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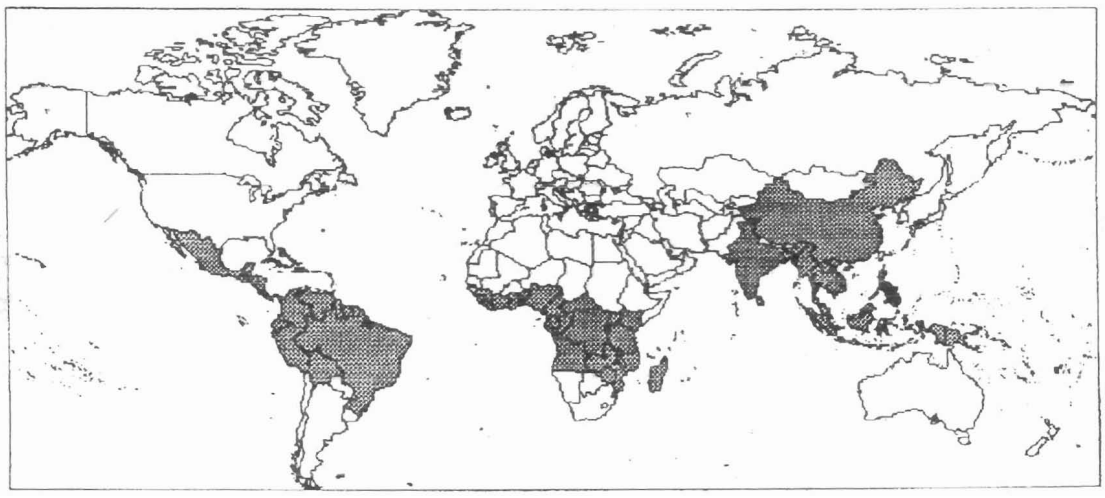
OMO BIOSPHERE RESERVE, CURRENT STATUS, UTILIZATION OF BIOLOGICAL RESOURCES AND SUSTAINABLE MANAGEMENT

NIGERIA

by

Augustine O. ISICHEI



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Omo Biosphere Reserve, Current Status, Utilization Of Biological Resources And Sustainable Management (Nigeria)

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ABSTRACT

Omo Biosphere Reserve, which derives its name from River Omo that traverses it, is located between latitudes 6° 35' to 7° 05' N and 4° 19' to 4° 40' E in the Ijebu area of Ogun State in southwestern Nigeria. The Reserve was constituted in 1925 and covers about 130 500 hectares, about 20 km from the Atlantic coast in its southernmost parts. Geologically the Reserve lies on crystalline rocks of the undifferentiated basement complex which in the southern parts is overlain by Eocene deposits of sand, clay and gravel. The terrain is undulating and the maximum elevation of 150 m above sea level is towards the west while the lowest parts of the Reserve are in the south where the River Omo joins River Oni, the Reserve's eastern boundary, before flowing into the Lekki Peninsular on the Atlantic coast. There are swamps in the south especially near the junction of the two rivers. The soil is tropical ferruginous (Ferric luvisol, according to FAO nomenclature). The mean annual rainfall ranges from about 1600 to 2000 mm with two annual peaks in June and September, with November and February being the driest months. The Reserve is in the mixed moist semi-evergreen rainforest zone. The northern parts of the Reserve is relatively dry forest with typical species such as Sterculia rhinopetala while Nauclea diderrichii and Terminalia superba are common in the wetter central parts. In the wet forests on sandy swampy soils in the south Lophira and trees in the Meliaceae family are common.

There is a 460 ha Strict Natural Reserve (SNR) which was established in 1946 as a inviolate plot but later designated an SNR, in the north central area of the Reserve. An elephant sanctuary has recently been created around the SNR. Around the sanctuary and the SNR is the 'open' area of the Reserve where experiments and other treatments are located. There are about eight enclaves some of them fairly large and inhabited by farmers and hunters in the open area. There is also a sawmill and a *Gmelina* plantation. Timber from the Reserve

and *Gmelina* logs from the plantation support the sawmill while the *Gmelina* is also exploited as raw material for the recently commissioned Iwopin Paper Mill by Lekki Peninsular. Farmers also exploit wildlife in the Reserve for meat and several non-timber forest products. The farmers practice the Taungya system of farming whereby they participate in forest plantation establishment by nurturing tree seedlings during cropping on land allocated by the Reserve administering authority.

Omo Biosphere Reserve, along with other reserves in the Nigerian forest zone has been used for studies on tropical moist forest regeneration with emphasis on 'economic' species and has since 1978 being the focus of the activities of the Nigerian Man and Biosphere (MAB), Theme One Project. Theme One is concerned with the 'Ecological effects of increasing human activities in tropical and sub-tropical forest ecosystems' and studies have been carried out on natural forest structure, plant and animal species composition, regeneration processes and response to treatments and human interference. There has been deep concern about the diminishing Nigerian forest estate and the rapid changes taking place in forest ecosystems including the socioeconomic activities of the people interacting with the changing forest landscape.

The MAB studies have shown that conversion of natural forest to Gmelina plantation does not necessarily lead to total loss of biodiversity. Forest conversions are inevitable in the foreseeable future in view of current levels of wood demand and the issue of management of plantations for biodiversity sustenance deserves international research attention as non-timber forest products get more emphasis. Furthermore, the forestry sector is joining the emerging trend of privatization of management of natural resources. Already in Nigeria the benefits of private crop plantations are evident but the gestation period before private forests are harvestable has made private forests unattractive. Management of private and communal forests in a sustainable manner as opposed to subsistence farming should interest many tropical countries.

Forest Reserves are locally controlled in Nigeria but the Strict Nature Reserves are managed by the forestry Research Institute of Nigeria (FRIN), a Federal Government agency. There has been conflicts of interest arising from differences in perception of the roles of Reserves. This report discusses these conflicts in terms of biodiversity conservation and sustainable development. Recommendations are made on the management of Biosphere Reserves as exploitable economic resource on the one hand and as global life support systems on the other.

RESUME

La Réserve de la Biosphère de l'Omo doit son nom à la rivière Omo qui la traverse. Elle est située entre les latitudes 6° 35' et 7° 05' N et entre les longitudes 4° 19' et 4° 40' E dans la zone d'Ijebu, État d'Ogun, sud-ouest du Nigeria. La Réserve fut créée en 1925 et occupe près de 130.500 hectares, à environ 20 km de la côte atlantique, dans sa partie la plus méridionale. Au point de vue géologique, la Réserve s'étend sur des roches cristallines du complexe basal indifférencié surmonté, dans sa partie sud, par des dépôts éocènes de sable, argile et graviers. Le terrain est ondulé et l'altitude maximale de 150 m se trouve dans la partie ouest alors que les parties les plus basses de la Réserve sont dans le sud, où la rivière Omo conflue avec la rivière Oni, limite orientale de la Réserve, avant de se jeter dans la Péninsule de Lekki, sur la côte atlantique. Il y a des marais dans le sud, surtout près du confluent des deux rivières. Le sol est tropical ferrugineux (luvisol ferrique selon la nomenclature de la FAO). La pluviométrie annuelle moyenne varie de 1600 à 2000 mm avec deux pics annuels, en Juin et Septembre. Les mois de Novembre et Février sont les mois les plus secs. La Réserve est située dans la zone de forêt pluviale semi-décidue humide. La partie nord de la Réserve est une forêt relativement sèche avec des espèces typiques comme *Sterculia rhinopetala* alors que *Nauclea diderrichii* et *Terminalia superba* sont communs les parties centrales plus humides. Au sud, dans les forêts humides, sur les sols sableux et marécageux, *Lophira* et arbres de la famille des Meliaceae sont communs.

Dans le centre-nord de la Réserve, une Réserve Intégrale Naturelle (RIN) de 460 ha fut établie en 1946 en tant que parcelle vierge et constituée plus tard en RIN. Un sanctuaire pour éléphants a été récemment créé autour de la RIN. Autour du sanctuaire et de la RIN se trouve la zone "ouverte" de la Réserve où sont réalisés diverses expérimentations. Il y a, dans la zone ouverte, environ 8 enclaves, dont certaines sont plutôt grandes et habitées par des fermiers et des chasseurs. Il y a également une scierie et une plantation de *Gmelina* . Les arbres de la Réserve et les troncs de *Gmelina* de la plantation alimentent la scierie et les *Gmelina* sont aussi exploités comme matière première pour la société *Iwopin Paper Mill* récemment créée par Lekki Peninsular. Les fermiers exploitent également faune et flore sauvage dans la Réserve, pour la viande et pour des produits forestiers autres que le bois. Les fermiers pratiquent le système Taungya de culture par lequel ils participent à la création d'une plantation forestière en soignant les jeunes plants d'arbres pendant les récoltes, sur les terres allouées par l'administration de la Réserve.

La Réserve de la Biosphère de l'Omo , en compagnie d'autres réserves dans la zone de forêt nigériane, à servi de cadre pour des études sur la régénération des forêts tropicales humides, en particulier sur les essences à valeur 'économique'. Depuis 1978 elle a été le point

focal des activités du Projet Thème Un du Comité MAB Nigérian. Thème Un s'intéresse aux 'Effets écologiques de l'augmentation des activités humaines dans les écosystèmes forestiers tropicaux et subtropicaux' et des études ont été menées sur la structure de la forêt naturelle, composition des espèces de plantes et d'animaux, processus de régénération et réponse aux traitements et aux interférences humaines. Il y a eu de profondes inquiétudes sur la diminution du domaine forestier nigérian et sur les changements rapides qui interviennent dans les écosystèmes de forêt, y compris en matière d'activités socio-économiques des populations qui induisent des changements du paysage forestier.

Les études du MAB ont montré que la conversion des forêts naturelles en plantations de *Gmelina* ne conduit pas nécessairement à une perte totale de biodiversité. Les conversions de forêt sont inévitables dans un futur prévisible, en vue de répondre au niveau usuel de la demande de bois et la question de la gestion des plantations pour l'entretien de la biodiversité mérite l'attention de la recherche internationale, dans la mesure où les produits forestiers autres que le bois sont davantage demandés. De plus, le secteur forestier rejoint le courant naissant de la gestion privatisée des ressources naturelles. Déjà, au Nigeria les bénéfices des récoltes de plantations privées sont évidents mais la période de gestation avant que les forêts privées ne puissent être récoltées ne rend pas celes-ci attractives. La gestion durable des forêts privées et des forêts communales, en opposition aux cultures de subsistance, devrait intéresser de nombreux pays tropicaux.

Les Réserves forestières sont contrôlées localement au Nigeria mais les Réserves Naturelles Intégrales sont gérées par l'Institut de Recherche forestière du Nigeria (FRIN), une agence fédérale gouvernementale. Il y a eu des conflits d'intérêt en raison des différences de perception des rôles des Réserves. Ce rapport discute ces conflits en termes de conservation de la biodiversité et de développement durable. Des recommandations sont faites pour que les Réserves de la Biosphères soient gérées, d'une part, comme des ressources économiques exploitables et, d'autre part, comme un système supportant globalement la vie.

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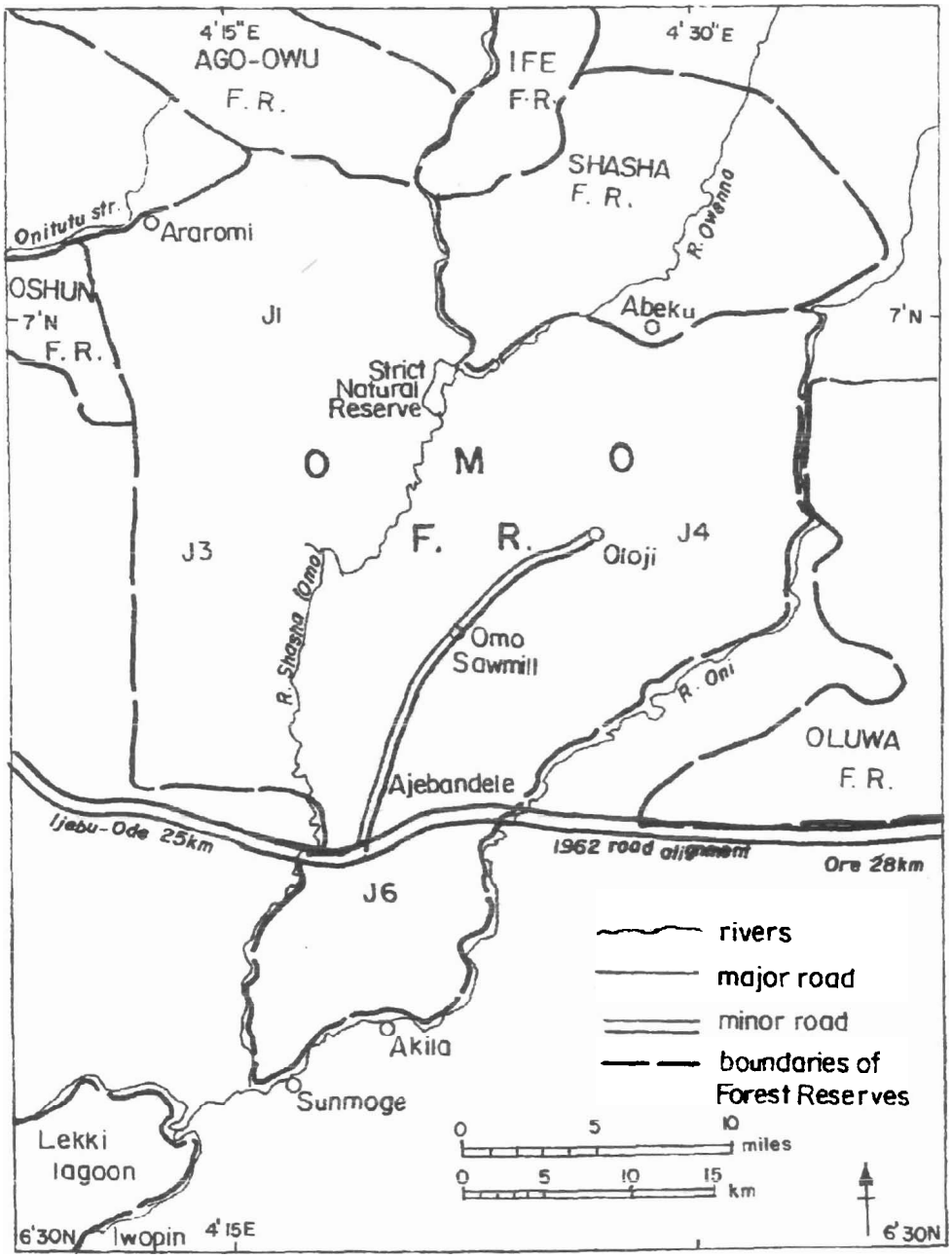
I- INTRODUCTION

Biosphere Reserves are sites for the conservation, for present and future use of the diversity and integrity of biotic communities of plants and animals within natural ecosystems, and are used to safeguard the genetic diversity of species on which their continuing evolution depends (Mackinnon and Mackinnon 1986). They serve as benchmarks or standards for measurement of long-term changes in the biosphere as a whole and are consequently important sites for environmental monitoring. They are conceived of as places where government decision-makers, scientists, managers and local people co-operate in developing a model programme for managing land and water to meet human needs while conserving natural processes and biological resources (Okali 1991). Biosphere Reserves also provide opportunities for baseline ecological research and for studies on the impacts of human interference as well as for monitoring long-term changes in natural ecosystems. In addition to these they also serve as sites for environmental education and training. Usually, Biosphere Reserves should be large enough, at least 1000 ha to contain the range of habitats that can sustain the biological populations protected and they must be zoned into: (i) a core area from which even manipulative research is excluded, (ii) a buffer zone around the core area in which manipulative research may take place, and (iii) a transition zone where compatible, sustainable human use may be permitted.

The core area of Biosphere Reserves is designated Strict Natural Reserve, SNR. An SNR should cover a minimum of 500 ha in the high forest zone and extend over the major habitat types of the ecological formation in which it is located. Strict Natural Reserves are created to protect representative samples of natural ecosystems for preservation of biodiversity and ecological processes, for scientific study, environmental monitoring, education and for the maintenance of genetic resources in a dynamic and evolutionary state. Local needs of forest resources use should be allowed for by designing buffer zones of sufficient width and permitting various categories of compatible uses and adhering to the provisions of the African Convention for the Conservation of Nature and Natural Resources as it relates to the protection of Strict Natural Reserves. The United Nations Educational, Scientific and Cultural Organization (UNESCO) pioneered the setting up of biosphere reserves when it hosted the 1968 UNESCO Conference on Rational Use and Conservation of the Resources of the Biosphere. This led to the establishment and global interest in biosphere reserves in several countries including Nigeria.

There are 323 Biosphere Reserves world wide, in 82 countries covering 80% of the world's biogeographical areas. There are 31 Biosphere Reserves in 17 countries within the Afrotropical Realm (Mackinnon and Mackinnon 1986).

Map 1 : *Omo Biosphere Reserve, Nigeria (From Lowe 1993)*



II- CURRENT STATUS OF OMO BIOSPHERE RESERVE

1) Location, Geology and Climate

Omo Biosphere Reserve, which derives its name from River Omo that traverses it, is located north of Sunmoge, between latitudes 6° 35' to 7° 05' N and 4° 19' to 4° 40' E in the Ijebu area of Ogun State in southwestern Nigeria (Map 1). The Reserve was constituted in 1925 as part of a bigger Shasha Forest Reserve. Shasha was later split into Omo, Oluwa and Shasha Forest Reserves, the last two lying to the east and north-east of the present Omo. To the north and north-west of the Reserve (Map 1) are Ife and Ago-Owu, and Oshun Forest Reserves, respectively. Omo covers about 130 500 hectares, which includes a 460 ha Strict Natural Reserve (Okali and Ola-Adams 1987), plus about 6 500 ha of enclaves (Photo 1) and cut out areas with a total of about 20,000 inhabitants (Dike 1992); is roughly triangular in shape, and tapers southwards with its southernmost tip about 20 km from the Atlantic coast. River Oni forms its eastern boundary while the western boundary at the southern tip is, for about the first 50 km, formed by River Omo (formerly River Shasha) before the Reserve broadens out such that River Omo is centrally located for the rest of the length of the Reserve.

Geologically the Reserve lies on crystalline rocks of the undifferentiated basement complex which in the southern parts is overlain by Eocene deposits of sand, clay and gravel. The terrain is undulating and the maximum elevation of 150 m above sea level is towards the west while the lowest parts of the Reserve are in the south where the River Omo joins River Oni before flowing into the Lekki Peninsular on the Atlantic coast. The Lagos-Ore-Benin Highway passes through the southern tip of the Reserve.

The mean annual rainfall ranges from about 1600 to 2000 mm with two annual peaks in June and September, with November and February being the driest months (Lowe 1993, see also Hall 1977).

2) The Biological Resources of the Reserve

The Reserve is in the mixed moist, semi-evergreen rainforest zone, in the Congolian sub-unit of the Guinea-Congolian Centre of Endemism or Phytochorion (White 1983, Mackinnon and Mackinnon 1986). The Guinea-Congolian zone is extremely rich in species and has very high levels of endemism. The area is the richest in Africa for butterflies, a high proportion of which species are endemic, highest in richness of bird species and richest in mammal diversity (Mackinnon and Mackinnon 1986). Sanford (1969) observed 24 orchid species 12 of which are characteristic of wet forest sites while 3 are exclusive to Omo in his study of orchid species in 31 sites in Nigeria.

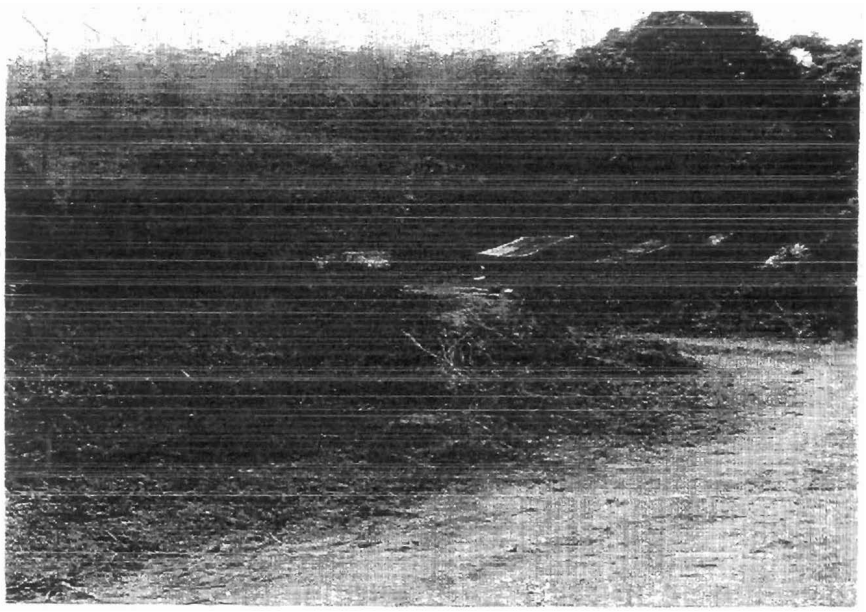


Photo 1 : One of the small enclaves within the Omo Biosphere Reserve. A *Gmelina* plantation is in the background.

The northern parts of Omo Biosphere Reserve is, considering the north-south length, relatively dry forest. Hall (1977) has concluded that much of the variation in forest species composition was associated with soil differences and that a primary division of the Nigerian high forest should be made according to the underlying soil type-Ferrallitic or Ferruginous Tropical Soil. Forests on Ferruginous Tropical soil could, according to him, be usefully divided based on rainfall, but allowance for other factors was needed. Forests on Ferrallitic soil, on the other hand could be divided on a geographical basis which mainly reflect factors other than rainfall. Hall's ordination of Nigerian high forests based on pre-exploitation species composition put Omo sample plots in the wet sub-group of the ferruginous tropical soil group. The abundant plant species in forests on ferruginous soils include *Hunteria umbellata, Lannea welwitschii, Terminalia superba* and *Triplochiton scleroxylon.* Hall listed the following species as characterizing the wet sub-group:

Bridelia atroviridis, Celtis milbraedii, Discoglypremna caloneura, Erythrophloeum ivorense, Khaya ivorensis, Mitragyna ciliata, Pausynstalia macroceras, P. talbotii, Scottellia coriacea.

It has to be noted that the interest in high forests has almost always been in timber species. Okali and Ola-Adams (1987), however, report on the general plant species composition of a mature plot in the Reserve with species in the families Euphorbiaceae,

Rubiaceae, Ebenaceae, Meliaceae, Annonaceae, Apocynaceae, Moraceae and Sterculiaceae being the most abundant in that order. They observed about 50 species in 25 families in 0.75 ha plots. They further observed a woody stem density of 563 per hectare and a basal area of 29.6 m^2 ha-1 in the mature plot, and 310 and 12.7 respectively, in a 28-year old plot. A woody dry matter of 229.6 t ha-1 was observed in the mature plot and 91.1 t ha-1 in the 28-year old plot.

Dike (1992) has observed that the most abundant climax forest species in the Strict Natural Reserve were *Diospyros dendo, Drypetes paxii, Rinorea dentata* and *Strombosia postulata*. The most frequent pioneer species was *Funtumia elastica* while the common climbers were *Hippocratia pallens* and *Strychnos spp*. The herbs *Lankesteria thyrsoidea, Geophila afzelii* and *Cyanastrum cordifolium* were abundant.

It appears that the SNR now serves as a refuge for animals driven by human disturbances from other parts of the Reserve. A wide variety of mammals and fish are present in the Reserve (Table 1).

In addition to the mammals and fish listed, some reptiles such as Nile crocodile and monitor lizard and the snakes rock python and black cobra were also sighted. Several birds were also seen.

3) Resource Utilization in The Reserve

a- Traditional Use of the Forest-Non Timber Forest Products

Lamb (1990) has observed that in Papua New Guinea 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 is true for southwestern Nigeria as 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) report that out of the estimated 4 614 plant species in Nigeria, 205 are endemic out of which 38 are in the western and central parts of Nigeria. Many of these species go into multipurpose or particular uses. 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* and clothe dyeing is a big industry 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. Wildlife is also extensively used. Animals are eaten, the plumes or furs are used as decorations, skins are used for drums and bones are used for tools.

Table 1 : *Some animals sighted at the Strict Natural Reserve, Omo Biosphere Reserve, Nigeria (From Dike 1992).*

a) Fish

FAMILY	SPECIES	COMMON NAME
Bagridae	*Bagrus docmac*	Catfish
	Chrysischthys nigrodigitatus	Silver catfish
Centropomidae	*Lates niloticus*	Nile perch
Cichlidae	*Oreochromis niloticus*	Tilapia
Claridae	*Clarias anguillaris*	Mudfish
	Clarias spp.	Catfish
	Heterobranchus bidorsalis	
Malapteruridae	*Malapterurus electricus*	Electric fish
Mochokidae	*Synodontis nigrita*	Catfish
	S. membranacous	Catfish
Mormyridae	*Gnathonemus tamandus*	Trunk fish
	Mormyrus rume	Trunk fish
Osteoglossidae	*Heterotis niloticus*	

b) Mammals

FAMILY	SPECIES	COMMON NAME
Bovidae	*Syncerus caffer*	Buffalo
	Tragelaphus scriptus	Bush buck
Suidae	*Choeropsis liberiensis*	Pigmy hog
	Potamochoerus porcus	Red river hog
Cephalophidae	*Cephalophus maxwelli*	Maxwell duiker
	C. rufilatus	Red flanked duiker
	C. sylvicultor	Yellow headed duiker
	Cephalophus spp.	Duikers
Felidae	*Panthera leo*	Lion
	Caracal caracal	Hunting dog
Viverridae	*Vivera civetta*	African civet
Manidae	*Manis spp.*	Pangolin
Procaviidae	*Dendrohyrax dorsalis*	Tree hyrax
Trichechidae	*Trichechus senegalensis*	West African manate
Anomaluridae	*Anomalurus beecrofii*	Fly squirrel
	Idiurus macrotis	Pygmy fly squirrel
	Epixerus epli	Palm squirrel
Muridae	*Rattus rattus*	Common rat
Cercopithecidae	*Cercopithecus mona*	Mona monkey
	Cercopithecus spp.	Monkeys
Colobidae	*Colobus badius*	Colobus monkey
Pongidae	*Pan troglodytes*	Chimpanzee
Elephantidae	*Loxodonta africana cyclotis*	Elephant

Of the almost 300 plants listed as being of medicinal value in western Nigeria (Adjanahoun et al. 1993), over two hundred are found in Omo or ecologies very similar to it. These plants are spread over several families including ferns, bryophytes, and some fungi.

Edible wild plants which could be used as leafy vegetables, edible fruits and seeds and starchy roots and tubers include the following (Ola-Adams and Onyeachusim 1993, Isawumi 1993, Morakinyo 1994; a long list of usable plants is also given in Spore 1994. See also Photos 2, 3 & 4):

i) Leafy vegetables e.g. *Boerhavia diffusa, Portulaca oleracea, Ceiba pentandra, Cyrtosperma senegalense, Assytasia gangetica, Gnetum africana, Emilia sonchifolia*;

ii) Spices, such as *Piper guineensis, Monodora tenuifolia, Aframomum melegueta, A. daniellii, Xylopia aethiopium*;

iii) Fresh fruits and juices *Annonidium manii, Antrocaryon klaneana, Canarium schweinfurthii, Carpolobia lutea, Chrysophyllum albidum, C. perpulchrum, Diallium guineensis, Saba florida, Landolphia owariensis, Sorindea warnekei, Trichoscypha acuminata, Dissotis grandiflora, Dacryodes edulis, Irvingia gabonensis var. dulcis, Lecaniodiscus cupanioides, Myrianthus arborea, Spondias mombin, Napoleana vogelii, Synsepalum dulcificum*;

iv) Soup condiments, e.g. *Pentaclethra macrophylla, Gongronema latifolium, Brachystegia* spp. *Irvingia gabonensis* var. *dulcis, I. gabonensis* var. *excelsa*;

Photo 2 : Edible fruits being sold in one of the villages inside the Reserve. In the first row are seeds of *Afzelia africana*, then seeds of *Brachystegia eurycoma*. The seeds in the last row could not be identified. Onions (not produced in Omo) are in the basket.

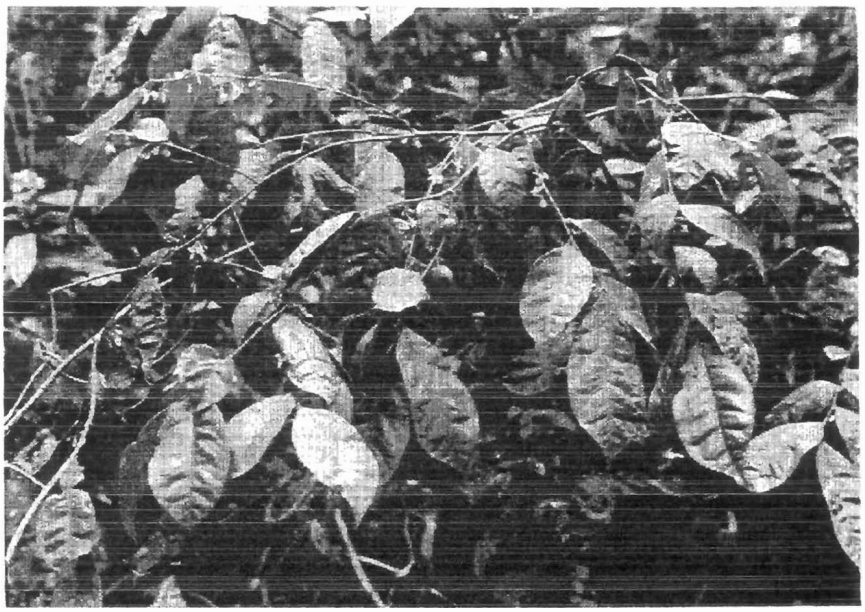


Photo 3 : Edible wild fruit of the understorey shrub, *Carpolobia lutea* beyond Oshoku in the Omo Biosphere Reserve.

Photo 4 : *Aframomum melegueta* (pink flower), used as a spice, in the Omo Biosphere Reserve.

v) Sweeteners, such as *Dissotis grandiflora, Dioscoreophyllum cumminsii, Synsepalum dulficum;*

vi) Edible seeds-*Garcinia cola, Eribroma oblonga, Tetracarpidium conophorum.*

vii) *Thaumatococcus danielli* is extensively used for wrapping food.

Morakinyo (1994) has 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 which have the greatest commercial importance. These are *Gnetum africana*, chewing sticks and rattan (*Garcinia mannii, Massularia acuminata; Calamus spp., Laccosperma spp.* and *Oncocalamus spp.*, and *Eremospatha spp.*), Bush mango (*Irvingia gabonensis*) and Bushmeat (meat from wildlife). These same resources, with the possible exception of fewer species of rattan, are also found in the Omo Biosphere Reserve and playing similar economic roles.

Apart from these species directly utilised some wild or semi-wild relatives of cultivated crops also abound in the wild, including Omo Biosphere Reserve. Ola-Adams (1986) listed 54 such species which include species of *Capsicum, Coffea, Cola, Dioscorea, Solanum, Irvingia* and *Ipomea*. These species will be needed for the genetic improvement-resistance to new diseases and pests, environmental stresses, and increased productivity and nutrient content, of those already being utilised.

b- Timber Resources

Forests are primarily exploited, especially since colonial times, for export timber. Redhead (1971) has grouped timber yielding forests into four and Omo is placed, along with Akure-Ofosu, Idanre, Ijebu-Ife, Onishere, Oluwa and Otu,all in southwestern Nigeria, in Group 2-forests in the 1524-2032 mm annual rainfall zone (see also Hall 1977). The following species were considered as 'economic' in 1952 when various silvicultural treatments were commenced at Omo to maximise the timber resources of the Reserve (Okali and Ola-Adams 1987, Lowe 1993):

Afzelia bipindensis, Antiaris africana, Brachystegia nigerica, Chlorophora excelsa, Cordia platyhyrsa, Entandrophragma angolense, Eribroma oblonga, Erythrophleum spp., Guarea cedrata, G. thompsonii, Khaya ivorensis, Lophira alata, Lovoa trichilioides, Mansonia altissima, Mitragyna ledermannii, Nauclea diderrichii, Nesogordonia 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 (Photo 5).

Omo is divided into five timber working areas-1, 47, 49, 53 and 58 and later into J1, J3, J4 and J6 (Map 1). Exploitation of area J6 began as early as 1914. Selected tree species: *Khaya ivorensis*, for export, *Lophira alata, Nauclea diderrichii, Sacoglottis gabonensis* and *Uapaca spp.* used locally, mainly for railway sleepers, were logged. Logging was initially near rivers to enable the logs float down to the base camp. Later, tractors were used for logging. Richards (1939) reports seeing primary forests mainly in swampy areas and in areas far away from rivers during the Cambridge Expedition of 1935 (but see Okali and Ola-Adams 1987). At present most of the Reserve (except the Strict Natural Reserve) has been selectively logged at one time or the other.

The fact that tropical forests are exhaustible was realised very early in the exploitation history and to ensure continuous timber supply, many African forestry departments tried to take up the challenge of silviculture in moist forests, beginning in the 1950's. Some of the methods relied on natural regeneration, others utilized techniques for improving the dynamics

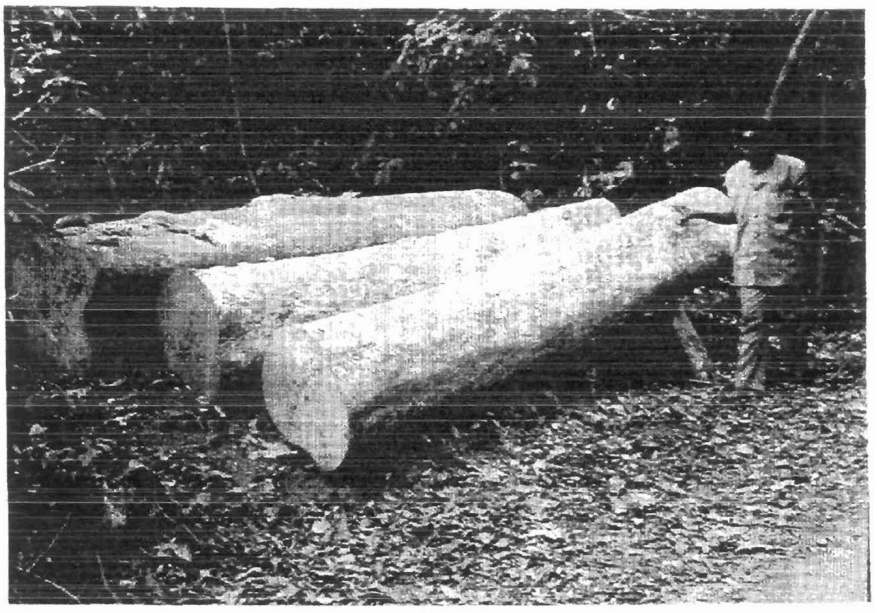


Photo 5 : Logs from *Celtis zenkeri*. Not regarded as 'economic' this tree is now heavily exploited.

of the stands, and others used artificial regeneration (Schmidt 1991). The forest management technique based on natural regeneration used in Nigeria was the Tropical Shelterwood System, TSS (Okali and Ola-Adams 1987, Schmidt 1991). The objective of TSS was to enhance the natural regeneration of valuable species before harvesting by gradually opening up the canopy by poisoning of undesirable trees and freeing of regeneration by climber-cutting, to obtain at least 100 one-metre high seedlings per ha over 5 years (Schmidt 1991). Okali and Ola-Adams

(1987) list 13 forest sites so treated in Nigeria between 1952 and 1972. The Omo site, Investigation No. 208, was instituted in 1952 and covered 192 ha. Kio (1978) concluded that TSS was effective in influencing regeneration and growth of natural forest stands. Selective poisoning or exploitation accelerated development of poles and trees and climber-cutting improved stocking of saplings. TSS had, however, to be dropped because it led to exuberant growth and spread of climbers following canopy opening and thereby the failure of valuable species to grow adequately. Poisoning also eliminated trees which later turned out to be commercially valuable. In many parts of Africa positive management of natural forests have more or less disappeared due to lack of funds or the inviability of the management techniques. Exploitation has, however, continued at a faster pace in response to increasing local demand.

The difficulties associated with the management of natural tropical forests led most forest managers to conclude that silvicultural methods of enhancing natural regeneration following logging are ineffective, and are therefore not cost effective (Nnachi 1993). In view of the diminishing extent of accessible land available for forestry, rate of logging well beyond the maximum sustainable yield in virtually all regions of Nigerian forests, and the variable and slow response of natural forests to silvicultural treatment, forest plantations are widely regarded as an economically attractive alternative form of forestry management. There has been a shift towards industrial plantations based fast growing soft wood and light hard wood species. The emphasis on fast growing species reflects a desire on the part of forest managers for plantations that have (i) short rotation, providing a rapid return on investment; (ii) have simple stand structures, facilitating silvicultural treatment; (iii) provides a uniform product and can be harvested in a single felling.

Plantations were started in southwestern Nigeria at the beginning of this century. Species used were mainly *Tectona grandis* (teak) and *Nauclea diderrichii*. Several other species such as *Anogeissus leiocarpus, Milicia excelsa, Cedrella odorata*, and *Triplochiton scleroxylon* were also included in early trials. *Gmelina arborea* was introduced into Nigeria in 1932 to provide pit props at the Enugu (Eastern Nigeria) coal mines and following an expansion of interest in the species as a pulp wood, it has become the dominant industrial plantation species in the southern states of Nigeria. First plantings of the species began in Omo in 1966. There were 216,026 ha of industrial forest plantations in Nigeria as at 1990 (FORMECU 1991). Ogun State, where Omo is located has 29 740 ha of plantations, 21 994 of which are in Omo.

The Taungya system of farming is used for plantation establishment. Taungya, or agri-silviculture is defined as a method of raising forest crops in combination with agricultural crops. Usually, agricultural crops are planted before the tree crops which number up to 79 species worldwide (King 1968). In the early years of Omo, tree crops planted included *Nauclea diderrichii, Lovoa trichilioides, Khaya ivorensis*, and *Entandrophragma spp.* but

since it was decided to massively plant *Gmelina* it has been the major, if not the exclusive species.

Dawkins (1961) has indicated that when optimum utilization is needed, intensive replacement of natural forest ecosystems takes precedence over extensive improvement. This was the situation in Nigeria at the time agri-silviculture was introduced. There were also intense demands on forest reserves for food production. The introduction of agri-silviculture was the only method of ensuring the survival of the forest estate in these areas. It now appears that with the prevailing scarcity of land for agriculture and forestry under single land use, Taungya has come to stay and ways have to be found to accommodate other roles that forestry plays in the environment. Taungya may prove to be one of the cheapest means of establishing forests of all kinds and at the same time supplying food for the general population (Roche 1993). Tree-crop plantations, such as cocoa, could also be established along with the trees.

Jaiyesimi (1966) advocated the establishment of forest villages to ensure the success of agri-silviculture. When Omo Forest Reserve was first proposed in 1916, there were 37 camps and small villages along the banks of the Omo and Oni Rivers of which only four Ajebandele, Molofe, Oke Ode and Sunmoge, plus the forestry camp at Akilla then contained more than ten houses (Lowe 1993). According to Lowe, these settlements were said not to exist before the 1880's and were occupied by hunters, fishermen and rubber collectors. There are several settlements inside the Reserve today, the most prominent of which are "J4" where the Omo Sawmill is located, and Oshoku and Etemi, both of which are close to the Strict Natural Reserve. Several trades have developed in the settlements and these include carpentry, tailoring, firewood collection, petty trading, food vending, palm (especially *Raphia*) wine tapping and traditional medical practice.

Lowe (1993) observes that plantations of the exotic tree, *Gmelina arborea* (and some Teak?, Photos 6 & 7) were begun at Ajebandele with a view to forming pulpwood plantations to supply a pulp/paper mill at Iwopin on the Lekki Lagoon on the Atlantic coast. By 1980 two thousand hectare had been planted and a World Bank Project was started with the intention of planting, ultimately, about 40% of the area of the Reserve to produce both sawlogs and pulpwood. At present, a total area of about 21 994 ha has been planted. The Iwopin Paper Mill was commissioned in 1994 and the Gmelina plantation has been supplying the Omo Saw Mill (a brief history of which is given below) with timber (Photos 7 & 8).

Lowe writes that a Government sawmill was erected during the 1914-1918 world war at Ijora near Lagos and logs were shipped from Sunmoge in rafts and lighters. A forest tramway extended from Sunmoge to the present location of the Omo sawmill also now known as "J4", because it is located in one of the timber exploitation blocks of the name (see Figure 1).

Photo 6 : Teak plantation at the entrance to the Omo Biosphere Reserve, along the Benin-Ore highway

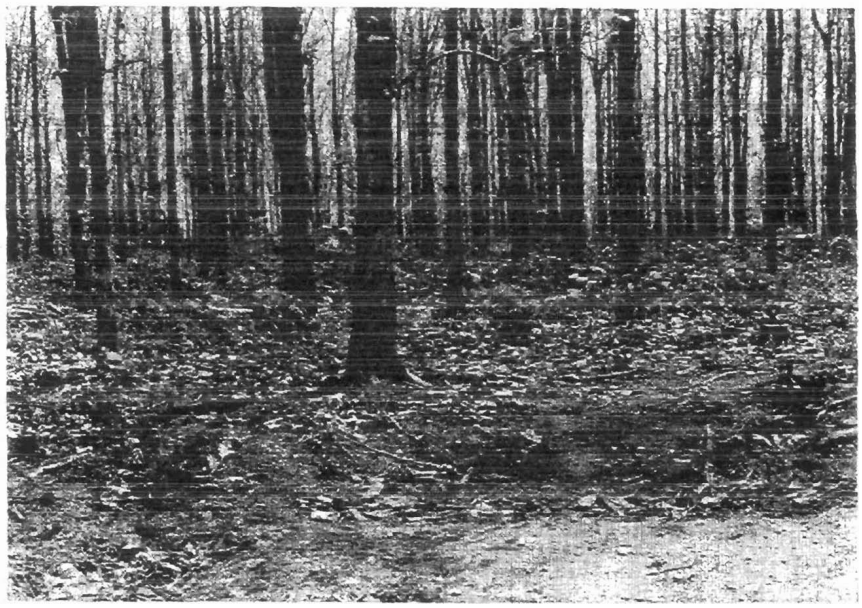


Photo 7 : Teak plantation at the entrance to the Omo Biosphere Reserve, along the Benin-Ore highway

Photo 8 : *Gmelina* logs being loaded into a lorry, and deposited on the grounds of Omo Saw Mill.

A forestry station was opened at Akilla and compensatory plantations of Nauclea were initiated there from 1918 to 1939 when the plantation area totalled 456 ha. Meanwhile, a timber company was formed which established two sawmills at Sunmoge and Eba. The sawmill machinery were eventually transferred to Aponmu near Ondo. In 1935 a timber concession was granted for the exploitation of Blocks J4 and J6. These concessions changed hands several times and there were company re-groupings. The Omo Sawmill was erected in 1951 and commenced production in 1953. The Sawmill was sold to private operators in the early 1970's but was taken over by Ogun State Government as Gateway Sawmills Ltd. The Sawmill, plantations and the unplanted, natural forest blocks are today managed by the Ogun State Plantation Project. A Chinese company was awarded a concession to exploit 100 km^2 of Block J1, an area largely unexploited for several decades and also part of the area marked out as a buffer zone around the SNR for the conservation of forest elephants.

c- Conservation

Traditional conservation of individual plants is a well known practice in Nigeria. The problem with the practice is their localisation such that very overall little protection is afforded the plants and animals. The importance of preserving representative samples of different plant communities, as opposed to the traditional method of preserving only useful plant species, was

initiated in Nigeria in 1946 (Ola-Adams and Iyamabo 1977). Strict Natural Reserves ('Inviolate Plots') designed specifically for the conservation of samples of natural vegetation and plants in perpetuity, and Game Reserves directed towards the conservation of animal wildlife were established.

According to Ola-Adams and Iyamabo (1977), 'Inviolate plots were laid down in forest reserves by the then unified Nigerian Forest Department in 1946 'to preserve typical pieces of Nigerian forest in an untouched state for posterity'. Since 1954, these areas have been designated Strict Natural Reserves (SNR's) by the Federal Department of Forest Research (now Forestry Research Institute of Nigeria, FRIN) in accordance with the 1933 London Convention on the Preservation of the African Flora and Fauna. In 1968, Nigeria acceded to the Organization of African Unity Convention for the Conservation of Nature and Natural Resources. There are now seven operative SNR's in Nigeria, each representing a major ecological zone.

The forest zone SNR's are as follows:

(i) Moist lowland evergreen forest:

Omo Forest Reserve (SNR 1)-460 ha;

Usonigbe forest Reserve (SNR 3)-64 ha;

Oban Forest Reserve (SNR 4)-64 ha;

(ii) Moist lowland semi-deciduous forest:

Akure Forest Reserve, Aponmu, (SNR 2)-32 ha

(iii) Moist Permanent Swamp Forest:

SNR 1 and 4 include areas of permanent swamp.

Ola-Adams and Iyamabo observe that the Strict Natural Reserves do not have legal status distinguishing them from the forest and game reserves in which they are located. The rights granted to the local people and timber contractors to extract produce are not extinguished. Protection can be provided by giving the agency administering the SNR's the power to make regulations restricting or prohibiting all uses in accordance with Article III, Section 4a of the African Convention for the Conservation of Nature and Natural Resources. Hedberg (1986), while listing National Parks and Biosphere Reserves in West Africa observed that the exercise was more of indications of interest in conservation since most of the reserved areas are so badly disturbed that they should not really have the status of reserves. Hall (1983) observes that SNR's are not actively managed due to lack of practical guidelines. According to him the threats that weaken the inviolate status of Strict Natural Reserves must be identified and the severity of each threat assessed. Such treats include intrusion, external events such as climate change and fire, and unpredictable effects such as the arrival of exotics into the SNR. It should be pointed out here that the Omo SNR is fully protected by legislation, thanks to the

efforts of the Forestry Research Institute of Nigeria and the Nigerian Man and Biosphere National Committee.

The role of Omo as a Biosphere Reserve is better appreciated by examination of Tables 2 and 3 (see Map 2 also). First, the lowland rain forest vegetation type forms only a small proportion of Nigeria's land area and what there is is fast disappearing. This makes conservation of the lowland forest a high priority. Nigeria's forest and woodland estate was estimated to be 60 million ha in 1897 but this has now dwindled to roughly 9.6 million ha of forest reserves much of which is degraded, and only 2.4 million ha are in the forest zone (Nwoboshi 1986). The estimates of FAO (1981) put the area of remaining lowland forest at 27 684.40 (circa 2.8 million ha) and the area of it under reserve as 14 072.08 km^2. Of significance is the 67 742.44 km^2 of potential forests that had been converted to farmlands and other uses in Nigeria's forest zone. Ogun State, in which Omo is located has an estimated total land area of 17 179.69 km^2 of which 2 731.54 km^2 or 15.90% are forest reserves. Omo forms almost half of this reserve area.

Map 2 : ***The vegetation zones of Nigeria.***

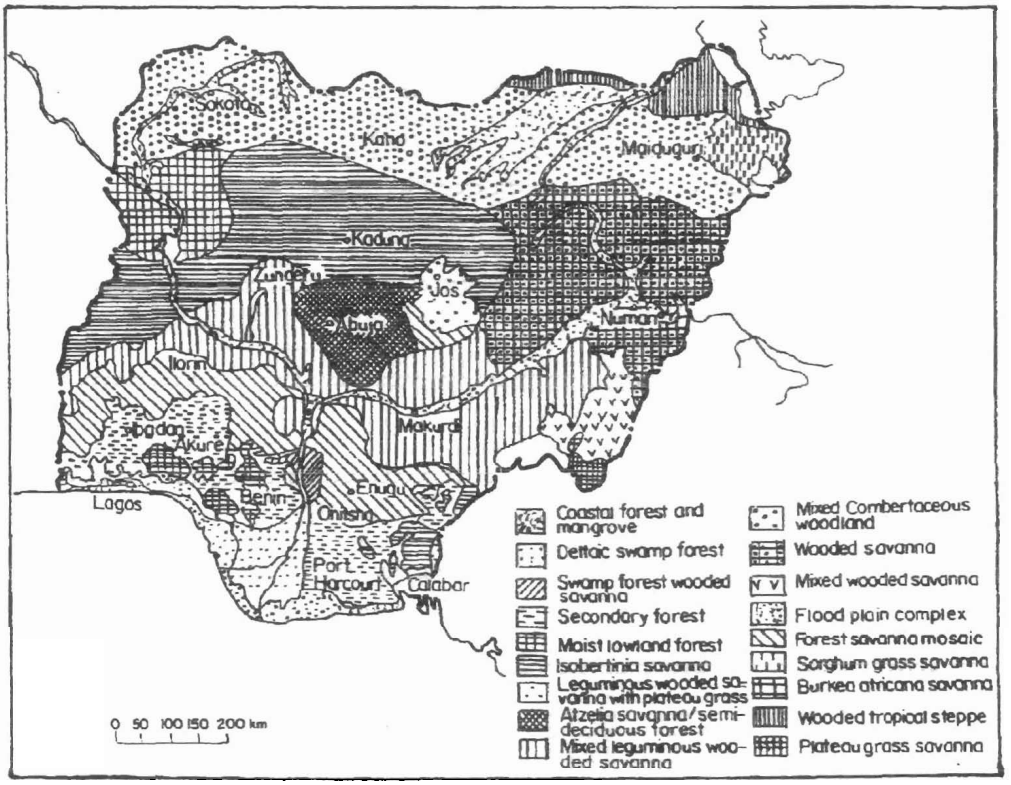


Table 2. *Area of forest estate by vegetation type in Nigeria (Onochie 1991).*

Vegetation type	Area (km^2)	% Total land area	Area of forest reserve (forest estate) (km^2)	Forest estate as % total land area
Sahel	31 463	3	2 571	0.3
Sudan savanna	342 158	35	31 247	0.2
Guinea savanna	400 168	40	38 271	0.9
Derived savanna	75 707	8	3 208	0.3
Lowland rain forest	95 372	10	19 986	2.0
Fresh water swamp forest	25 563	3	256	0
Mangrove and coastal vegetation	12 782	1	522	0.1
Total	**983 782**	**100**	**96 061**	**9.8**

Table 3 : *Land use in Nigeria as determined by Side-Looking Air Borne Radar (NEST 1991).*

Formation	Area (ha)	% of Total
Grassland	12 821 302	14.1
Grassland/Shrub Transition	1 779 382	2.0
Shrubland/Thicket	2 288 311	2.5
Wooded Shrub Grassland/ Woodland Transition	23 747 306	26.1
Woodland	4 197 209	4.6
Forest	8 874 255	9.8
Farmland	35 870 552	39.5
Plantations and Agricultural Projects	276 500	0.3
Water, Rivers; Built-up Areas	1 024 231	1.1
Total	**90 879 048**	**100.0**

At the continental level, Mackinnon and Mackinnon (1986) have observed that only four of the 17 Phytochoria analyzed in the Afrotropical realm were regarded ass having adequate protection. At the other extreme, four phytochoria prominent amongst which is the Guinea-Congolian stand out as needing much greater conservation efforts. Protection was

observed to be weakest in the lowland rain forests of West Africa, Madagascar and isolated mountains and island communities.

d- Wildlife Resources.

About 19% of the locally produced animal foods in the rural areas of southern Nigeria were obtained from wild animals at least up till the 1980's. Sixty percent was obtained from fish and only 24% from livestock (Charter 1970). Bushmeat formed a significant proportion (over 90%) of the cash value of meat consumption. The large quantities of local fish consumed is a striking feature of these figures, and since a proportion of this catch is from forest reserves it could be as forest or wildlife produce. Charter had noted that the highest percentages of bushmeat eaten in comparison with total meat consumption relate to areas in or adjoining the larger forest reserves e.g. Ondo, adjoining Omo, 67%.

The animal species caught by trapping or hunting for meat include brush-tailed porcupine (*Antherurus africanus*), maxwell's duiker (*Cephalophus maxwelli*), grass cutter (*Thyronomys swinderianus*), bush buck (*Tragelaphus scriptus*), Tree hyrax (*Dendrohyrax sp.*), pangolin (*Manis tricuspis*) and giant rat (*Cricetomys gambianus, C. emini*). Many of these animals, apart from being a source of protein also serve as tools in traditional medicine. Table 4 lists some animals so utilised.

Table 4 : *Utilization of wildlife in traditional medicine.*

ANIMAL	PART OF THE BODY USED	UTILISATION IN MEDICINE
Gorilla	Bones	Against witchcraft
Bush pig	Head	Good luck for traders and businessmen
Brush-tailed porcupine	Whole animal	Easy childbirth in women
African civet	Anus	Prevention of convulsion in children
Bush fowl	Whole animal	Prevention of stillbirth
Hooded vulture	Whole animal	Procuring evil things for one's enemies
Parrot	Red tailfeathers	Success in undertakings
Giant rat	Head	Personal protection
Grass cutter	Hair	For general healing

e- Fisheries

The extensive river systems and patches of wetlands in the reserve and the large variety of fish observed also means a potential for fisheries development. There is also good possibility for aquaculture considering that the southern tip of the Reserve is just 20 km from the Atlantic coast.

III- EVALUATION OF RESOURCE USE

Two major resources are currently extracted from Omo Biosphere Reserve. These are timber from the natural forest and from the industrial plantation, and the considerable amount of foodstuffs grown under the Taungya system. The Strict Natural Reserve is also a unique national resource, being the only one located in the inner core of a biosphere reserve. The other uses such as extraction of non timber forest products are peripheral and economically of little significance in comparison with the major uses. Timber extraction, especially at the non sustainable rate at which it is being carried out, could eventually destroy the reserve. Not only are the timber trees a major component of the biological resource base, activities associated with its extraction such as trampling, construction of minor roads and bush paths and destruction of non-target trees pose problems to the existence of the Biosphere Reserve. Lowe observed that trees only 60-70 cm in diameter were being felled, just when they are growing fast, instead of being left to attain diameters of at least 80 cm. At this rate the productive base of the forest could be destroyed within 5 to 10 years. There is also considerable wastage in wood processing. Even if pit sawing is no longer practised, there is still considerable wastage in log utilisation due to sub-standard machinery. Alviar (1983) estimates that wastage rate may be up to 50%. Lowe has observed that another source of wastage is the length of logs which minimum length is 12 feet. There is no reason why the logs cannot be shorter to ensure maximum utilisation of timber. There has also been classification of trees as 'economic', a factor determined by export markets and which led to over-exploitation of some trees and under-utilisation of others. The list of economic species has been expanding an it is hoped that advances in technology will mean utilisation of most species, and thereby spread of risk and a reduction in the rate loss and wastage.

Plantations are expected to increasingly supply most of Nigeria's timber needs well into the next century. In fact, the earliest teak plantations have been a source of timber in the last decade or so. The natural forests have much lower stocking of commercial standing timber than plantations of fast growing species of the same age (Adegbehin et al. 1993). Moreover, the fast-growing exotics have been found to be more productive than plantations of indigenous species such as *Triplochiton scleroxylon, Terminalia spp.*, etc. In view of the current international concerns about biodiversity, plantations could, however, be viewed negatively.

However, Okali and Onyeachusim (1991) have observed that plantations do not mean total elimination of forest species, at least over the first rotation of *Gmelina* growth (Photo 9). They observed as many as 190 species of flowering plants in 0.75 ha of a *Gmelina* plantation against 160 in the Strict Natural Reserve. The study demonstrates that on conversion forest species do not disappear immediately and that converted forests can be managed for multiple benefits, yielding secondary products if wood production is the primary objective.

Photo 9 : Copious undergrowth under *Gmelina* plantation, showing that plantations of some exotics do not always drastically reduce biodiversity.

Biodiversity management is still at a very rudimentary level. It must be emphasized that it is through proactive intervention and change of orientation that the potentials of the Biosphere Reserve and indeed other such areas in Nigeria, can be realised. In Africa, about two-thirds of the land that could support habitats for wild plants and animals is now used for other purposes (Mackinnon and Mackinnon 1986). To the extent that biodiversity represents an important international as well as national and local resource, Africa's competitive advantage is enhanced not only by the fact that its environment is among the world's richest biologically but also by the fact that it has not yet sacrificed its endowment of these resources (BSP 1993). The international, scientific values of biodiversity have hitherto been the main focus in conservation areas of high species richness and endemism like the Guinea-Congolian sector of the Afrotropical Realm. Dependence on biological resources has to be recognised and new, aggressive strategies that incorporate local and national values brought into the

management of biosphere reserves. Such strategy should involve education and more research into the regeneration of biological resources that are currently utilised and/or are potentially utilisable.

In-situ and *ex-situ* conservation measures are being undertaken by various organizations in Nigeria. These include the State Forestry Services, Forestry Research Institute of Nigeria, World-wide Fund For Nature (WWF), Man and Biosphere Programme and the Nigerian Conservation Foundation, for in-situ conservation. FRIN, Forestry Development and Investigation Branch (FDIB), the National Centre for Genetic Resources Conservation, National Institute for Horticultural Research and some other organizations undertake ex-situ conservation.

FDIB has successfully developed vegetative propagation techniques (by bud grafting and stem cuttings) for about 20 indigenous woody plant species. Suitable germination techniques were also developed for *Dacryodes edulis, Irvingia gabonensis, Treculia africana,* among others (Okafor 1993).

But there are many wild plants which are hardly cultivated. *Dioscoreophyllum comminsii, Landolphia spp., Piper guineense, Gnetum spp., Tetracarpidium conophorum,* all climbers are usually the first to be eliminated during forest clearing and are thus very vulnerable. Shrubs and small trees such as *Maesobotrya spp., Dennettia tripetala, Synsepalum dulcificum* are also fast disappearing. Loss of big trees readily attracts attention because of their visibility. Understorey shrubs and climbers are easily lost because of their highly specialised environmental demands such as low light intensity and quality as is characteristic of sunflecks and relatively low temperature compensation points. These plants are also readily accessible and tend to be easily over-exploited. Also threatened are 'uneconomic' timber species which are eliminated with careless abandon, often to make way for the 'economic' ones. There are also the recalcitrant species such as *Chrysophyllum albidum* which have low seed viability and are lost when there is a change in land use. Species of high economic value such as Gnetum sp. and under utilized plants such as *Treculia, Tetracarpidum* are disappearing due to over-utilization and neglect, respectively. There are also several plants that are relatives of crop plants *Oryza, Dioscorea, Sphenostylis,* etc. which special attention (Table 5) (Okafor 1993).

Unorganized hunting is the only management there is of the wildlife resources of the Reserve. The potentials for rearing wildlife are high. Areas of such great potential include snail rearing, the forest being a natural habitat of the giant African snail. The successful rearing of the grass cutter, *Thyronomys swinderianus,* has been demonstrated in many pilot schemes (Ajayi 1979). The animal does very well in early regrowth vegetation where herbaceous vegetation is abundant. Martens (1994) has reported on the butterfly trade in Papua New Guinea as a touchstone for sustainable utilization of wildlife.

Table 5 : *Important food plant resources that need increased conservation efforts in the forest zone of Nigeria. (From Okafor 1993).*

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

West Africa has one of the world's greatest variety of butterflies (Mackinnon and Mackinnon 1986) and such a trade has great economic promise. The Papua trade is regulated by an agency that markets butterflies supplied by 500 collectors and ranchers in 14 out of the 19 Provinces of Papua New Guinea. Martens reports that incomes are up to $350 a month, the same salary as that of a public servant. St. Leger (1984) has reported on the distribution of the butterfly sub-family *Charaxidinae*, one of the most sought after of all African butterflies due to their large size, powerful flight and bright colours, in Nigeria. One species of *Euxanthe* and 17 *Charaxes* species were recorded from Omo Biosphere Reserve. Nine species out of the 40 of the genus *Euphaedra*, a group of large, powerful butterflies, mainly dark blue or green in colour and which glide through the forest floor (St. Leger 1989) are found in Omo or locations close to it.

According to Ashiru (1989) seven species of silk-producing moths have been recorded in Nigeria. These are (with their principal host plants) *Anaphe ambrizia* (*Bridelia ferruginea*), *A. infracta* (*Bridelia micrantha*), *A. moloneyi* (*Isoberlinia doka*), *A. reticulata* (*Pericopsis laxiflora*), *A. venata* (*Triplochiton scleroxylon*), *A. vuilletii* (*Tamarindus indica*) and *Gastroplakaeis rufescens* (*Isoberlinia doka*). It has long been the practice to collect *Anaphe* cocoons from the wild in Nigeria and sell them to weavers. The prospects for non-mulberry sericulture is bright and the age-old practice should be resuscitated. The decline in

the largely rural business is attributable to deforestation and to the fact that no efforts were made at rearing the moths. One of the important host trees is *Triplochiton scleroxylon*, a tree whose core habitat is in southwestern Nigeria. Non-seed propagation of *Triplochiton* is now widely practised, especially at the Forestry Research Institute of Nigeria and some plantations of it exist in the Ibadan area, the tree being the raw material for the manufacture of match sticks. Mulberry sericulture has also been demonstrated at a pilot scale and shown to be possible. Imported larvae of *Bombyx mori* were reared on the exotic tree, *Morus bombycis* locally available in gardens in Ibadan (Ashiru 1989). FRIN now has a mulberry orchard and can support a multiplication programme.

Some Nigerians also eat the larvae of *A. venata*, which provide a protein addition to their basically carbohydrate diet. Of the eight amino acids essential to humans, six are contained in the larvae. The crude protein content was 60% and the larvae also substantial levels of mineral elements. *Anaphe* can thus be used to supplement foods deficient in proteins and mineral elements. It is not surprising that the larvae are sold openly in Ibadan markets (Ashiru 1989).

Gómez-Pompa and Burley (1991, p. 7) have discussed the most important questions that need to be asked in the restoration of biological resources. These range from the management of areas of secondary vegetation and degraded soils for the benefit of local people to the utilisation of Strict Natural Reserves in restoration role, and the nature of conversions to be undertaken where this is necessary. Other questions include accurate valuation of biodiversity generally, and non-timber forest products in particular (Erhenfeld 1988, Bawa 1992). Ecology is recognised as the basis for conservation and restoration activities.

Perhaps the first obstacle to overcome in organizing grassroot conservation of biodiversity is to inculcate the practice of planting and regeneration of plants. It is a widely held notion in many parts of the tropics that organisms just regrow so the habit of nurturing is not very widespread. Okafor (1993) has listed the basic scientific requirements for successful conservation and restoration of biodiversity in Nigeria. These include studies of ecology, phenology and taxonomy of the species of interest, identification of parameters to be used in species selection procedure, propagation techniques and procedures, dissemination of information on the species and extensive research into utilization.

IV- ON-GOING RESEARCH AND MONITORING

UNESCO's Man and Biosphere Programme, Theme One, is concerned with the "Ecological Effects of Increasing Human Activities in Tropical and Sub-Tropical Forest Ecosystems". Its main research since 1978 has been based at the Omo Biosphere Reserve and

the Theme's activities have attempted to address the issues raised in the previous section:- tropical moist forest regeneration, conservation and conversion, including agro-forestry.

Data gathered at Omo during three enumerations in 1935, 1952 and 1981 suggest that the forest can remain stable in tree composition, tree density and size-class structure when selectively exploited at long enough intervals (Okali and Ola-Adams 1987). Approximately 50-60 tree species at a density of 400-600 stems ≥10 cm diameter at breast height per hectare were recorded at the Strict Natural Reserve (MAB 1988). Forest regeneration, yet to be clearly understood at Omo and in most tropical moist forests, is believed to be controlled by forest gap phase dynamics (Hubbell and Foster 1986). Since species can, on the basis of succession be divided into two groups-pioneers or early successional species that require relatively large amounts of light, and those that appear late in succession or climax species and which can tolerate shade, it is presumed that gaps in forests play crucial roles in regeneration and forest succession. Hubbell and Forster state that gap disturbances provide the principal or only means by which most tree species can maintain their representation in closed canopy forests. Nigerian MAB Programme, Theme One, has investigated forest gap formation, distribution, frequency, sizes and turnover rates at Omo and two other moist forests in Nigeria (Dike 1992). About 37% of the gaps were created by windthrow, 36% by snapping, 21% by branchfall and 7% by standing dead trees. Three hundred and three gaps were observed in a 58 ha area with an average of 5 gaps per hectare. Average gap size was about 190 m^2 but most gaps were between 5-50 m^2 with the observed maximum being 508 m^2. The most numerous trees formed the highest numbers of gaps. The estimated gap turnover rate was 103 years.

Fifteen pioneer (early successional) species were observed to germinate from soil monoliths from the SNR as compared to nine climber, seven herbaceous and four climax (late succession) species. A significant statistical interaction was observed in terms of germination between species ecological class (pioneer, climax) and season, confirming the short life of climax tree species seeds (Olatoye 1967). Okali and Onyeachusim (1991) observed that climax species completed their germinations within 84 days after seed dispersal. The MAB study observed that the diversity of germinated species increased with gap size but decreased with gap sizes in excess of 1000 m^2.

The phenology of 43 important (in terms of abundance) were also studied. Most trees fruited at least once a year except for 14% of the trees which did not fruit. Nineteen of the studied species flowered once and 24 flowered twice a year. Fruits/seeds are mainly fleshy or plumed and most of the fruits/seeds would fall vertically under their canopy in still air and cannot thus get to the centres of gaps.

Seedlings of most pioneers did not survive for up to 12 months in gaps except where the height of the immediate canopy was less than 10 m. Climax species survived and

established in all gap sizes. Death of climax species seedlings was mainly caused by climbers smothering the seedlings, by herbivory and diseases.

In closed canopy, secondary forest, pioneer tree seedlings were few with *Ceiba pentandra, Funtumia elastica* and *Ricinodendron africanum* being the most common. Climax species seedlings were, on the other hand numerous and appeared in clusters around mother trees. The most common seedlings were *Strombosia pustulata, Khaya ivorensis* and *Diospyros dendo*. Seedling survival depended on the architecture of the immediate canopy tree. *Macaranga barteri, M. paxii* and *Trema orientalis* were the most common tree species to germinate from abandoned farmlands. *Chromolaena odorata* was the most abundant herbaceous plant and it tended to smother woody plants. In logged areas pioneer tree species, climbers and herbs dominated the gaps created. Only one climax species, *Entandrophragma angolense*, was observed.

Overall, the study results emphasize the need for human interference in the management of regeneration of tropical moist forests for the production of timber species (usually climax species). Such an interference would involve artificial storage of the seeds of the desired species and germinating them at periods when establishment can be assured, and transplanting to gap centres. Seedlings, which are usually abundant in closed canopy secondary forests can also be transplanted into gap centres. The study further observed that climber cutting introduced under the Tropical Shelterwood System needs to be revived to ensure survival of climax species.

It is worthy of note that there is as yet no active monitoring of the the use of non-timber forest products. This again emphasizes the interest in timber as a major resource of forests.

V- MANAGEMENT OF OMO BIOSPHERE RESERVE.

Omo Biosphere Reserve started as a Forest Reserve until 1977 when its status changed to an internationally recognised biosphere reserve. Nigeria's forest reserves are managed and protected by State government forestry services, which also control the commercial removal of forest products from lands outside forest reserves (NEST 1991). At the Federal level, the Division of Wildlife Management of the Federal Department of Forestry and Agricultural Land Resources, in the Ministry of Agriculture and Natural Resources, has responsibility for conservation matters in the country. Research on 'conservation of natural flora, fauna and vegetation types in different ecological zones' is, however, the responsibility of the Forestry Research Institute of Nigeria (FRIN), until recently under the Ministry of Science and Technology (as all Research Institutes were) but now in the Ministry of Agriculture and Natural Resources. FRIN has a wildlife school at New Bussa in Niger State.

Two schools of forestry designed to train middle level manpower were also under FRIN but these have also recently become specialized, autonomous and are now funded by the National Board for Technical Education. Nigeria also had, between 1989 and 1993 a Natural Resources Conservation Council which had to be merged with the Federal Environmental Protection Agency.

The management of the 460 ha Strict Natural Reserve in Omo is the responsibility of FRIN. Several important studies on the Nigerian high forest have been carried out in the SNR, true to its founding aims. There is an arrangement whereby the Baale or local leader of Etemi Oke where the SNR is located acts as the forest guard. He has been very effective in that regard and the SNR can be said to be reasonably protected. Ideally, FRIN should have employed him as a permanent staff but cannot because he does not possess the first school leaving certificate, the minimum qualification required for employment into the Nigerian public service. FRIN has devised procedures to compensate him for his valuable services.

Management of the main Reserve has not been as carefully planned. The Reserve formed part of the forest estate of then Western Region, from its inception in 1918 until 1967 when Western Region was split into Western State and Lagos State. Western State was further split into three States in 1976, namely Ogun, Oyo and Ondo. This meant that the adjoining reserves of Oluwa, Shasha and Oshun came under different State managements. Each time there was a change in political boundaries, reaffirmation of the reserve had to be made by way of legal notice and management had to change. Up till the 1980's there were attempts to abide by the management plans drawn up in the 1950's. Ayeni (1985) has observed that Nigeria is rich in proposed and gazetted wildlife conservation areas, but sadly, the level of supervision and enforcement leaves much to be desired, a situation that applies, even more so, to forest reserves. He observes that there are no trained personnel to man conservation areas in many States. Each adjustment of political boundaries, as has occurred in southwestern Nigeria saw the movement of some personnel to their States of origin. This trend must have affected the management of Omo (Photos 10, 11 & 12).

The Tropical Shelterwood System (TSS) was begun in the reserve in 1951, and in 1952 an investigation into the regeneration of tropical high forest was laid down in Compartment 45 (see Okali and Ola-Adams 1987). TSS operations had to be discontinued in 1955 because there was no marked accelerated growth of economic trees and the stocking obtained was not enough to justify the expense of TSS treatments. In 1953 enrichment of natural forest was begun by line planting of two-year old transplanted nursery stock of *Khaya ivorensis* and *Lovoa trichiloides* which were supplemented in some cases with striplings of *Milicia excelsa, Nauclea diderrichii* or *Terminalia ivorensis* (Lowe 1993).

Photo 10 : Secondary forest cleared of undergrowth.

Photo 11 : Secondary forest with some of the bigger trees being burnt at their bases.

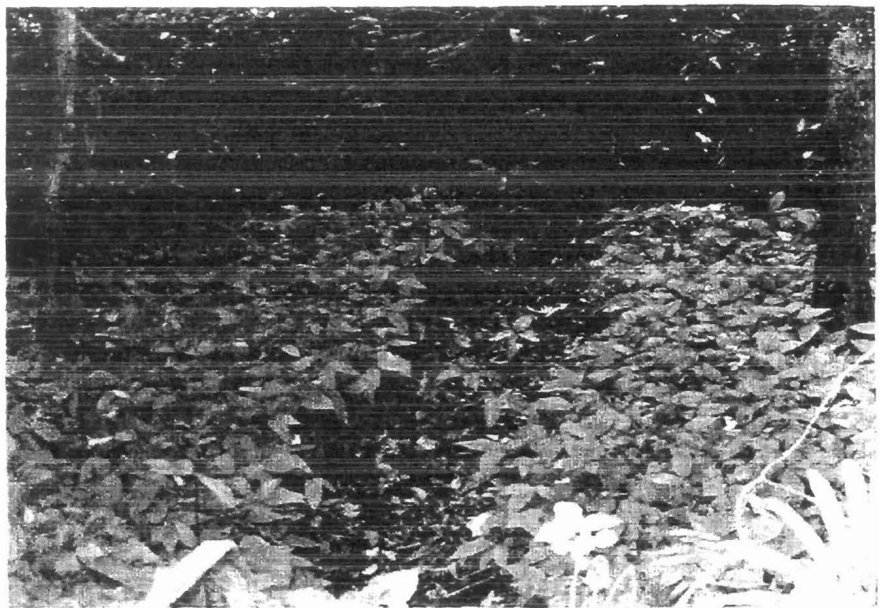


Photo 12 : The clearings might be for a cocoa (*Theobroma cacao*) plantation, seedlings of which are being raised inside the Reserve.

This method of line enrichment did not prove successful as the mahoganies were not sufficiently fast growing to escape being swamped by forest regrowth, and only fast growing species such as *Cedrela odorata, Terminalia ivorensis* and *Triplochiton scleroxylon* were able to establish themselves. Maintenance of line plantings was also difficult because access was restricted by regrowths, line planting being a post exploitation exercise. It was probably due to such frustrations that the decision was taken to plant up 40% of the Reserve with *Gmelina*, beginning from 1966. In 1955 an exploitation rotation of about 80 years had been planned for the reserve, but as Lowe observed all that seem to have been abandoned such that trees of very small diameter are now felled. Lowe further observes that there is apparently no working plan for the *Gmelina* plantation.

There is an area of the Reserve, in Block J1, that has not been exploited for many years but which has now been leased out to a Chinese Company for exploitation. It is in this Block that forest elephants are now confirmed to exist. A group of conservationists, The Nigerian Forest Elephant Protection Group, has embarked upon a project that aims at creating an elephant zone in the area. The zone is adjacent to the Strict Natural Reserve and should be a good buffer between the SNR and the outer areas of forest conversion. The Group is reportedly encountering problems with the wood exploiters whose lease is seemingly not very clearly defined. The Elephant Group hopes to be able to develop eco-tourism in Omo, which is very close to Lagos and Ibadan, the two biggest urban centres in Nigeria. The Ogun State Government has been co-operative and The Elephant Group has just been co-opted into the

Nigerian National Committee of the Man and Biosphere Programme, a position that should give it an excellent operating platform and scientific base. The Group will also be able to participate, along with the Nigerian MAB Committee in the new project, "Biosphere Reserve for Biodiversity Conservation and Sustainable Development in Anglophone Africa" (see below).

The major financing of the plantation project was provided by the World Bank at a time when its policy did not include considerations for the environment and biodiversity in particular. The plantations at the outer area of the Reserve (usually preceded by Taungya farming) with the natural forest exploited for timber, next to the SNR might look like the typical lay-out of a biosphere reserve but it is not in reality since the World Bank was also funding another plantation project in adjacent forest blocks in the Ondo State Government-owned Oluwa Forest Reserve. There is no co-ordination between the management of the SNR and the Ogun State Sawmill and Plantation Project which runs the natural forest exploited for timber as well. This state of affairs must have led to the erroneous delimitation of the 460 ha SNR as the Omo Biosphere Reserve. The size of the Strict Natural Reserve is inadequate for a Biosphere Reserve and does not satisfy the zonation characteristics of a biosphere reserve. The Nigerian MAB Committee is already taking steps to readjust the Biosphere Reserve boundaries. The Ogun State Government is co-operating in the plan, the Elephant Protection Group has been brought in and a 60 km^2 elephant buffer zone around the Strict Natural Reserve has been recognized by the State Government. It is hoped that a biosphere reserve manager will be appointed very shortly. These arrangements have given the Nigerian MAB Committee a good start in the implementation of the project on Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Anglophone Africa. No major obstacles are foreseen especially as no new legislations are required for the mentioned processes.

The "Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Anglophone Africa" project, funded by the Government of Germany is a follow-up to the Biodiversity Convention adopted at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil in 1992. The project also falls within Agenda 21, one of the principal products of UNCED now adopted by the UN General Assembly as a United Nations priority, and is also in line with Recommendation 20 of the fourth World Congress on National Parks. Chapter 15 of Agenda 21, "Conservation of Biological Diversity" points out that our planet's essential goods and services depend upon the variety and variability of genes, species, populations and ecosystems (Chapter 9, "Protection for Development", Chapter 10, "Planning and Management of Land-use" and Chapter 11, "Combating Deforestation" are also applicable). Development of counter measures to the loss of biodiversity was delegated to the Biodiversity Convention. The Biosphere Reserves project

aims at ensuring the long term conservation of biodiversity in a coordinated network of biosphere reserves in Ghana, Kenya, Nigeria, Tanzania and Uganda while at the same time ensuring that the needs of local people living in and around the reserves are met through sustainable use of natural resources. It is hoped that the management plans of the representative biosphere reserves will be upgraded and that sharing of knowledge and expertise by the participating countries will increase African collaboration and improve environmental management capacity building.

Foresters in Nigeria and elsewhere have long advocated private forest estate development as opposed to the current situation of sole state control. Most of the crop plantations in the forest zone including cocoa, rubber and oil palm are in private hands so it is logical that private forestry is feasible. The last decade has seen multinational concerns acquiring parts of Government-owned forest estates for development. This should be encouraged except that the vast tracts of degraded lands in various parts of the country should be allocated instead of forest reserves. The land Use Decree gives the Government enormous powers over allocation of land for development. The major consideration that may hamper private forestry remains the long gestation periods before forests are harvestable. Even fast growing exotics take up to thirty years to reach harvestable size compared to five years required for oil palm and rubber to reach maturity. There are indications that parts of Omo Biosphere Reserve may have been allocated to private developers for the establishment of cocoa plantations.

VI- RECOMMENDATIONS ON THE USE OF RESOURCES.

1) Community Participation in the Control of Resource Use.

Traditionally, international and national conservation efforts have tended to rely on strict protection through the establishment of national parks and other protected areas. Communities surrounding protected areas, however, have often borne the costs and rarely received the benefits associated with neighbouring protected areas and hence have usually had little vested interests in the protection of the biological resources in those protected ares. As a result, local people's attitudes often have been biased against the protected areas (BSP 1993). In situations where the management of a protected area is weak, a very common situation in Nigeria, pressures of growing populations, widespread poverty, and unsustainable land-use practices outside the protected area boundaries can cause people to engage in illegal and destructive encroachment within protected areas. These pressures on protected areas in Africa are expected to increase with the ever-increasing demand for land, food, fuel, fibre and wood.

The future viability of protected areas in Africa appears to hinge on the co-operation and support of local people. This co-operation and support, in turn depends on whether the areas can provide local communities with benefits that are sufficiently concrete for people to want to maintain the areas as reserves (BSP 1993). In the case of the Omo Biosphere Reserve, the first step is to identify the communities of interest. Such a community includes a variety of people who have a stake in the Reserve. Amongst these are the international conservation community and non-governmental organizations with vast interests in wildlife and forests, members of government who are supposed to hold resources in trust for citizens, industry that utilize forest products and indigenous people that inhabit the more than twenty enclaves within the Reserve.

The most important stakeholders in the Reserve are those that live within it. The settlement pattern in southwestern Nigeria is that of widely separated large towns and urban areas. The nearest large settlements to Omo are Ondo (about two hours by road but about 20 km from the northeastern edge of the Reserve), Ijebu-Ode and Ibadan. The Benin-Ore road crosses the southern edge of the Reserve but it is by no means easily accessible. The biggest settlement is "J4" or Oloji, where the Omo Sawmill is located. Most activities in the settlement revolve around the sawmill, majority of the inhabitants being employees of the sawmill and its ancillary activities. Most of the settlements depend on farming and collection of non-timber forest products. Two such notable occupations include palmwine tapping by men and collection of leaves of Thaumatococcus daniellii by women. Catering and food vending and petty trading, including sale of fruits and spices are also exclusively carried out by women. Fishing is a major occupation near the rivers. There are daily motor vehicular movements into and out of the Reserve, mainly from Ore and Ijebu-Ode for the collection of farm produce. It is not unlikely that there is seasonal migration of farm labour from other parts of western Nigeria.

It is with this background that community participation in a new management of the Reserve could be assessed. Many of the residents of the enclaves may not find biodiversity conservation beneficial because their interaction with the Reserve is that of extraction for immediate economic purposes. There is even the very big question of whether the State Government is ready to partially relinquish control of parts or all of the Reserve. The trend in Nigeria in the last two decades has been to de-reserve reserved areas for various purposes. Omiyale (1993) estimates that 61 938 ha of forests have been de-reserved in the forest zone states of Edo, Delta, Ondo and Oyo by converting to rubber and oil palm plantations and through taungya farming which may never revert the land back to forest again (see NEST 1991, p.138). Government officials and the politically powerful in society have, in some cases, been the major beneficiaries of de-reservation.

Community participation thus has to be well articulated and should involve a mobilization strategy with outsiders: the State Government, MAB in Nigeria and UNESCO (as implementation agency) and the World Bank designing a plan of action and then meeting the communities to find out their perceptions about sustainable utilization of the Reserve. Eventually, a community development strategy should be adopted so that some level of control of the use of the resources of the Reserve will be exercised by the communities. The level of control exercised by the community will depend on the particular resource. For example, it is easier to have local control of the use of non-timber forest products than, say, timber.

2) Alternative Resource Utilization Strategies.

Omo Biosphere Reserve can yield several other resources or increased value from those currently exploited. The aim of new resource exploitation strategies is to expand the resource base and reduce the pressure on the forest resources. It is thus envisaged that fewer people will depend on utilization that degrades the environment leading to conservation and improved sustainability. New resource uses suggested include bee keeping, snail raising, horticulture and mushroom growing. Suggestions are also made on ways to improve extraction of other non-timber forest products.

a- Bee Keeping

Honey bees are indigenous to Nigeria. Natural colonies of the true honey bee, Apis mellifera, build their nests in holes in trees and under thick branches, or in other hollow objects, especially where these are in a cool, dark site (Mutsaers 1993). Nectar and pollen are the food of honey bees which they collect from flowers. Honey, produced from nectar, water and pollen is also the raw material for bee wax. The plants most frequently visited by bees in western Nigeria include *Nymphaea lotus, Combretum smeathmanii, Elaeis guineensis, Trichilia monadelpha, Pterocarpus osun, Pentaclethra macrophylla, Bombax buonopozense, Ceiba pentandra, Albizia glaberrima* and *Spondias mombin* (Mutsaers 1991). These and many other trees listed by Mutsaers are found in Omo. The highest numbers of bee swarms were observed in western Nigeria by Mutsaers between August and October, and between January and April. These are the main periods of nectar flow (plants in flower). Ikediobi et al (1985) estimate that there are 100 000 beekeepers in Nigeria managing an estimated 700 000 bee colonies and producing 2 800 tons of honey.

Honey is used as a foodstuff and sweetener, especially in northern Nigeria where it is used traditionally to make candy-floss. The following account of the uses of honey is extracted from the reports of Dr M. Mutsaers of the International Institute of Tropical Agriculture,

Ibadan who has worked extensively on bee keeping in Nigeria. Among the Yoruba, honey is used at ceremonies such completion of apprenticeships, funerals, weddings and child-naming when it is placed on a plate with salt and other ingredients and given to the baby to taste to show what can be expected on earth. Honey is also used to symbolize happiness, prosperity and success. Christians and Moslems alike put honey on their tongues when praying during ceremonies.

Its use in Yorubaland is more akin to medicine than to foodstuffs a factor that counts for its scarcity and high price. Honey is also used medicinally to treat cough and to clear the voice by singers and preachers. It is also used on sores and used to treat such disorders as infertility in women and men. Honey contains the bactericidal agent, inhibine.

Wax is used for the "lost wax technique" in bronze and brass casting in Benin, Nigeria. Sekant Industries, Lagos buys crude combs and wax blocks from all over Nigeria, refines and sells it to the cosmetics industry. Wax batik is also used by Osogbo artists in Adire making.

Propolis, another hive product which the bees manufacture from resins and other sticky materials collected from trees, is used to fill up holes. Mixed with wax (= "ida" in Yoruba) it is used on talking drums to preserve the drum skin and lower the pitch. Propolis has antifungal, antibacterial and antiviral properties and may be used as an antiseptic. It is applied to the skin around broken limbs by traditional bone healers before the broken bones are held in place with splinters. Preparations of propolis in alcoholic or oil solutions are sold in health stores in many parts of the developed world.

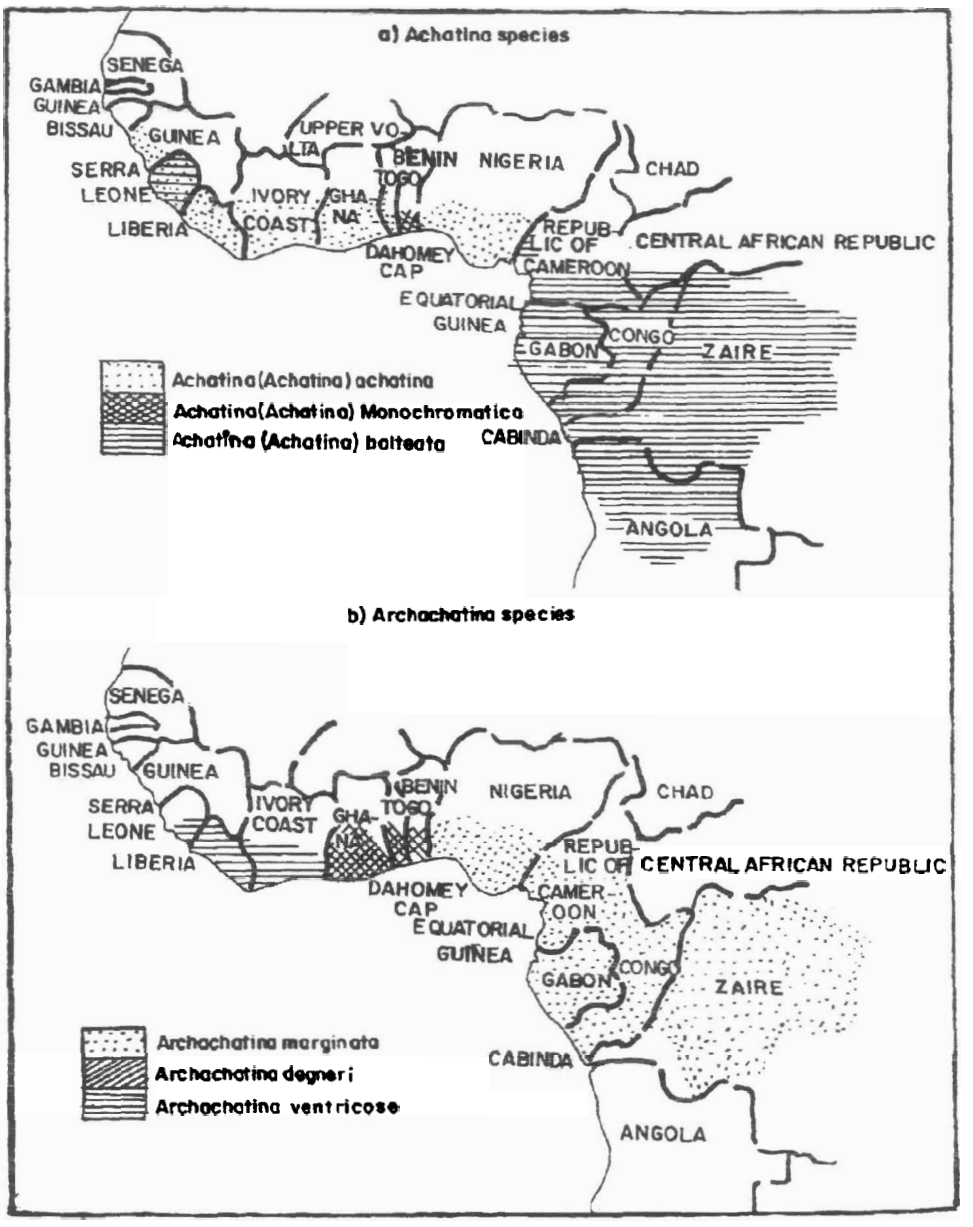
All the resources needed for a bee keeping business are available in Omo and the technology to harness the resource is also locally available. It is most likely that collection of wild honey takes place in the Reserve. Two cultivated plant species, *Manihot esculenta* (cassava) and *Gmelina* which are known to attract bees, in addition to the indigenous ones listed, are abundant in the Reserve. Local adaptation of efficient bee collection technologies have been tested and are taught to students in some nearby agricultural schools (Mutsaers 1991). With the widespread use of hive products and good potential markets, the commercial viability of bee keeping is almost guaranteed.

b- Snail Raising

It is a well known fact that there is acute shortage of protein in Nigeria, especially in the south where the ecology favours production of mainly tuber crops rich in carbohydrates and where, due to high human population density, wildlife is not commonly found except in reserves. The rising cost of beef and diminishing higher wildlife resources call for new directions in raising protein levels in common diets. The African giant snail, *Archachatina*

achatina ('Achat snail') and some species of the genus *Achatina* have traditionally been picked up from moist forests for consumption (see Lowe 1993). *Achatina achatina* is widely distributed in the forest zone of West Africa from Nigeria to the Republic of Guinea. *Archachatina marginata*, another giant snail but not as large as *Achatina* is distributed from Nigeria to Central Africa (von Korn et al. 1989, Map 3).

Map 3 : *The distribution of* Archachatina *and* Achatina *snails in West and Central Africa (von Korn et al. 1989)*



According to von Korn *et al.*, the hermaphroditic Achat snail becomes sexually mature at 7-11 months (first egg-laying). Fertilization usually involves two individuals and after about 8-20 days the whitish-yellow eggs are laid. An interesting phenomenon is that eggs are laid several times at intervals over a period of up to several months. Number of eggs may reach over a hundred but is dependent on shell size. Hatching takes place between 2 and 15 days and hatching rate is below 50% but this may increase substantially under controlled breeding conditions. Mature Achat snail could attain body weights of up to 200-350 g. They hibernate in the dry season and seal the opening of their shells by means of an epiphragma.

Achat snails are usually omnivorous, although several plants including some cultivated species (lettuce, eggplant, banana, pineapple etc.) and several indigenous species are preferred. The increased demand for snails by the wealthier urban populace and the degradation of their forest habitat have drastically reduced their numbers in many areas. Controlled gathering is difficult if not impossible so controlled extensive raising or farming in an open system as well as intensive breeding in a closed system are the feasible alternatives.

Snail raising in an extensive open system represents a variant of the present gathering activity and requires keeping snails temporarily under controlled conditions to enhance their longevity. Under this system, sexually mature snails could be collected during the rainy season and fattened in an enclosure after reproduction. The fattened snails could be sold in the dry season while the hatchlings are returned to the forest to be gathered later. This system could be refined towards an intensive closed system where only a few young snails are returned to the forest while the bulk of the hatchlings are raised to marketable sizes. Some could be retained over long periods for reproductive purposes.

The resources necessary for production are available at Omo moist forest where feed for the snails is abundant and almost all-year round high humidity. There have been advances in snail raising in Nigeria and production ventures can benefit from such available technology (see Ajayi et al. 1978). For example, it has been established that snails consume paw-paw (*Carica papaya*) and cassava leaves, two readily available feed stock. There may be no need to construct a shed or extensive enclosures, neither are serious pests and diseases known. The capital outlay is thus well within the reach of resource-poor farmers. The nearby urban centres will provide ready market for a large quantity of snails. Snail raising has the additional advantage of being more of a female occupation and could help raise the incomes of rural women.

c- Domestication of some rodents.

Domestication of grass cutter, *Thyronomys swinderianus* is in the same category as snail raising. The giant rodent fulfils a need for relatively cheap protein and high quality meat

and the technology for its production in West Africa is now well established and can be transferred easily to farmers. It thrives well in regrowth vegetation and can be grown semi-intensively. There is a large body of literature on its domestication, especially in the last twenty years (see Ajayi 1979) and some enterprises specialized in its rearing may already be in existence in Nigeria and other parts of West Africa.

d- Mushroom Growing

Several species and varieties of fungi are consumed in humid tropical Africa. Balogh (1988, see also Zoberi 1973, Oso 1975) lists 16 species of edible mushrooms in Nigeria including six species of *Termitomyces*, two *Pleurotus*, and species belonging to *Volvariella, Psathyrella, Calvatia, Auricularia, Tricholoma* and *Schizophyllum* all in the phyllum *Basidiomycota*. Zoberi (1973) states that about 25 edible species have been identified in Nigeria but Balogh has expressed strong doubts about edible mushrooms being fewer than in Europe where 50 species are consumed by humans. Mushrooms have been known for centuries in Nigeria but has been collected mainly from the wild. Alofe (1991) analyzed samples of *Termitomyces robutus, Tricholoma lobayensis* and *Volvariella esculenta* for amino acids and concluded that the proteins of the three mushrooms seemed to be adequate in the essential amino acids determined except lysine and methionine. The mushrooms also contained nutritionally adequate quantities of chromium, cobalt, nickel and zinc.

There is ready market all over the country for mushrooms and in western Nigeria the peak season is September/October when wild mushrooms are gathered from cocoa plantations and from rotting logs of wood. The technical limitation has been in raising suitable cultures. A large body of literature exists on edible mushrooms (see, for example, Alofe 1991).

e- Horticulture

Several wild plants exist in natural forests that could be utilized for horticulture. Most of the ornamental plants in use in Nigeria and other areas of the tropics have their origins in tropical Asia and South America. First, the forest zone provides the habitats for most epiphytic and ground orchids, many of which are of high ornamental value. The wet areas of Omo Reserve contain several species of lillies many of which could be used for beautification. There are also several trees that have either beautiful inflorescences or leaves or which have elegant architecture. An example of a plant with showy inflorescence is *Spathodea campanulata* while the deep red young leaves of *Brachystegia spp.* which appear in the middle of the dry season make the plant suitable as an ornamental. The elegance of *Terminalia*

ivorensis could also be utilized in some situations. The list of species valuable as ornamentals is an extensive one but the crucial factors include ease of propagation and ecophysiology.

3) Extraction of Some Non-Timber Forest Products.

The Miracle Berry, Miraculous Berry and Serendipity Berry, from the plants *Synsepalum dulcificum, Thaumatococcus daniellii* and *Dioscoreophyllum cumminsii*, respectively, share some characteristics: they are sweet fruits and the sweet substances in them are plant proteins instead of sugars. The plants are forest undergrowth: *Synsepalum* is a shrub, *Thaumatococcus* a forest ground layer herb and *Dioscoreophyllum* a climber (vine). They are found in semi-deciduous forest and are believed to hold the key to man's search for alternative sweeteners.

Synsepalum fruits yield miraculin which is a taste modifier in that anything eaten after it tastes sweet. *Thaumatococcus*, a member of the family Marantaceae is found in humid, shady and marshy localities beneath trees in the forest zone of West Africa, Cameroun, Gabon and Zaire and has been reported from Uganda (Nicol 1976). It grows well in secondary forest and in cultivation under cassava, coffee, bananas, plantains cocoa, rubber and oil palm. The leaves are tough and are used as food wrappers. The leaves are waterproof, heat retentive and biodegradably disposable. The petioles (stalk) are used for weaving household items like mats and baskets. Women, being the greatest users in the local food industry, gather the leaves for sale and its further commercialization will benefit rural women.

The fruit of *Thaumatococcus* grows at ground level on a bract which can carry several berries. Inside each berry are three black seeds at the top of which are fleshy arils in which the sweetener is concentrated. The sweet principle is thaumatin, a protein which has probably now been synthesized in the developed world. Nigeria will save the cost of payment for patents if its industries can have enough supply of thaumatin directly from the source plant.

There are several other plants utilized for various purposes other than for food. For example, *Cordia aurantiaca* of the family Boraginaceae is a small tree that could grow up to 12 m at maturity. The long apiculate green fruit of the tree is embedded in gummy juice which is a very high quality gum. A small plantation of *Cordia* or the tree growing under agro-forestry conditions, supported by a press or some extracting machine can produce income-yielding office gum.

Certainly, problems are anticipated in the change of emphasis in resource use. These problems relate to economics, politics and ecology. It is envisaged that with the input of the necessary resources most of the suggested uses of the biological resources of the Omo Biosphere Reserve will be realised. Social scientists will employ participatory techniques to mobilize the local people for new roles in the management of the Reserve. The Nigerian

national Committee of the Man and Biosphere Programme and the international sponsoring and coordinating bodies will do the political groundwork to ensure useful policy formulation. The pressure to conserve natural resources globally is so intense and it is anticipated that this will provide the necessary driving force for a change in the pattern of resource use that will ensure sustainability. It also has to be acknowledged that a change in policy at Omo without a corresponding change in the adjoining areas will render all efforts futile. Already the Government of Ogun State has some instruments which could be positively utilised. The Land Use Decree of 1978 vests all land in any Nigerian State in the government of that State.

Ecology is at the core of sustainable use of biological resources and in the present case only a few of the driving variables are well known. There has been a great deal of romanticisizing about the use of biological resources by indigenous people but the enormous problems associated with increased use of the resources have not been fully addressed. The question is whether the host environments can have stability or some resilience in the face of heightened use. A first step is to ensure some balance in the utilization of the various suggested resources in such a way that environmental degradation is avoided. It may be advisable to carry out environmental impact assessments before any projects are embarked upon and ensure community participation at all stages.

VII- INTERNATIONAL CO-OPERATION.

The South-South Co-operation on Environmentally Sound Socio-Economic Development in the Humid Tropics, a programme being executed by UNESCO, United Nations University and the Third World Academy of Science and under which ambit the project on Biosphere Reserves would be carried out, is premised on the need to improve understanding of the working of human settlements in tropical ecosystems. The programme is also premised on the need to improve our knowledge of the biological and cultural diversity in the humid tropics in the context of socially, environmentally and economically sustainable development, that ensures conservation of biodiversity. The scope is to make new technologies available to small-scale farmers who are engaged in traditional resource use patterns with the aim of integrated, improved food-energy production systems. Biosphere reserves, especially the buffer zones and the outer, manipulated areas provide the appropriate locus for interdisciplinary research directed at finding new resource-use patterns that will ensure conservation and sustainabilty.

Most of the tropical developing world have similar problems in natural resource management. The resource management strategies are externally driven and relate to colonial influence. Certain vital biological resources are totally left out of the cash economy. It is hoped that the South-South Co-operation Project will accelerate the development of certain neglected

resources, some of which have been mentioned in this report, and improve their management through shared knowledge and experiences.

Mushroom growing in tropical Africa, for example, has not taken off due to lack of biological knowledge in the area of biotechnology of spore production. Other areas that require capacity building and sharing of information include storage and marketing. More relevant biological knowledge will also be required for snail growing.

The inventorization and autecological studies involved for raising the status of non-timber forest products also require international co-operation. Remote sensing and Geographic Information Systems technologies will be needed for some inventories, and most tropical countries do not have such technologies.

The Nigerian Man and Biosphere study identified the role of forest gaps in forest regeneration. Reforestation will benefit from such knowledge. Further, the fact that exotic-tree plantations do not necessarily lead to a drastic loss of forest floor strata biodiversity is also worth further study so that more benefits by way of non-timber products could be derived from plantations.

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ANNOUNCEMENT

The Programme is publishing its Newsletter
South-South Perspectives,
which can be received free of charge on request.

The first Newsletter was published in October 1994and the second in October 1995. The Newsletter is edited in English, French and Spanish.

In the Newsletter, its editors would be glad to write short notes about books received and other kind of publications on *environment conservation, biodiversity, sustainable management of renewable resources* and *South-South cooperation.*

We would also reflect information on the present South-South cooperation activities in these fields.

All comments are welcome.

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N° 1 (1995) : *The Mata Atlantica Biosphere Reserve (Brazil) : An overview*
Antonio Carlos DIEGUES

N° 2 (1995) : *The Xishuangbanna Biosphere Reserve (China) : A Tropical Land of Natural and Cultural Diversity*
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N° 4 (1995) : La Réserve de la Biosphère de Dimonika (Congo)
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N° 10 (1995) : *La Reserva de la Biosfera Sierra del Rosario (Cuba)*
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N° 11 (1995) : *The Omo Biosphere Reserve (Nigeria)*
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N° 12 (1995) : *Environnement naturel et socio-économique de la forêt classée de la Lama (Bénin)*
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