCAULACEAE	3	SCYTOPPELACEAE	2
EUPHORBIACEAE	31	SELAGINELLACEAE	1
FLACOURTIACEAE	7	SIMAROUBACEAE	2
GENTIANACEAE	2	SLOGANACEAE	1
GERANIACEAE	1	STERCULIACEAE	4
GNETACEAE	1	THELYPTERIODACEAE	2
GOODENIACEAE	1	THYMELAEACEAE	3
GRAMINEAE	19	TILIACEAE	2
GUTTIFERAE	4	ULMACEAE	1
HYPMENOPHYLACEAE	4	UMBELLIFERAE	3
HYPERICEAE	3	URTICACEAE	2
ICACINACEAE	2	VERBANACEAE	2
GUTTIFERAE	4	VIOLACEAE	2
IRIDACEAE	1	VITTARIACEAE	1
LABIATAE	6	VOCHYSIACEAE	1
LAURACEAE	2	XYRIDACEAE	1
LECYTHIDIACEAE	2	ZINGIBERACEAE	2
LEMNACEAE	1		
LENTIBUARIACEAE	1		
LILIACEAE	2		
LOBELIACEAE	3		
LOGANACEAE	4		
LOMARIOPSIDACEAE	2		

Table 2. Plant Species Requiring Urgent Conservation Attention In Nigeria (FEPA, 1997)

No.	Names	Family	Status
1	*Crateranthus talbotti*	Lecythidaceae	E, M*
2	*Didelotia africana*	Caesalpinioideae	E, M
3	*Loesenera talbotti*		E, M
4	*Cryptosepalum diphyllum*		E
5	*Piptostigma pilosum*	Annonaceae	E
6	*Okoubaka aubrevillei*	Ocktoknemataceae	M*
7	*Dichostema glaucescens*	Euphorbiaceae	M*
8	*Cyrtogomone argenta*		M*
9	*Marcyopsis longifolia*		M*
10	*Acalypha manniana*		M*
11	*Pseudagrostistiachys africana*		M*
12	*Plagiostyles africana*		M
13	*Ophiobostrys zenkeri*	Flacourtiaceae	M
14	*Phyllobotryum soyauxianum*		M
15	*Arialopsis tabouensis*	Rutaceae	M
16	*Scytopelalus tieghemii*	Scytopelaceae	M
17	*Salvadora persica*	Salvadoraceae	M
18	*Radlkofera calodendron*	Sapindaceae	M

KEYS: E: endemic to Nigeria; **M**: Monospecific genera in Nigeria; *: Genus represented by only one species in the world flora

Table 3. Under-utilized and/or fast disappearing economic woody food plant species (Okafor, 1993):

a) **Forest Zone**

1. *Beilschemeidia mannii*
2. *Blighia sapida*
3. *Chrysophyllum albidum*
4. *Cola acuminata*
5. *C. lepidota*
6. *C. pachycarpa*
7. *Dacryodes edulis*
8. *Dennettia tripetala*
9. *Dialium guineense*
10. *Dioscoreophyllum cumminsil*
11. *Elaeis guineensis*
12. *Garcini kola*
13. *Gnetum spp.*
14. *Gongronema latifolium*
15. *Invingia gabonensis*
16. *Monodora myristica*
17. *Myrianthus arboreus*
18. *Ocimum gratissimum*
19. *Pentaclethra macrophylla*
20. *Piper guineense*
21. *Pterocarpus spp*
22. *Raphia hookeri*
23. *Spondias mombin*
24. *Synsepalum dulcificum*
25. *Tetracarpidium conophorum*
26. *Thaumatoccus daniellii*
27. *Treculia africana*
28. *Vernonia amygdalina*
29. *Xylopia spp.*

b) **Savanna Zone**

1. *Adansonia digitata*
2. *Afzelia africana*
3. *Annona senegalensis*
4. *Balanites aegyptiaca*
5. *Borassus aethiopum*
6. *Ceiba pentandra*
7. *Detarium microcarpum*
8. *Ficus capensis (F. sur)*
9. *Grewia mollis*
10. *Irvingia smithii*
11. *Moringa oleifera*
12. *Parkia biglobosa*
13. *Phoenix reclinata*
14. *Prosopis africana*
15. *Raphia sudanica*
16. *Pterocarpus santalinoides*
17. *Syzgium guineense*
18. *Tamarindus indica*
19. *Vitellaria paradoxa*

c) **Other Crops (Cultivated)**

1. *Diigitaria exilis*
2. *Amaranthus* spp
3. *Dioscorea spp.*
4. *Celosia spp.*
5. *Citrullus lanatus*
6. *Vigna subterranea*

Ola-Adams (1986) listed 54 such species that include species of *Capsicum, Coffea, Cola, Dioscorea, Solanum, Irvingia* and *Ipomoea.* These species will be needed for the genetic improvement of existing crops and their resistance to new diseases and pests, environmental stresses, and increased productivity and nutrient content. Apart from those species directly utilized, some wild or semi-wild relatives of cultivated crops also abound.

In a report on the combined role of plants as food and drug, Etkin and Ross (1982) observed that the bulk of the diet of Hausas of northern Nigeria was provided by sorghum, millet, cowpeas and groundnuts but that the porridges made from these grains were consumed with soups made from a variety of wild plants. They collected 61 such plants and noted that though these plants accounted for just 3% of the calorie intake, they contain several pharmacologically active compounds. Some of them were particularly active against malaria.

According to Balick and Cox (1996) plants can be of use to modern agriculture in 3 ways:

(i) Source of new crops: A former United States President, Thomas Jefferson, had observed that the greatest service that can be rendered any country is to add a useful plant to its culture. Of the several thousand plant species known to be edible, only 150 have become important enough to enter into global commerce. Less than 20 species produce the world food. Furthermore, the 4 major carbohydrate crop species – wheat, corn, rice and potatoes feed more people than the next 20 most important crops combined. Cassava, yams, cocoyams, beans, rice, sorghum, millet, maize, groundnuts and sweet potatoes dominate Nigeria's cuisine. Instead of expanding the food base in terms of domesticating new plants, efforts are directed at improving existing ones especially in terms of yield. Oil palm, groundnuts and soybeans supply cooking oil. Other crops known to indigenous people and used by them are often stigmatized as primitive. These crops tend to be robust, productive, self-reliant, free of indigestible compounds with relatively high nutritive value, and suitable for growing in some agricultural systems.

(ii) Improvement of crop varieties through cross- breeding: Relatives of commercial species must continuously be cross-bred with these species to improve crop yield, nutritional quality, durability, responsiveness to different soils and climates, and resistance to pests and diseases. Since many of the world's most important crop species originated in the tropics, we must look to our equatorial regions for wild or semi-domesticated relatives of commercial species to maintain or improve our crops.

Some examples: A barley plant from Ethiopia provided a gene that protects the California barley crop from yellow dwarf virus. (2) A wild variety of tomatoes discovered in the Peruvian Andes in the 1960's has increased

the sugar content of the fruits. (3) Rice grown in Asia is protected from the four main rice diseases by genes provided by a single wild species from India. (4) Yield of cassava increased 18 times because of disease resistance provided by a wild Brazilian species. (5) Disease resistance provided by wild Asian species of sugarcane has saved the sugarcane industry in southeast USA. (6) Perennial corn discovered in Mexico in 1977 has proven to be immune or resistant to seven major diseases of domesticated corn (Balick and Cox, 1996).
Utilizing the natural chemical defenses of plants. There are several examples of the use of plant extracts as pesticide (Balick and Cox, 1996):
(1) Calabar bean, *Physostigma venenosum,* is an ordeal poison in West Africa. Studies of the active principle in the plant led to the development of the methyl carbamate insectides. One of the plant's compounds, physostigmine is now used to cure glaucoma. (2) *Chrysanthemum cinerariifolium* (daisy) like some pyrethrum extracts is used to control insect pests. (3) *Lonchocarpus* is used as poison to stun fish. The roots are now imported into the U. S. A. as a source of rotenone, a biodegradable pesticide. (4) Some allelochemicals are being developed for crop protection.

Plants and the Evolution of Drugs

Interest in the medicinal uses of plants has been on the upsurge in recent times. Humans depended on plants for cure of most ailments until scientific advances introduced chemical syntheses. The search for viral diseases-curing plants has greatly re-awakened interest in ethnobotany especially in the western world. New ethnobotanical drugs are now needed for cardiovascular diseases, cancer, microbial infections and neoplasms. Many nations are now integrating traditional medicine into primary healthcare systems. Twenty-five per cent of global prescription drugs are directly derived from plants.

According to Balick and Cox (1996), the three factors of immobility, carbohydrate production and diverse biochemistry make plants far more useful to humans than any other kingdom of organisms. Plants compete with each other for light and for a place to anchor and being stationary, are easy to reach reliably. They rely on wind and water to move their pollen and seeds, or alternatively entice animals to do these for them. This is the essence of flowers and delicious and nutritious fruits. Not all animal-plant interactions are, however, benign. Animals pose a threat to plants and plants have, therefore, become specialists in animal biochemistry. Their chemicals function not only to reward animal pollinators and carriers of pollen and seeds but also to repel, maim, or poison those animals that attempt to destroy them. These chemical agents employed by plants have profound implications for medicine. These constitute 25% of prescription drugs and nearly all our recreational chemical substances including caffeine in coffee, nicotine in tobacco, theophylline in tea, theobromine in chocolate and a host of psychoactive substances. One of the earliest plant-derived drugs is aspirin from the plant then known as *Spiraea ulmaria*, 'queen of the meadow', now called *Filipendula ulmaria.* Salicylic was first extracted from the plant in 1839 while Bayer of Germany produced acetylsalicylic acid, the artificial derivative, in 1899. Aspirin was simply derived from 'a' for acetyl and 'spirin' from Spiraea. Quinine was extracted from *Cinchona spp.*

Almost 300 plants are listed as being of medicinal value in western Nigeria alone (Adjanahoun *et al.*, 1993). These plants are spread over several families including ferns, bryophytes, and some fungi. Okafor and Ham (1999) identified 55 plants as being of medicinal value in southeastern Nigeria while Anwana and Obot (2003) reported that 67 plant species in 38 families are used for treating 18 categories of ailments by people living inside and within the support zone of the Cross River National Park, Okwango Division, in Cross River State. The World Health Organization (WHO) reports that over 3.5 billion people in the developing world rely on plants as components of their primary health care (see Table 4). An estimated 80% of the rural people in Nigeria depend on herbal medicine.

Table 4: Percentages of medicinal plants used in various treatment categories by indigenous peoples of 15 countries compared to the percentage of drugs used in the same treatment categories in western societies (from Balick and Cox, 1996).

Treatment Category	Western Pharmacopoeia	Indigenous Pharmacopoeia
Inflammation	7	12
Dermatology	1	15
Gastro-intestinal	2	15
Cancer	4	1
Obstertrics/gynaecology	14	7
Cardio-vascular	10	2
Nervous system	29	10
Renal-blood-immune system poisons	17	11
Antimicrobial	12	9
Others	4	16

Timber Resources

Forests are primarily exploited, especially since colonial times, for export timber. The following species were considered as 'economic' in 1952 when various silvicultural treatments were commenced to maximize the timber resources (Okali and Ola-Adams, 1987; Lowe, 1993): *Afzelia bipindensis, Antiaris africana, Brachystegia nigerica, Chlorophora excelsa, Cordia platylyrsa, Entandrophragma angolense, Eribroma oblonga, Erythrophleum spp., Guarea cedrata, G. thompsonii, Khaya ivorensis, Lophira alata, Lovoa trichilioides, Mansonia altissima, Mitragyna ledermannii, Nauclea diderrichii, Nosogordonia papaverifera, Piptadeniastrum africanum, Sterculia rhinopetala, Terminalia ivorensis, T. superba and Triplochiton scleroxylon.* It was observed in the report by Ola-Adams and Iyamabo (1977) that whereas in 1950 only 17 species were thought to be of economic importance as commercially acceptable timber trees, by 1975 the number so regarded had increased to 47. For example, *Daniellia oliveri* can be considered one of the most intensely utilized timber species today. With just any tree being felled for timber these days, all trees can be regarded as economic. The situation is so acute that timber has overtaken usually imported items such as roofing sheets as the most expensive component in housing construction. There are virtually no hardwoods left in the wild in most parts of Nigeria.

Traditional use of the Forest-Non Timber Forest Products

The forest can provide miscellaneous raw materials for building purposes, tools and weapons, artifacts, clothing and personal ornamentation and materials for ritual and magical purposes. This can be attested to by the many reports in the work of Okogie and Okali (1993). Okafor (1993) has reported 171 indigenous woody plants of nutritional importance within the forest zone of Nigeria. Ola-Adams and Onyeachusim (1993) reported that many of the estimated 4,614 plant species in Nigeria (including 205 endemic ones) go into multipurpose or particular uses. For example, the well-known Nigerian cloth called "Adire" (Oyelola, 1992) is dyed with extracts from *Lonchocarpus cayenensis* that had been mixed with the filtrate from the ash from *Daniellia oliveri* in southwestern Nigeria. Particular forest trees are retained during shifting cultivation, or their growth is actually promoted in various ways because their fruit or timber is especially prized. Morakinyo (1994) observed that the Ekuri Community in the support zone of the Cross River National park in southeastern

Nigeria identified five principal non-timber forest products that are of great commercial importance and they are *Gnetum africana*, chewing sticks *(Garcinia mannii, Massularia acuminata)*, rattan *(Calamus spp., Laccosperma spp, Oncocalamus spp., and Eremospatha spp.)* and bush mango *(Irvingia gabonensis)*.

Crop Plants in the Nigerian Economy

Cocoa, palm oil, groundnuts, rubber and cotton were the major economic crops in pre- and immediate post-independent Nigeria. The major food crops have been cassava, cocoyams, guinea corn, maize, millet, and yams. The increased production and export of crude oil diverted attention from agriculture generally and there was a decline in production of both the cash crops and the food crops. Food production did not match population increases and importation made up for shortfalls. Importation is a threat to national security and in response to this threat, various interventions were designed to stimulate interest in agriculture in a national population dominated numerically by youth who were always city-bound. The interventions had not been successful due to a variety of reasons prominent among which is the drudgery involved in agricultural practices. Efforts are continuing to bring people back to the land but agriculture is still a less rewarding activity than participation in many other sectors of the Nigerian economy. Agriculture has witnessed increases in land cultivation but lack of rigorous scientific contribution to traditional agriculture and environmental decline have combined to frustrate increased productivity.

Horticulture

Most of the horticultural decorations in Nigeria are carried out using exotic plants of tropical American or Asiatic origin. Yet, Nigeria is endowed with rich natural vegetation full of attractive and decorative plants. Horticulture is one area where Nigerian plants need development. After a floristic survey of the then new federal capital territory we listed those plants that could be used for horticultural purposes (Sanford and Isichei, 1981) as shown in Table 5. Some plants just need to be domesticated while breeding for certain characteristics may be necessary for others.

TABLE 5: Recommended Woody Ornamental Plants of the Federal Capital Territory (Sanford and Isichei, 1981)

Acacia farnesiana
Acacia barteri
Allophyllus africana
Andira inermis
Anogeissus leiocarpus
Anthocleista djalonensis
Bambusa vulgaris
Belonophora hypoglauca
Berlinia grandiflora
Bombax costatum
Borassus aethiopum
Boswellia dalzielii
Carpolobia alba
Cassia sieberana
Clappertonia ficifolia
Erythrina sigmoidea
Feretia apodanthera
Ficus abutilifolia
Gardenia erubescens
Heeria insignis
Hymenodictyon floribundum
Irvingia smithii
Isoberlinia doka
Kigelia africana
Linnea kerstingii
Leea guineesis
Lonchocarpus cyanescens
Lonchocarpus sericeus
Lophira lanceolata
Manilkara obovata

Cola lateritia
Combretum hispidum
Combretum paniculatum
Combretum racemosum
Cussonia barteri
Daniellia oliveri
Dichapetalum guineense
Dichrostachys glomerata
Dissotis grandiflora
Dracaena arborea
Dracaena surculoss
Erythrina senegalensis
Oxyanthus unilocularis
Oxystelma bornouense
Pavetta corymbosa
Pterocarpus erinaceus
Pterocarpus santalinoides
Rothmannia longiflora
Ruspolia hypocrateriformis
Smeathmannia pubescens
Sterculia trangacantha
Maytenus senegalensis
Milettia thonningli
Minusops kummel
Monodora tenuifolia
Mussaenda elegans
Myrianthus arboreus
Napoleona imperialis
Napoleona vogelli
Nauclea latifolia
Newbouldia laevis
Ochna afzelii
Oncoba spinosa
Oxyanthus racemosus
Phoenix reclinata
Prosopis africana
Protes elliottii
Stereospermum kunthianum
Syzygium guineense
Terminalia macroptera
Uapaca togoensis
Uvaria chamae
Vincentella passargei

Table 6: Categories of Biodiversity Values (From Okali, 2004)

Use values				**Non-use values**
Direct use				
Consumptive	**Non-consumptive**	**Indirect use**	**Option value**	**Existence value**
Generic value: goods for home consumption, manufacture or trade		Ecological functions for maintaining sustainability & productivity	Possible future of serendipity	Satisfaction from knowledge of existence and ability to bequeath
Example values from diversity: mixed crop varieties; mixed food combinations	Aesthetic value of diverse landscapes; bird watching	Diversity of species assists ecosystem resilience and stability	Gene pool: potential medicines and drugs	Special concern for rare and threatened species and ecosystems
Example values from abundance: food, fuel fodder, raw materials	Bird watching and recreation	Carbon storage, nutrient cycling, photosynthesis, waste assimilation, flood protection	Future availability of resources	Wilderness aplenty, cultural and spiritual assets
Example beneficiaries:				
Poor rural people, especially women	Visitors and tourists	Downstream users of land, water and energy; the world community	the young and future generations	Environmental lobbies and concerned people

**Biodiversity and Poverty Alleviation, Chief S.L. Edu Memorial Lecture, NCF, Lagos, 8 Jan. 2004*

THE PRESENT STATE OF NIGERIAN VEGETATION: DEFORESTATION AND ITS CONSEQUENCES

Impacts of Deforestation

There are several adverse effects of deforestation most of which have a bearing on climate. These include: increased surface albedo, perturbation of the carbon cycle causing variations in the atmospheric levels of carbon dioxide, local changes in the water balance, addition of particulates to the upper atmosphere, both directly from perturbation of the hydrological and turbulence characteristics over areas where tall forest stands are replaced by low crops or cleared land.

Albedo refers to the reflectivity of a surface and is usually measured as the ratio of reflected radiation to the amount coming on to the earth's surface. Tropical forests, because of their dark green colour are 'dark' and, therefore, absorb most of the incoming radiation in the visible band. Albedo values for tropical forests range from 0.12 to 0.14. Cleared forestlands, on the other hand, are 'lighter' in colour and, therefore, reflect more incoming radiation than forests. This increased reflectivity has climatic implications. Radiation absorbed by the forest canopy and ground is returned to the atmosphere as sensible and latent heat. Sensible heat transfer is the cooling of the surface by dry ventilation of the surface by air passing over it. Latent heat transfer refers to the energy used in evapotranspiration. Where there is no vegetation, this latent heat is transferred back into space resulting in significant increase in local air and ground temperatures. It is even feared that reduced evapotranspiration might result in reduction in local rainfall and marginal regional changes in rainfall patterns.

Perturbation of the carbon cycle comes about by combustion of vegetation and mineralization of soil organic matter. Certain wavelengths of solar radiation (such as the infra-red region) are re-radiated back into space by water vapour. When carbon dioxide is present in the atmosphere, this re-radiation is blocked causing increase in surface temperatures. There has been a steady increase in global atmospheric carbon dioxide concentration since the 1950s when measurement started. Burning – wild fires and agricultural combustion also emit pollutants into the atmosphere. The Guinea and transition savanna zones that cover 417,630 km^2 or approximately 45% of Nigeria's land area is subjected to intense annual fires. Deforestation in the forest zone results in the invasion of degraded forests by *Chomolaena odorata* a semi-annual shrub that dries up in the dry season and burns easily. Approximately half of the Guinea and transition zones is burned annually and from this is emitted 27,369 gigagram, Gg (= 10^9 g; cf. 1 kg = 10^3g) carbon, 145 x 10^9 g CH_4, 3,831 x 10^9 g CO, 2 x 10^9 g N_2O and 49 x 10^9 g oxides of nitrogen, NO_x (Isichei *et al.*, 1996). An estimated 125,561 Gg CO_2 is released from burning of cleared forest, delayed emission from decay of unburned wood, and long-term emissions from soil in Nigerian forests and woodlands. 300 Gg CH_4, 4375 Gg CO, 2.4 Gg N_2O and 24 Gg NO_x are estimated to be released from the burning of cleared forest and woodland. Burning of over 80 million cubic metres of wood as fuel is included in these estimates. Carbon dioxide is a commonly known global warming gas and if its global warming potential is taken as 1, that of methane, CH_4 is 22 while nitrous oxide, N_2O has a warming potential of 270. There is also addition of particulates and other global warming gases such as volatile organic compounds to the atmosphere during burning. These have implications for climate.

Tree felling, apart from disturbing the hydrological cycle, affect the turbulence characteristics over areas where tall forest stands are replaced by low crops or cleared land. There is no impediment to wind movement and as the winds move over open expanses they gather speed increasing their power for destruction of structures.

Data presented by the Nigerian Conservation Foundation (NCF, 2002) show that the northwest geo-political zone has 15.21% of its land area under reserves, northeast 6.55%, north central, 10.26%, southwest 16.69%, southeast 1.63% and south-south 15.61%, giving a national percentage of 10.99%. The protected areas include national parks, game reserves, forest reserves and sacred groves run by local communities. There is a general belief that the protected areas may indeed be smaller than 10%. The protected areas in Nigeria and institutions involved in conservation are shown in Tables 7 and 8, respectively.

In addition to deforestation, the factors that affect the extinction or disappearance of food plant resources, especially the indigenous crops include endemism, by which the species being confined or restricted in distribution, can be easily lost if the habitat is destroyed; over-utilization, lack of adequate policy measures, resulting in the neglect of local crop plants, in research, development, utilization and conservation; destructive methods of harvesting and overall deforestation practices (Okafor, 1993).

Arising from these factors, among others, the following categories of plants are now facing a serious threat of extinction:

Table 7: Some Protected Areas of Nigeria (FEPA, 1997)

Protected Area	State Where Located	Legal Status	Area (km^2)
Game Reserves			
Alaira	Niger	Gazetted 1971	296.2
Dagida	Niger	Gazetted 1971	294.2
Gilli-Gilli	Edo	Gazetted 1960	363
Kwiambara	Sokoto	Gazetted 1971	2 614
Opara	Oyo	Gazetted 1971	2 486
Orle River	Delta	Gazetted 1960	1 100
Pai River	Plateau	Gazetted 1971	2 486
Pandam Wildlife Park	Plateau	Gazetted 1972	224
Wase Rock Game Sanctuary	Plateau	Gazetted 1972	2 800
Falgore	Kano	Gazetted 1969	920
Lame Burra	Bauchi	Gazetted 1972	2 058
Sambisa Game Reserve	Borno	Gazetted 1978	686
Hadejia/Baturiya Wetland Game Reserve	Jigawa	Gazetted 1976	297
Strict Nature Reserves			
Snr No. 2 (Akure)	Ondo	No Separate Legal Status	0.32
Snr No. 3 (Usonigbe)	Edo	Within Gazetted Forest Reserve	0.64
Snr No. 44 (Oban)	Cross river	Forest Reserve	0.64
Snr No. 5 (Ribako)	Kaduna	Forest Reserve	1.45
Snr No. 7 (Bonu)	Niger	Forest Reserve	1.45
Snr No. 8 (Bam Ngelzarma)	Borno	Forest Reserve	1.42
Biosphere Reserve			
Omo	Ogun	Biosphere Reserve	1 350.5
National Parks			
Kainji Lake	Niger	Act No. 46 of 1979	5 309
Yankari	Bauchi	1993	2 240
Old Oyo	Oyo	Gazetted 1991	2 529
Gashaka-Gumti	Adamawa	Gazetted 1975	6 363
Cross River	Cross River	Gazetted 1991	4 463
Chad Basin Complex	Borno	Gazetted 1978	2 280
Okomu	Edo	Gazetted 1985	1 100
Kamuku	Kaduna		

Table 8: Institutions Involved in *ex-situ* Conservation in Nigeria

Institutions	Commodity	Conservation Method
Forestry Research Institute of Nigeria (FRIN)	Forest trees and fruits	*In-Situ, Ex-Situ* Seed Genebank and Live Field Genebanks (Arboretum)
Cocoa Research Institute of Nigeria	Cocoa, coffee, tea, cashew, cola	*In-situ* (cola), *ex-situ* seed genebank, live field genebank and *in vitro*
Rubber Research Institute of Nigeria	Latex-producing plants (rubber, *Funtumia* and *Acacia*)	Mainly *Ex-Situ* Seed Genebank and Live Field Genebank
National Cereals Research Institute	Rice (*Oryza sativa*), soyabean, beniseed, groundnut	Mainly *Ex-Situ* Seed Genebank and Live Field Genebank
Nigerian Institute For Oil Palm Research (NIFOR)	Oil palm. Raphia, coconut, date palm	Mainly *Ex-Situ* Seed orchards seed Genebank and Live Field Genebank
International Institute of Tropical Agriculture	Cowpea, yam, bambara groundnut, cassava, banana, maize, sweet potato, rice, taro, multi-purpose trees	Mainly *Ex-Situ* Seed Genebank and Live Field Genebank
National Root Crops Research Institute	Cassava, potato, sweet potato, ginger and coco yam	Live field genebank on-farm
Institute of Agricultural Research, Samaru	Sorghum, millet, wheat, maize, barley cowpea, soybean, groundnut, cotton, tomato, Bambara nut, sunflower, sesame, castor, kenaf, jute, Roselle, onion, okra, ginger, citrus, mango,grape, melon	Seed Genebank and Live Field Genebank
Institute of Agricultural Research, Ibadan	Maize, cassava, coco yam, kenaf, cowpea, soybean, large ruminants, small ruminants, pigs, rabbits, grasscutter, snail	Seed Genebank and Live Field Genebank

National Horticultural Research Institute, Ibadan	Vegetables and fruits, tomato, peppers, onion, melon, okra, African spinach, bitterleaf, garden egg, fluted pumpkin *Corchorus*, *Hibiscus*, *Gnetum*	Seed Genebank and Live Field Genebank *in vitro*
National Center For Genetic Resources and Biotechnology (NACGRAB)	Forest trees, fruit trees, vegetables and horticultural plants	Seed Genebank and Live Field Genebank *in vitro*
Murtala Mohammed Memorial Botanical Garden, Epe, Lagos	Indigenous and exotic trees, shrubs, herbs and horticultural plants	Field genebanks
Nigerian Universities	Indigenous and exotic trees, shrubs, herbs, epiphytic orchids and horticultural plants	Field genebanks

(a) ***Wild plants that are hardly cultivated***: *Dioscorephylum comminsii, Landolphia* spp, *Piper guineense, Gnetum* spp, *Tetracarpidium conophorum,* are very vulnerable; Shrubs and small trees such as *Maesobotrya* spp are also vulnerable. *Dennettia tripetala* and *Synsepalum dulcificum* are also fast disappearing;
(b) ***"Uneconomic" timber species:*** Examples are many and they include fruit and vegetable species;
(c.) ***Recalcitrant species:*** Seeds of many forest trees often lose viability early and, therefore, fail to germinate or regenerate in the wild. *Chrysophyllum albidum* (star apple) is an example.

RECOMMENDATIONS ON HOW TO MAXIMIZE THE VALUE OF PLANTS FOR ECONOMIC GROWTH

The Need for Vegetation Conservation

Forests are a natural environment for education and advancement of science activities. Tropical forests still contain very many unknown useful products such as drugs and other natural products. The world now looks to the forests for the cure of certain diseases and control of pests. Our forests also contain some primates whose drug-induced reactions so closely mirror that of humans that their use for biomedical research has mushroomed in the last two decades.

Savanna occupies nearly 80% of Nigeria's land area and supplies most of the food. The fertility of the savanna soil is thus very important and deforestation leads to soil loss by water and wind erosion, together with depletion of soluble minerals by leaching. Most Nigerian livestock is reared in the savanna zone. Le Houerou (1991) lists 20 herbaceous fodder plants and 22 browse plant genera that are wild and have potential for further development for intensive use as animal feed. Several savanna grasses have been bred as fodder plants in Australia and Central and South America. Many valuable forage species, especially in the Family Papilionioideae are under-utilized (Skerman, 1977).

It is thus compelling that we must conserve our forest and savanna lands for we serve humanity by doing so (Table 6). Conservation here means the rational use of vegetation resources to achieve the highest quality of living for our citizens. Conservation implies some use of vegetation and ecosystems, yet it also implies some degree of preservation so that the biotic and abiotic basis for its potential renewability will not be severely

diminished or destroyed forever.

Having made it clear that conservation does not prevent us from using our vegetation resources, I will now discuss those roles that forest and savanna vegetations play in our lives that make their conservation compelling. Forests and woodlands located in catchments regulate stream flow by retaining water in their roots and humus layers and releasing it as sustained flow over a long period of time. In this way, the forests protect the land beneath them from erosion, reduce flooding and minimize the silting of rivers and canals. Most of Nigeria's catchments are not being protected against degradation. Such protection is vital for ensuring water availability for our future generations.

A rich organic matter layer on the surface characterizes undisturbed forests soils with considerable biotic activity that opens large channels in the soil and allows for rapid infiltration of water. In addition, forest and woodland canopies and litter effectively intercept raindrops and reduce their kinetic energy in high intensity thunderstorms. When vegetation is removed infiltration rates decrease and soils are no longer able to absorb high intensity rainfall. When additional disturbance like ploughing and tillage are added the upper soil biotic channels are destroyed and further biotic activity (earthworms, termites, etc.) in the disturbed soil is discouraged due to the ever-decreasing organic matter content. Soil aggregate deterioration follows and this permits considerable soil detachment and, therefore, a large volume of loose material made available for transportation by overland flow. This is what is deposited as sediments in streams and rivers. Many of our rivers, reservoirs and other water bodies have disappeared in the last twenty years due to sedimentation. Altogether, about 30 million tonnes of soil are lost annually from Nigerian farmlands with the southeastern states losing over 10 million tonnes and Jos Plateau losing 6 million tonnes.

In addition to sediments in water bodies in deforested areas, substantial amounts of soluble matter mainly silicates, phosphates and nitrates are carried in the water bodies. These nutrients enrich the water bodies when they receive flood and overland flows. The subsequent increases in the chemical contents of the waters are often associated with increased algal blooms and excessive weed growth noticed in most of Nigeria's reservoirs.

Ethnobotanical studies in aid of conservation and wider use of plant resources

Conservationists often talk about the problem of disappearing species, but the knowledge of how to use these species is disappearing much faster than the species themselves. In order to collect this information, we need to expand ethnobotanical field research.

Usually, the results of such research are not only lists of useful species but also data on potentially useful wild and cultivated varieties as well as ecological information on how best to utilize tropical ecosystems in a sustainable manner. Such information and programs designed to bring promising species into cultivation will eventually enrich our diets and reduce our dependence on current crop species. Okafor (1993) has listed the activities necessary for domestication to include inventory, studies of ecology, phenology and taxonomy: appropriate selection procedure, propagation techniques, eco-physiological studies, extension education and full utilization. Vegetation conservation has to shift from just carving out areas for conservation to more sophisticated autecological studies that involve biological indexing and species mapping. Such studies give details of species environmental growth conditions, uses and distribution (see Ahuama, 2004). Furthermore, the practice of planting trees must be made part of extension services so that the culture can be fully imbibed at all levels. Botanists should establish germination and early growth conditions of all Nigerian plants. This will encourage the development of community woodlots, groves, etc. More biosphere reserves should also be created to allow full interaction between scientists, conservationists and ordinary people who depend on forest resources (Isichei, 1995a, b).

In addition to domestication, we should be able to fall back on our past successes and engage in plant

breeding programmes. Nigerians successfully bred the 'Ife brown' cowpea and the 'plum tomato', both of which are now important parts of Nigerian cuisine. Breeding also made it possible to have maize grown in almost all ecological zones of Nigeria. We will be able to maximize the attractive features of our wild plants if research efforts in the form of plant breeding and biotechnology become part of their cultivation and management.

A 'BIOMASS' ECONOMY

Harvesting the Sun

As a tropical country with a high percentage of its land able to sustain plant growth, Nigeria can maximally harvest the sun for economic development. The cassava policy of the Federal Government is a welcome development in this direction. As pointed out for maize above, cassava is now grown in almost all ecological zones of Nigeria. Cassava can tolerate nutrient-poor soils and carry out photosynthesis under conditions most other crops may not cope with. To improve its nutritive quality, its protein content can be increased through genetic modification. Pests and diseases that attack it present special challenges that could be surmounted. It is most disheartening that Nigeria has to import sugar when the conditions for the growth of sugar cane is near optimal. Smallholder sugar cane processing should be intensified so that Nigeria can become self-sufficient in sugar. Furthermore, if Nigeria can work with the West African Rice Development Association (WARDA) and improve rice yields, then a major step must have been taken towards strengthening food security.

Industries based on Ethnobotany

a) Okafor (1993) has observed that there are prospects for commercial development of cottage industries based on edible forest species. In addition to enhancing the improved and efficient utilization of the species, such industries could also promote the conservation of the species and aid in rural poverty alleviation (Okali, 2004). Products expected include:
b) Jams and Jellies from *Irvingia gabonensis var gabonensis*, *Chrysophyllum albidum* and *Dialium guineense*;
c) Fruit Juice: With the exception of *C. albidum*, all the species listed above for jam and jelly are also suitable for fruit juice. Other suitable species include *Tamarindus indica* and *Parkia biglobosa;*
d) Confectioneries: Breadfruit flour, processed from *Treculia africana*, can be used to produce a variety of sweetened baked goods including cookies, buns, cakes, biscuits and snacks;
e) Soup mixes: The flour of *T. africana* is suitable for the preparation of a product that tastes much like mushroom soup;
f) Non-alcoholic beverage from *T. africana* seeds;
g) Composite seasoning from *Xylopia spp., Piper guineense, Monodora myristica*, and the leaves of *Ocimum gratissimum*;
h) Oils from the fruits of *Dacryodes edulis, Elaeis guineensis, Irvingia gabonensis* and *Vitellaria paradoxa*;

Utilizing Lower Plants

Lower plants such as algae and bryophytes are also useful for several food and environmental services as well as in industry as shown in Table 9. Mass culturing of algae is important for aquaculture (Isichei, 1990; Isichei and Okusami, 1993).

Table 9: Microalga and their useful products in agriculture, industry and environment. (After Knutsen and Metting, 1990).

Microalga	Products and Uses
(a) Cyanobacteria (blue-green algae):	
Spirulina	Protein, health, foods, linolenic acid, water soluble dyes.
Anabaena, Nostoc, Aulosira, Other genera	biofertilizers
Lyngbya, Oscillatoria, Calothrix	Antibiotics,antineoplastic compounds, toxins, phenolics *Phormidium* emulsifier, polysaccharides
Anabaena, Aphanizomenon,	anatoxin, saxitoxin
Microcystis	
Various genera	phycobilins,restriction endonucleases
(b) Chlorophyceaae (green algae):	
Chlorella	feed protein, wastewater oxygenation, proline, health foods, pigment
Dunaliella	carotene, glycerol
Scenedesmus	wastewater oxygenation, feed protein
Botryococcus	hydrocarbons
Chlamydomonas, Asterococcus	soil conditioners
Neochloris, other genera	triglycerides
Neospongiococcum, other genera	carotenoids
(c) Bacillariophyceae (diatoms)	
Phaeodactylum	wastewater oxygenation, palmitic acid
Chaetoceros, other genera	lipids
Thalassiosira, Navicula,	
Chaetoceros other genera	aquaculture
(d) Cryptophyceaae (cyptophytes)	
Cryptomonas, other genera	carotenoids
(e) Pyrrophyceae (dinoflagellates)	
Gonyaulax, Gymnodinium,	saxitoxin, other toxins

Crypthecodinium other genera	carotenoids
(f) Euglenophyceae (euglenoids)	
Euglena	tocopherol
(g) Rhodophyceaa (red algae)	
Porphyridium	polysaccharides
(h) Crysophyceae (golden-brown algae)	
Isochrysis, Ochromonas	lipids, aquaculture
Prymnesium, other genera	carotenoids
(i) Eustigmatophyceae	
Nannochloris	lipids
(j) Xanthophyceae (yellow-green algae)	
Various genera	lipids, aquaculture

Taming Plant Invasions Through Utilization

A benign action of planting Nypa palm (*Nypa fruticans*) in a botanical garden in Calabar in 1906 has resulted in a devastating invasion of our mangrove swamps of the Niger Delta and other coastal areas. Nypa is currently displacing mangrove plants and has spread from Calabar westward to the heart of the Niger Delta. Control of Nypa is not easy so one option of slowing down its spread is to use the plant. We can learn from Asia but the efforts of the Nigerian Conservation Foundation should be supported to reduce the menace.

Water hyacinth (*Eichhornia crassipes*) has also invaded creeks and canals, starting from Nigeria's western creeks and lagoons. Already, fishing and navigation are being disrupted in many localities. Biological control has been mooted and demonstrated in laboratories but utilization will help to keep the plant in check.

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APPENDIX I.
USES OF NIGERIAN PLANTS AS FOOD

Leafy vegetables

1. *Amaranthus spp.*
2. *Assystasia gangetica*
3. *Boerhavia diffusa*
4. *Ceiba pentandra*
5. *Cyrtospermae senegalense*
6. *Emilia sonchifolia*
7. *Gnetum africana,*
8. *Portulaca oleracea*
9. *Talinum triangulare*
10. *Telfaria occidentalis*

Spices

1. *Aframomum danielli*
2. *Aframomum melegueta* (alligator pepper)
3. *Cleistopholis patens*
4. *Gongronema latifolium*
5. *Monodora myristica*
6. *Monodora tenuifolia,*
7. *Piper guineensis* (African black pepper)
8. *Xylopia aethiopium*

Fresh fruits and juices/seeds

1. *Ananas comosus*
2. *Annona muricata*
3. *Annonidium mannii*
4. *Anona squamosa*
5. *Antrocaryon klaneana*
6. *Antrocaryon klaneanum,*
7. *Arachis hypogeae*
8. *Blighia sapida*
9. *C. perpulchrum,*
10. *Canarium schweinfurthii*
11. *Carica papaya*
12. *Carpolobia lutea*
13. *Chrysophyllum allbidum,*
14. *Chrysophylum perpulchrum*
15. *Citrillus lunatus*
16. *Citrus sp.*
17. *Cocos nucifera.*
18. *Cola acuminata*
19. *Cucurbita maxima*
20. *Dacryodis edulis*
21. *Dennettia tripetala*
22. *Diallium guineensis,*
23. *Dissotis grandiflora*
24. *Eribroma oblonga*
25. *Eugenia jambos*
26. *Garcinia kola*
27. *Icacina trachanta*
28. *Irvingia gabonensis*
29. *Irvingia gabonensis var. dulcis,*
30. *Landolphia dulcis*
31. *Landolphia owariensis*
32. *Lecaniodiscus cupanioides*
33. *Musa spp.*
34. *Myrianthus aborea*
35. *Napoleana vogelii*
36. *Pachira aquatica*
37. *Saba florida*
38. *Sorindea warnekei*
39. *Spondias mombin*
40. *Synsepalum dulcificum*
41. *Syzygium guineense*
42. *Tetracarpidium conophorum*
43. *Trichoscypha acuminata*

Soup Condiments

1. *Abelmoschus esculentus*
2. *Afzelia bella*
3. *Afzelia bipindensis*
4. *Brachystegia eurycoma*
5. *Brachystegia kennedyii*
6. *Brachystegia nigerica*
7. *Brachystegia spp.*
8. *Capsicum spp.*
9. *Citrillus lanatus*
10. *Cucumeropsis manic*
11. *Gongronema latifolium*
12. *Irvingia gabonensis va. dulcis*
13. *Irvingia gabonensis var. excelsa*
14. *Lycopersicum sp.*
15. *Pentaclethra macrophylla*
16. *Ricinus communis*
17. *Solanum melongena*
18. *Telfaria occidentalis*

Sweeteners

1. *Dioscoreophyllum cumminsii*
2. *Dissotis grandiflora*
3. *Synsepalum dulcificum*
4. *Thaumatococcus danielli*

Food wrappers

1. *Thaumatococcus danielli*
2. ***Mitragyna ledermannii*** (for cola nuts)