THE STATE OF THE WORLD's FOREST GENETIC RESOURCES

COUNTRY REPORT

GHANA

This country report is prepared as a contribution to the FAO publication, The Report on the State of the World's Forest Genetic Resources. The content and the structure are in accordance with the recommendations and guidelines given by FAO in the document Guidelines for Preparation of Country Reports for the State of the World's Forest Genetic Resources (2010). These guidelines set out recommendations for the objective, scope and structure of the country reports. Countries were requested to consider the current state of knowledge of forest genetic diversity, including:

- Between and within species diversity
- List of priority species; their roles and values and importance
- List of threatened/endangered species
- Threats, opportunities and challenges for the conservation, use and development of forest genetic resources

These reports were submitted to FAO as official government documents. The report is presented on www. fao.org/documents as supportive and contextual information to be used in conjunction with other documentation on world forest genetic resources.

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

The State of the World's Forest Genetic Resources

COUNTRY REPORT: GHANA

Ministry of Lands and Natural Resources

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ACRONYMS

AAC- Annual Allowable Cut

ABS- Access and Benefit Sharing

AFORNET- African Forest Research Network

CBD- Convention on Biological Diversity

CIDA- Canadian International Development Agency

CITES- Convention on International Trade in Endangered Species of Wild Fauna and Flora

CORAF- Conference des Responsables de Recherche Agronomique Africans

CPA- Convalescence Protection Area

CRIG- Cocoa Research Institute of Ghana

CSIR- Centre for Scientific and Industrial Research

DANIDA- Danish International Development Agency

DS- Dry Semi-Deciduous

EU- European Union

FAO- Food and Agriculture Organisation

FC- Forestry Commission

FFRT- Faculty of Forest Resources Technology

FGR- Forest Genetic Resources

FIP- Forest Inventory Project

FORIG- Forestry Research Institute of Ghana

FR- Forest Reserve

FRNR- Faculty of Renewable Natural Resources

FSD- Forest Services Division

FWP- Forest and Wildlife Policy

GDP- Gross Domestic Product

GECCA- Ghana Environmental Conventions Coordinating Authority

GEF- Global Environment Facility

GHI- Genetic Heat Index

GRENEWECA- Genetic Resources Network for West and Central Africa

GSBA- Globally Significant Biodiversity Area

HCV- High Conservation Value

HFZ- High Forest Zone

ISSR- Inter-Simple Sequence Repeats

ITPGRFA- International Treaty on Plant Genetic Resources for Food and Agriculture

ITTA- International Tropical Timber Agreement

ITTO- International Tropical Timber Organisation

IUCN- International Union for the Conservation of Nature

KNUST- Kwame Nkrumah University of Science and Technology

MLNR- Ministry of Lands and Natural Resources

MOFA- Ministry of Food and Agriculture

MS- Moist Evergreen

NBSAP- National Biodiversity Strategy and action Plans

NCSA- National Capacity Self Assessment

NFP- National Forest Programme

NGO- Non-Governmental Organisation

NLBI- Non- Legally Binding Instrument

NRAC- Natural Resources Advisory Council

NREG- Natural Resources and Environmental Governance Programme

NRMP- Natural Resources Management Programme

NTFPs- Non-Timber Forest Products

OFI- Oxford Forestry Institute

PGRC- Plant Genetic Resource Centre

PGRRI- Plant Genetic Resources Research Institute

PPA- Provenance Protection Area

PPRSD- Plant Protection and Regulatory Services Department

RAPD- Random Amplified Polymorphic DNA

REDD- Reducing Emissions from Deforestation and Degradation

RMSC- Resource Management Support Centre

RTIP- Root and Tuber Investment Project

SFM- Sustainable Forest Management

SMFEs- Small and Medium Forest Enterprises

SODEFOR-La Societe de Developpement des Forets

SWMP- Savannah Woodland Management Project

UNDP- United Nations Development Programme

UNESCO- United Nations Educational, Scientific and Cultural Organisation

UNFF- United Nations Forum on Forests

USAID- United States Agency for International Development

WE- Wet Evergreen

WHC- World Heritage Convention

WITC- Wood Industry Training Centre

Executive Summary

Two main ecosystems exist in Ghana; the high forest and savanna ecosystems. Forest species characterization follows these zones with rainfall and soil fertility as the main determinants of species distribution, abundance and possibly intra specific variation. Intra specific variation studies in the country are at the infancy. The few available ones are research on the genus *Milicia* and *Khaya* for tree populations tolerant to insect attack and *Talbotiella gentii* for conservation needs identification. There is therefore no established information system on intra specific variation among forest plants in place.

Germplasm collection, screening for genetic resistance (progeny, provenance and clonal trials) and biotechnology techniques, constitute methods being employed to analyse and assess intra specific variation in the country. Biotechnology approaches **(**DNA marker assisted selection and organogenesis) have been identified as the way forward for improving the understanding of intra specific variation. However, no specific actions have yet been earmarked for the survey of intra specific variation among indigenous tree species in the country except what has been mentioned above. For teak (*Tectona grandis*), the most widely planted exotic tree, differences in provenances brought from different countries are well noted and described.

At the moment the objectives and priorities for improving the understanding of intra specific variation are geared towards identification of planting stocks resistant to insect and disease infestation under forest plantation conditions. Training of scientists at PhD level in forest genetics, training of technicians and expansion of the biotechnology lab at FoRIG are the capacity building needs for enhancing assessments and monitoring of inter specific and intra specific variations.

The productive value of forest genetic resources in Ghana is linked to timber, firewood, food and medicinal plants. In terms of trade timber is the most important but volume wise firewood is highest constituting roughly 91% of wood consumption. Many forest trees are also actively managed for environmental services especially on traditional cocoa farms and the bush fallow system where they provide the microclimate and soil conditions for agricultural sustainability. In settlements ranging from villages, to cities a wide range of species are managed for shade and landscaping.

A number of forest tree species are considered economically threatened due to over harvesting by the timber industry. Notable among these are *Pericopsis elata, Milicia excelsa, Milicia regia, Teighemella heckelii* and members of the Meliaceae numbering about seven. The state of genetic diversity of the main forest tree species has not been analysed but with the loss of most of the dry semi-deciduous forests the risks of decrease in diversity is real especially for species like *Antiaris africana* and *Milicia excelsa* that are typical of this forest type. Ghanaian forest trees have been classified according to their conservation status i.e. along a gradient of abundance through rarity and endemism. This allows for prioritization of species and locations for conservation purposes.

The main threats to forest and savanna ecosystems and the species therein are deforestation, over exploitation of timber and fuelwood and lately species invasion. At present there is no scheme for assessing genetic erosion of forest trees however, periodic forest inventories give clues regarding dynamics in species populations and forest cover which so far point to a decline in forest resources with time. This suggests a possibility of gradual forest genetic erosion over the years. Probably the most

threatened species is *Talbotiella gentii* which is endemic to Ghana, and confined to the small remnants of the Southern Marginal and South–east Outlier forests.

There is an information system available on threatened species and conservation trends in the form of species classification based on conservation status. This is however not very dynamic. In 1995 a forest reserves of Ghana graphical information exhibitor computer software was developed, that provided an interactive data base and dynamic map of plants and forests but seems to be out of date. The country's strategies to improve monitoring of genetic erosion and vulnerability are continuous inventories using permanent sample plots, GIS and remote sensing, periodic review of species conservation status and needs, capacity building, the application of genetic principles for determining intra specific variation and exchange of information. To improve the response to observed erosion and vulnerability, the periodic review of conservation status of species should be more frequent.

All forest species irrespective of use and conservation status are actively managed in one way or the other within in situ conservation programmes. However, some specific forest species are given differential protection based on a relative conservation priority system. The highest priority species for protection are those that are rare (both nationally and internationally) or endangered. Currently there are 52 of such species. In situ forest conservation areas established for this purpose are timber production forest reserves, provenance areas for economically threatened timber species and strictly protected areas known as globally significant biodiversity areas (GSBAs). Others are hill sanctuaries, swamp sanctuaries and convalescing forests. Wildlife reserves distributed across the various vegetation types also constitute important in situ conservation areas in the country.

The greatest constraints to improving in situ conservation in the country relate to weak law enforcement which results in over harvesting of trees especially for timber, reserve forest encroachment, mining, and wildfires. Priority actions for improving in situ conservation at the moment are effective law enforcement and rehabilitation of degraded forests. Future priorities will concentrate on fine-tuning the timber yield formula and harvesting regulations in timber producing forests. Outside the forest reserves, community forests and on-farm tree management should to be encouraged and supported. Capacity building needs and priorities for in situ conservation actions include building expertise in plant systematics and genetics. Research priorities include understanding how development policies and patterns are affecting forest genetic resources, the effect of climate change, intra specific variation and development of ecological indicators for monitoring changes in different conservation areas. Policy priorities for conservation actions are related to the question of how to reward forest owners and communities whose lands are held under strict forest protection and are therefore denied of any forest revenues.

Ex situ forest genetic resource conservation effort in Ghana is generally below expectation when viewed from the backdrop of the wide array of economically important and widely used forest species available in the country. This is principally due to lack of research funding and until about the year 2000, the low priority given to plantation forestry. FoRIG spent several years on collection of important germplasm and their consequent establishment in field trials. However the programmes were not followed through and some of the provenance trials have been destroyed by fire and illegal tree harvesting. A National Seed Centre is under construction at FoRIG and for now the Institute uses cold room facility for short term and working collections. FoRIG also has a germplasm laboratory and tissue culture facility to carry out rapid multiplication of genetic materials. Other CSIR institutions and universities have infrastructure capacity such as cold storage facilities for the conservation of orthodox seeds at -20ºC (long term) and 5ºC (short

term and working collections) for ex situ conservation. Field genebanks are also available for the conservation of timber species and forest medicinal plants. Existing ex-situ conservation achievements include provenance trials and clonal seed orchards of a few indigenous species; *Terminalia ivorensis, Pericopsis elata* and *Triplochiton scleroxylon* and the exotics *Tectona grandis, Gmelia arborea and cordia alliodora*. Six clonal banks have been established for *Terminalia spp., Khaya ivorensis, Ceiba pentandra, Entandrophragma angolense, Triplochiton scleroxylon* and *Milicia sp.* In addition, Ghana has eight arboreta located in the forest zone three of which contain indigenous forest species exclusively.

The major constraints, to *ex situ* conservation activities in the country are inadequate funding and working facilities, illegal harvesting of trees and insufficient well trained staff in the field of conservation of FGR. Breeding capacities of national institutions in Ghana have been increasing but because almost all the institutions concentrate on agricultural crops, very few forest species have benefitted from breeding programs. The main users of stored forest genetic material in Ghana are the Forestry Commission, private tree growers, FoRIG and university faculties involved in forestry research. The major plantation species is teak, for which there are improved planting material but other plantation species including both exotics and indigenous are raised from seeds collected from ordinary plantation stands or natural forest due to limited seed production from FoRIG's seed orchards. Despite the low level of tree improvement programmes in the country, there are some important achievements. For example the productivity and quality of West African teak, plantations have been improved using the genetic diversity and sustainable management of existing germplasm collections in the country. Similarly, using local germplasm, FoRIG has been able to reduce the impact of the insect pest, *Phytolyma lata on* the successful establishment of *Milicia excelsa plantations*.

The country has had a national plant genetic resources (PGR) programme since 1964 coordinated by the Plant Genetic Resources Centre (PGRC) that involves five CSIR institutions, the Cocoa Research Institute and the agricultural faculties of Ghanaian universities. The programme covers FGR however it is only FoRIG that is actively pursuing the interest of FGR in the group. The country therefore needs a separate programme for FGR that may be directed and coordinated by FoRIG with participation by universities involved with teaching and research in forestry.

Ghana is a member of the Sub-Saharan Africa Forest Genetic Resources (SAFORGEN) Programme as well as two earlier programmes for plant genetic resources; Genetic Resources Network for West and Central Africa (GRENEWECA) and the international network on Cocoa Germplasm Utilization and Conservation, coordinated by Biodiversity International. Ghana has also ratified many conventions and international agreements including the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the country is however yet to get a policy and guidelines on the conservation and use of FGR including breeders' rights and benefit sharing. There is a law, dating back to 1965 which regulates the importation and exportation of plant genetic resources in the country but the implementation falls short of expectation due to inadequate facilities for its enforcement. Ghana's FGR potentially contribute to the achievement of four of the eight millennium development goals (MDGs): eradicate extreme poverty and hunger; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; develop global partnership for development. The country's priority for better understanding of the economic,

social, environmental and other contributions of forest genetic resources for food, agriculture and forest development is how to harness the potential in FGR towards the achievement of the MDGs.

SECTION 1

GHANA AND ITS FOREST SECTOR

Location and Economy

Ghana is situated on the west coast of Africa and lies between Lat. 4^{o} 44' and 11^{o}15'N and longitudes 3^{o} 14W and 1^{o} 12'E. It is bordered to the North, West, and East by Burkina Faso, Cote d'Ivoire and Togo respectively and to the South by the Gulf of Guinea. The country has a total area of 23.85 million ha with an estimated population of about 24 million people which is growing at an annual rate of 2.2%. About 54.6% of the population lives in rural areas. In 2010 Ghana's gross domestic product (GDP) per capita[1] was US$ 1343 whilst the annual growth rate of GDP was 7.7% (Ghana Statistical Service 2011). The main export commodities are cocoa, minerals, timber and recently oil. Agriculture which is dominantly small-scale and concentrated on cocoa, oil palm and staple food crops, is the dominant economic sector accounting for around two-thirds of employment and around 40% of total GDP. Services comprise the second largest sector and has been accounting for an increasing share of GDP in recent times. The country has a rather small industrial sector. Ghana has 10 administrative regions and Accra is the capital city with three other major cities being Kumasi, Sekondi-Takoradi and Tamale.

Relief and Drainage

About half of the country lies below 152m above sea level whilst the highest point, Mt Afadjato is about 880 m above sea level. Ghana is drained by three main river systems; the Volta, South-Western and the Coastal River systems. Their basins cover 70%, 22% and 8% respectively of the total area of the country. The Volta System consists of the Black and White Volta rivers, the main Volta, the Oti River and the Daka River. The South-Western River systems comprise four main rivers (Bia, Tano, Pra and Ankobra) and their tributaries whilst the coastal river systems is made up of Butre, Todzie/Aka, Densu, Ochi (Nakwa) and Ayensu rivers.

Climate and Vegetation

Ghana has a tropical climate divided into humid, sub-humid and semi arid zones with aridity increasing from south to north but also eastwards. It has two main vegetation types; savanna and forest (Figure 1.1) which are basically defined by the rainfall pattern, degree of humidity, geology, soils and fire regime (Hall and Swaine 1981). These vegetation types fall into the broad categories of the Sudanian regional centre of endemism, the Guineo-Congolian/Sudanian regional transition zone and the Guineo-Congolian regional centre of endemism (White 1983).

The savannah covering 67.7% of the land area is found north of the forest zone but stretches further south into the east coast and exists in three distinct forms; coastal savanna, Guinea savanna and the Sudan savanna. The coastal savanna forms about 7% of the land area of Ghana. The mean annual rainfall is 600 – 1 000 mm split between two wet seasons with the major season lasting from March/April to June whilst the minor is from September to October. The vegetation consists of tall grasses with scattered trees. The Guinea and Sudan savanna zones (interior savanna) cover about 57% of the land area of Ghana. Unlike the rest of the country these zones have only one wet season from April/May to October. Mean annual rainfall ranges from 800 to 1200 mm and humidity is lower than what pertains in the forest zone. The interior savanna zones are characterised by short scattered trees up to about 6m tall and a continuous cover of grass.

In the forest zone the annual rainfall decreases from about 2200 mm from the southwest corner to about 1,000 mm towards the northern part of the zone. The HFZ has a two-peak rainfall with one occurring from April to July and the other September to November. There is a short dry season in August and a longer one between December and March. The relative humidity is always high in the wet season seldom below 85% but drops significantly in the major dry season. The annual mean temperature ranges from 25^{o}C to 27^{o}C and is fairly constant throughout the year.

Along a rainfall gradient the forest vegetation changes in structure and species composition from Wet Evergreen to Moist Evergreen, Moist Semi-deciduous and Dry Semi-deciduous forest. Wet Evergreen forest occurs in areas >1750 mm annual rainfall, has an average canopy height of 30 m and contains few deciduous trees in the upper canopy. It is the richest in plant diversity. Moist Evergreen forest occurs between the 1500 and 1750 mm annual rainfall belt, the canopy is taller (40 m) but the forest contains fewer species than the Wet Evergreen forest. Moist Semi-deciduous forest is found between the 1250–1750 mm annual rainfall belt. It is the most extensive forest type and the upper canopy is composed of both evergreen and deciduous species in about equal proportions. The canopy trees have an average height of about 50 m. Very few species are confined to this forest type but it has the highest density of commercial timber species. The Dry Semi-deciduous forest occurs between 1250 and 1500 mm annual rainfall and is adjacent to the savanna zone. An extension of this forest type is found in the Volta Region, disjoint from the main block. The canopy reaches 30 – 40 m height and contains many deciduous

species. Besides these major forest types, three distinct but smaller forest types are also present: Upland Evergreen, Southern Marginal and South-east Outlier forest. The Upland Evergreen forest is located on isolated hill ranges (500-750 m elevation) within the area of the Moist Semi-deciduous type. Most of the characteristic species are herbaceous, rather than woody and less than 5% of the species is deciduous. The Southern Marginal forest is found in the south east of the country in areas with rainfall between 1000-1250 mm. Although the vertical structure is well developed the canopy rarely exceeds 30 m whilst the undergrowth is thick and characteristically has high densities of gregarious species. The South Eastern Outlier forest is short in vertical structure (<15 m), has only two strata and a low species diversity.

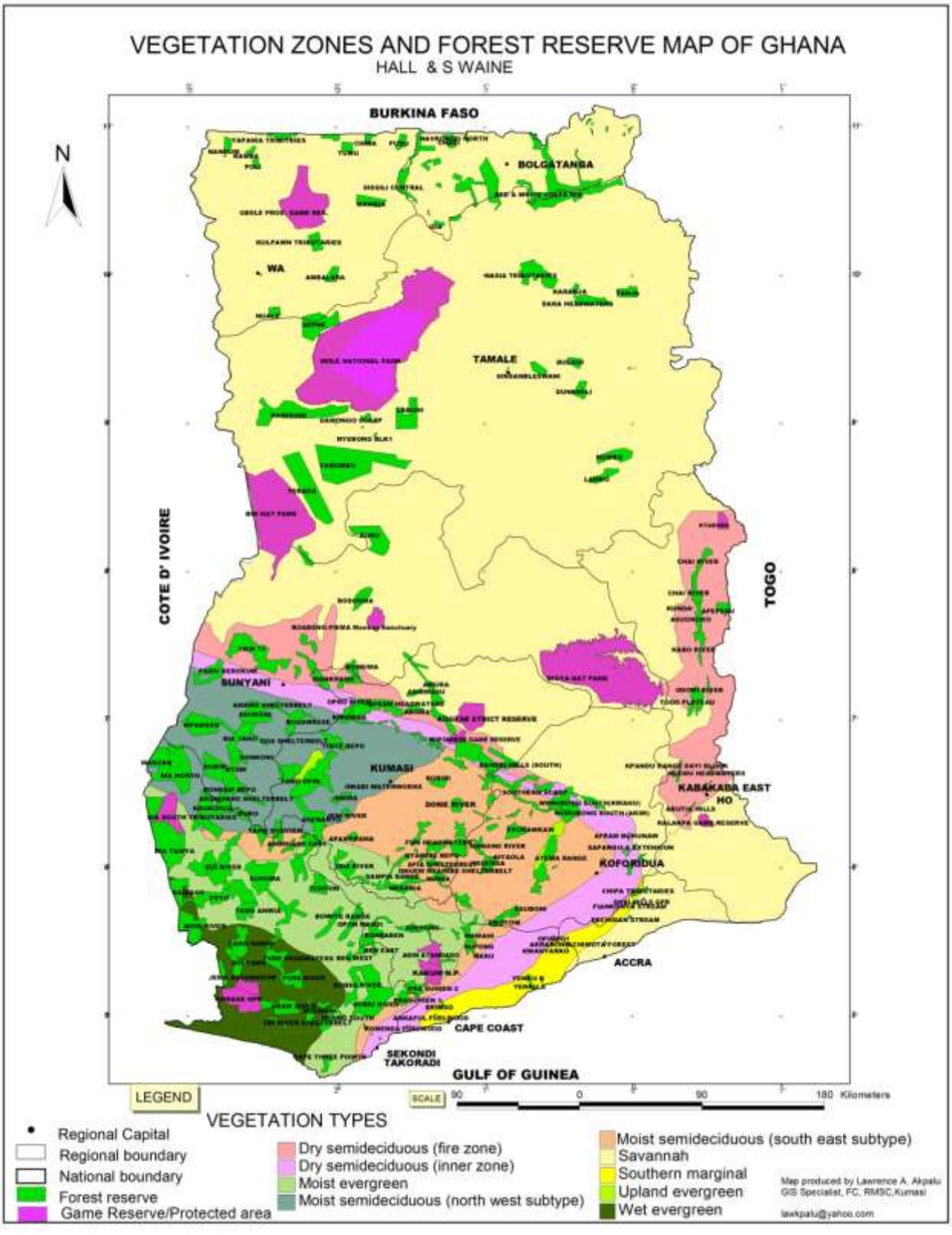

Figure 1.1 vegetation zones with corresponding forest and wildlife reserves in Ghana

The Forest Resource Base

The total forest cover is 6,335,000 ha (27.8% of land area) of which 6259,000 ha is natural forest and 72,000 ha plantations with a per capita of 0.3 ha (FAO 2000). Ghana's permanent forest estates consist of 266 forest reserves and 15 wildlife reserves distributed across the country in the form of government controlled-forest and wildlife reserves set up by the colonial administration between 1930 and 1950 and cover an approximate area of 3.5.million ha. Most of the forest reserves were set up in close collaboration with landowners and therefore occupy strategic locations in terms of environmental protection, local heritage and regional distribution though the highest concentration is in the Western Region where a lot of non-occupied lands existed at the time of reservation.

Outside the reserves, little primary forest remains but secondary forests at different levels of succession is found. These contain a lot of forest resources in the form of timber, fuel-wood and other non-timber forest products and are managed as part of the agricultural production system by farmers.

Forest Condition

Forest information in Ghana is relatively outdated. The information presented in this report is based on inventories and forest assessments conducted in the 1980s and 90s with the latest partial updates in 2000. Forest reservation was completed essentially by the middle of the 20th century, after which forest conservation efforts were all concentrated on the reserved areas whilst the off reserve areas were legally and intentionally converted into other land-uses notably plantation agriculture and bush fallow systems. Forest reserve boundaries were secured with remarkable success with the exception of few disputed cases but forest quality has been declining over the years. The forests of Ghana have had a long history of human disturbance and the forests condition is not judged by the absence or presence of human activities but by the degree of disturbance and the impairment of recovery to a healthy forest status. Even by this standard only half of the reserves were found to be in reasonable condition (less than 50% canopy disturbance) in 1995. At that time it was also noted that only 15% of the reserves had the lightest or no disturbance in recent history (Hawthorne and Abu-Juam 1995). Forest quality varies across the forest zone with the best conserved forests in the south-west and the most degraded towards the savannah in the north and eastward directions reflecting the combined influence of fire and logging (the most important forest degradation agents in Ghana) (Fig. 1.1). However, the wildlife reserves are well protected with only few signs of human induced degradation.

When information on Ghana's forest resource was updated in 2002 after an inventory of the production forests it came to light that within a period of 10 years the effective area of production forest reduced by 19% whilst basal area stocking fell by as much as 45% in some reserves (Affum-Baffoe 2002). In the 1990s the annual deforestation rate for reserved and

unreserved forests combined was estimated at 1.7% (FAO 2001). Recent estimates put deforestation rate for secondary forests at about 1.89% but a negligible rate for primary forests for the period 1990 to 2010 (Forestry Statistical Handbook 2011).

The Importance of Forests in Ghana

Forests play many important and sometimes changing roles in the lives of people and nations at various times and moments and that is what the situation has been for Ghana. In the early years of reservation the permanent forests were meant primarily for protecting the environment particularly for stabilizing the soil and climate suitable for sustainable production of cocoa and other commercial crops required for economic growth. From about 1948 onwards additional demand in the form of timber production was imposed on the forest alongside the collection of NTFPs which intensified as the non-reserved forests became smaller and smaller. In recent times, biodiversity conservation, climate mitigation, eco-tourism and livelihood improvement have become important in Ghanaian forestry bringing along with them significant changes in the way the forest is to be managed and exploited. These emerging roles and issues are already driving the agenda of forestry in the country.

Based principally on timber production the forest sector used to contribute about 6% of GDP but this has declined to about 3.6% due to a fall in timber production and expansion of the other sectors of the economy. Notwithstanding the decline in the volume of exports, timber still constitutes the third most important export commodity. The domestic market for timber products is also quite large estimated to exceed 1.7 million m^3 of roundwood (Marfo, 2010). For now most of this comes from off-reserve areas but forest reserves are increasing becoming sources of local lumber supply though through illegal operations.

Where forest reserves have become degraded and need to be converted into plantations, the modified taungya system being used to establish the plantations is reported to make significant improvement in food production and participating communities' incomes. Besides famers are entitled to 40% of the proceeds from timber and thinnings which is a big boost to the local economy

Various NTFPs used either on subsistence basis or traded on Ghanaian markets are also harvested from forest reserves. Although many NTFPs are harvested from agricultural fallow areas and farms, most of the products with commercial importance are available only from the closed canopy forests. These include chewsticks (*Garcinia spp*) and rattans. Many individuals in forest-fringe communities depend on NTFPs for their livelihoods but beyond this NTFPs also play key role in the national economy.

Forest genetic conservation is a key element in forest management in Ghana today although until the mid 90s it probably occurred by chance and not by plan. The wide distribution of the forest reserves ensured that a wide variety of plant and animal populations was reasonably catered for

even before biodiversity became an international issue and forest managers found the need to make separate plans for conserving biodiversity. Ghana is among the first 50 countries in the world with the highest diversity in plant and animal species (WCMC1994) and the forest reserve network is the main backbone for biodiversity conservation in Ghana. More than 2,100 plant species of which 23 are endemic have been found in the high forests of Ghana (Hall and Swaine, 1981). In total, there are 730 tree species, of which 680 attain a diameter at breast height (dbh) of at least 5cm, in the forests (Hawthorne 1989). Biodiversity levels are higher in the wetter forests but some of the dry forests protect some rare plant species and life-forms.

The contribution made by the Ghanaian high forest towards global carbon sequestration is not well studied. However it could be substantial bearing in mind that with the past logging history most of the forest will be recovering and therefore far from reaching equilibrium in carbon intake and output. The total carbon storage is estimated at 381 metric tonnes. Eco-tourism and forest recreation are generally under developed but for the Mole, Kakum and Ankasa national parks. The performance of these parks and the tourism sector as a whole should incite some interest in these forest uses among policy makers and the Ghanaian business community.

Both at the national and international levels the Ghanaian forest is valued from a variety of perspectives and for a variety of purposes and so far most of these have been taken care of in planning irrespective of the small size (0.3ha per capita). The challenge is how to transform these plans into practice. For now it appears the profound interest in timber is seriously undermining the sectors strategy for achieving a balanced goal for forest management.

Forest Sector Institutions/Actors

The forest sector comprises government and private entities involved in the administration, development and utilization of forest and wildlife resources. The key government agencies are the Ministry of Lands and Natural Resources (MLNR) in charge of the overall policy and direction and The Forestry Commission, responsible for policy implementation and monitoring. The FC has four divisions each with a specific forest management mandate:

Forest Service Division: protection and management of the permanent forest estates and regulation of timber harvests in areas outside forest reserves

Wildlife Division: management of wildlife protected areas

Timber Industry Development Division: promotion and regulation of timber trade

Timber Verification Division: timber legality assurance and verification

Resource Management Support Centre: planning and development of forest and wildlife management systems.

The Forestry Research Institute of Ghana and the Universities provide research and training support services.

The private entities comprise timber trade associations; made up of loggers, millers and wood workers as well as forest land owners. There are also several non-governmental organizations with focus on forests and the environment that, play active roles in forest policy formulation and implementation.

Chapter 1: The Current State of Forest Genetic Resources

1.0 Introduction

This chapter presents an overview of the ecological delineations of Ghana, management categories, trends in forest cover, stock of forest resources, forest information system, major factors influencing forest genetic resources and national priority needs.

1.1 The state of diversity between and within species

The High Forest Zone (HFZ) and the Savannah Zones are the two main ecological zones in Ghana. Ecologically the HFZ is sub-divided into different sub-types (Table1. 1). These groupings are a reflection of local climatic variation and soil differences prevailing in the country, which stretch beyond the boundaries of Ghana.Hall and Swaine (1981), classified the vegetation of the high forest according to the gradual change in forest composition, from the southwest, where the rainfall is highest and the forests are evergreen, towards the savanna boundaries in the east and north, where the forest is dry and deciduous.

Along this gradient, the vertical structure of the vegetation changes as the canopy trees become taller with the decreasing acidity of the soil due to less nutrient leaching. All these ecological zones have distinctive characteristics such as species diversity, abundance as well as composition and structure with the Wet Evergreen Forest being the most floristically diverse whilst the Semi-deciduous and Moist Evergreen forests constitute the main timber-producing areas. The largest plant family is Rubiaceae with 218 species followed by Orchidaceae with 148 species. The largest genus of trees is *Ficus* (33 species, many of which are epiphytic). There are no large genera of tall trees in Ghana: the largest genus in this category is *Entandrophragma* with only four species. However, larger genera exist among understorey trees (Hall and Swaine 1981). Some of the key commercial species in the moist and dry forests are *Triplochiton scleroxylon*, *Milicia excelsa*, *Mansonia altissima*, *Nesogordonia papaverifera* and *Khaya ivorensis*; in the evergreen forests the main species are *Guarea cedrata*, *Tieghemella heckelii*, *Tarrietia utilis* and *Uapaca spp*.

Intra specific variation studies in the country are at the infancy. The few available ones are research on the genus *Milicia* and *Khaya* for tree populations tolerant to insect attack and *Talbotiella gentii* for conservation needs identification. There is therefore no established information system on intra specific variation in place. Germplasm collection, screening for genetic resistance (progeny, provenance and clonal trials) and biotechnology techniques, constitute methods being employed to analyse and assess intra specific variation in the country. Biotechnology approaches **(**DNA marker assisted selection and organogenesis) have been identified as the way forward for improving the understanding of intra specific variation. However, no specific actions have yet been earmarked for the survey of intra specific variation among indigenous tree species in the country except what has been mentioned above. For teak (*Tectona grandis*), the most widely planted exotic tree, differences in provenances brought from different countries are well noted and described.

At the moment the objectives and priorities for improving the understanding of intra specific variation are geared towards identification of planting stocks resistant to insect and disease infestation under forest plantation conditions. Training of scientists at PhD level in forest genetics, training of technicians and

expansion of the biotechnology lab at FoRIG are the capacity building needs for enhancing assessments and monitoring of inter specific and intra specific variations.

Table 1.1 Description of general characteristics of the ecological zones

Vegetation Zone	Mean Annual Rainfall (mm)	Area (ha)
Wet Evergreen (WE)	>1750	657,000
Moist evergreen (ME)	1500-1750	1,777,000
Upland Evergreen	≤ 1700	29,200
Moist Semi-deciduous	1200-1800	3,318,000
Dry Semi-deciduous (DS)	1250-1500	2,144,000
Southern Marginal	1000-1250	236,000
Southern outlier	750-1000	2,000
Subtotal		**8.163,200**
Tall-grass Savanna	1000 - 1100	14,694,800
Short-grass Savanna		1,000,000
Subtotal		**15,694,000**
Mangrove Forest		11,000
Total		

Source: Ghana Forestry Statistical Handbook, 2011, Hall and Swaine (1981)

1.1.1 Trends in Forest area

Recent forest degradation trends indicate that Ghana lost an average of 135,000 ha of forest per year between 1990 and 2000. This amounts to an average deforestation rate of 1.8%. Likewise, between 2000 and 2010, the rate of forest change increased to 1.9% per annum. In total, between 1990 and 2010, Ghana lost 33.7% of its forest cover, or around 2.5 million hectares. This alarming trend is the motivation for successive governments to embark on massive plantation development programmes since 2001 in order to reduce pressure on natural forests that serve as gene banks (Forest Resource Assessment, 2010).Current estimates suggest that within the reserves, about 0.4 million ha degraded mainly by bushfires require replanting, 0.35 million ha classified as needing permanent protection (hill and swamp sanctuaries, biodiversity conservation, etc) and the remaining 0.9million ha classified suitable for timber production.

1.2 The main value of forest genetic resources

1.2.1 Forest reserves

In Ghana, forest reserves are owned mainly by the local communities, but government is responsible for management. The reservation of permanent forest estates reflected the major ecological zones (Table1.1) above) and this was done to preserve representative samples of the ecological and genetic diversity of the range of habitats. This is consistent with the first objective of the 1994 Forest and Wildlife Policy which aims to:

> *"Manage and enhance Ghana's permanent estate of forest and wildlife resources, conservation of biological diversity and the environment and sustainable production of domestic and commercial products."*

In pursuance of the implementation of 1994 Forest and Wildlife policy, a 25-year ambitious Forest Development Master Plan (1996-2020) was prepared to ensure short and medium to long-term sustainable management of Ghana's forest genetic resources (Table 1.2). This strategic plan aims to (a) ensure a

sustained and adequate supply of forest and woodland products (b) prevent further environmental degradation due to forest depletion and inappropriate farming practices; and (c) to stimulate community involvement in the management of the resources and enhanced economic wellbeing of the rural residents. Other strategies include the National Biodiversity Strategy and the Forest Protection Strategy which also sought to: (i) safeguard genetic and indigenous species diversity through an ecosystem approach; (ii) improve knowledge of the distribution and status of rare, threatened and endemic species through improved monitoring and habitat management and (iii) ensure sustainability and preserve genetic diversity within timber and non-timber forest species through data collection, regulation of harvesting and proactive management for sustainable production within forest reserves. This integrated approach also include the protection of significant forest habitats found outside forest reserves such as patches of forest found in sacred groves, swamps and strips of riparian forests. The importance of trees range from economic, social and environmental services (See Appendix 1 for a list of important tree species and uses).

Tab1e 1.2 Forest Management Categories in Ghana

National Classes	Production	Protection of soil and water	Conservation of biodiversity	Social	Unknown designation
Timber Production Area	762 400				
Convalescence	0		42 700	79 300	
Permanent Protection	0	352 500			
Conversion	127 200				
Not inventoried (conversion)	270 000				
Other off forest reserves	350 097			0	4 651 288
Total	**1 509 697**	**352 500**	**42 700**	**79 300**	**4 651 288**

Source FRA, Ghana Country Report, 2010

1.2.2 Off-reserve Forests

Much of the forest outside forest reserves was converted to agricultural lands during the 20th century. Currently, trees outside forest reserves are found in a mosaic of agricultural fields, fallow land, secondary forest patches and settlements. These areas are categorized into:

- Patches of old growth forest scattered in swamps and sacred groves
- Secondary forest regenerating from agricultural lands
- Riparian forest strips ranging from 5-50m wide along most streams
- Isolated trees standing on farms, collectively representing considerable tree resources
- Tree plantation covering a few hectares at a time in farmlands

1.2.3 Classification of Species and Genetic Heat Index

To ensure sustainable management and exploitation of the plant genetic resources in Ghana on a species by species basis, a Star Rating system was designed to guide the exploitation and use of these resources. Accordingly, all species are classified along a gradient of abundance through rarity and endemism (Table 1.3). Each of these star categories of species is weighted with the rarer (black star species) receiving the highest weight and the most common (green star species) the least. These star ratings allow for the

calculation of the Genetic Heat Index (GHI) of an area to determine its conservation status (Hawthorne and Abu-Juam, 1995). The Genetic Heat Index reflects the concentration of rare plant species in an area and allows for prioritization of areas for conservation purposes.

Table1.3 Star rating of species in Ghana

Star	No. of Species	Weight	Comment
Black	52	27	Attention is being pursued to conserve populations of these species. Rare internationally, and uncommon in Ghana
Gold	208	9	Fairly rare internationally and or locally
Blue	414	3	Widespread internationally but rare in Ghana or vice-versa
Scarlet	16	1	Common, but under serious pressure from heavy exploitation; is highly restricted.
Red	40		Common, but under pressure from exploitation
Pink	39	1	Common and moderately exploited This group has a sub group called Promotable Pinks where Government is encouraging their exploitation to reduce their numbers.
Green	1022	0	No particular conservation concern

1.2.4 Stock of timber resources

The total growing stock and biomass of Ghana's forests which in part represent the population dynamics of genetic resources have decreased from 1990 to 2010 (Tables 1.4 &1.5). It is estimated that growing stock for the ten most common species constituted about 22% of the growing stock in 2000. See appendix 2 for list of timber species and corresponding star ratings.

Table 1.4 Estimation of growing stock of tree species

Table 1.4 Estimation of growing stock of tree species

		Area (hectares)		
National Classes	**1990**	**2000**	**2005**	**2010**
Closed productive forest	1 694 526	1 386 478	1 255 205	1 123 933
Unproductive forests	352 500	352 000	352 000	352 000
Open forests	5 400 828	4 354 928	3 909 226	3 463 525
Total	**7 447 854**	**6 093 906**	**5 516 932**	**4 939 958**

1.2.5 Plantation Development

Generally, the policy seeks the development of a private sector led investment in a commercial plantation industry and an increased participation of communities, individuals and other groups in small-scale tree planting activities and an overall rehabilitation and restocking of the Nation's forests to ensure the sustainability of all forms of benefits derived from forests. Traditional taungya system was practiced from the early 1950s to help replant impoverished FRs in land –hunger areas in the high forest zone. Between 1960 and 1982 FSD was engaged in a reforestation programme which covered about 50,000ha. The success rate was about 30% due to poor maintenance; yet these plantations provide the key source of transmission poles for rural electrification, furniture and for export. To date, a total of 260,000 ha of

plantations have been established under various government-led programmes. The main plantation species are*Tectona grandis,Cedrela odorata and Gmelina* arborea which constitute (90%), of the total plantings. Indigenous species used in plantations are *Mansonia altissima, Terminalia superba, T. ivorensis, Entandrophragma angolense, Khaya ivorensis, Ceiba pentandra, Heritiera utilis and Triplochiton scleroxylon, Aningeria robusta and Pycnanthus angolensis.* So far 260,000 hectares of planted forests have been established through private and government led participatory programmmes.

1.2.6 Non Timber Forest Products (NTFP) Management

Non timber forest products are becoming increasingly important both in satisfying the needs of local communities and also on the export market to earn foreign exchange. Some of them hold special significance in providing vital material for the continued production of certain traditional foods and accessories. The most prominent NTFPs found to be abundant in commercial quantities are the various types of canes, climbers (comprising sponge, chew sponge, and *Piper guineense*), wrapping leaves, pestles and chew-sticks. The canes are more abundant in the wetter ecological zones whilst *Celtis* poles (pestles) are commoner in drier zones. Chew-sticks are almost entirely confined to the Wet Evergreen Zone. The present distribution of NTFPs is due to combination of over-exploitation and ecological preferences (Appendix 2). The harvesting intensity of the canes varies according to the demand and location of the resource. Those of very high harvesting intensities like the *Eremospatha* species and others require serious attention with regard to their propagation. The Collaborative Forest Management Unit of the Resource Management Support Centre (RMSC) of the Forestry Commission is working out modalities to manage the NTFP resource. Systems already developed through collaboration on the survey/inventory, management and harvesting of NTFPs will be replicated in other districts in the high forest zone.

1.2.7 Forest Products Production and Trade

Total industrial roundwood production in 2008 was 1.39 million m^3, little changed from the 1.37 million m^3 recorded in 2004 (SOFO, 2011). Sawnwood production was 513, 000m^3 in 2008, compared with 490 000 m^3 in 2004 and 455, 000 m^3 in 1999. About 191 000 m^3 of plywood was produced in 2009, compared with 140 000 m^3 in 2004 and 75 000 m^3 in 1999; 274 000 m^3 of veneer was produced in 2009, compared with 301 000 m^3 in 2004 and 150 000 m^3 in 1999 (ITTO 2011). The estimated export value of primary timber products was US$207 million in 2009, comprising logs (US$17.3 million – presumably teak and other plantation logs), sawnwood (US$70.0 million), veneer (US$63.4 million) and plywood (US$56.0 million) (ITTO ,2011). The export of timber products peaked in 2008 with a downward trend in 2009. Virtually all paper and paper board products are imported. The so-called lesser known and lesser used species categories have gained prominence through research and development.

Over 600 000 women in northern Ghana collect about 130 000 tonnes of nuts yearly from forests, about 40% of which is exported. This contributes about US$30 million annually to the national economy (Mayers, *et al*. 2008; Osei-Tutu *et al*. 2010). Other NTFPs with export market are thaumatin, a sweetener from seeds of *Thaumatococus danielli*, which is reputed to be easy to cultivate under plantation trees; and novella, an oil/margarine from seeds of *Allanblackia parviflora*. It is estimated that about 16–23 million

m^3 of wood valued at about US $ 200 million is consumed in various forms as energy per year (Table 1.5).This accounts for about 86% of urban energy; in rural areas, woodfuel makes up more than 95% of energy consumption (Mayers, *et al*. 2008; FRA, 2010). Charcoal production is concentrated in the transition zones between the forest and the Savannah woodlands. About 69% of all urban households in Ghana use charcoal and the annual per capita consumption is around 180 kg. About 91% of total round wood production is used as fuelwood. The remaining (9%) is used as industrial round wood (mainly timber).

Table 1.5 Estimation of wood fuel removal

Table 1.5 Estimation of Wood fuel removal			
	Extraction		
National Classes	**1990**	**2000**	**2005**
Total volume (1000m^3)	14 832.7	23 779.7	23 779.7
…. Of which from forest	15 832.7	23 779.7	23 779.7
Unit value (local currency/m^3 o.b.)	n/a	n/a	n/a
Total value (1000 local currency)	n/a	n/a	n/a
Source. FRA, Ghana Country Report, 2010			

1.3 Factors influencing the state of forest genetic diversity

In spite of the steps taken to conserve forest genetic resources in Ghana, there have been a number of challenges. High population growth, poverty, high dependence on natural resources and economic pressures in the late 1980s to early 1990s to increase exports and foreign exchange from agricultural, timber and minerals have been key contributors to the decline in forest area. The degradation of these ecosystems have made some of the ecological zones susceptible to wildfire. The main ecosystems threatened are the Dry Semi-deciduous forest and Southern marginal forest types. However, the primary underlying factor appears to be the inability to enforce forest laws and regulations due to institutional weakness and policy failures.

1.3.1 Agriculture

The traditional bush fallow system of cultivation involves slash and burn of forest and grassland. However, long fallows necessary for the forest to regenerate fully is only possible if population growth and pressure on the land are low. With increasing national population over the last two decades, demand pressure on land has been considerable. Demand for subsistence agricultural cultivation has been compounded by demand for cash crops like cocoa, coffee, oil-palm and cotton. Expansion of settlements and infrastructural development, have also pushed the forests further away.

1.3.2 Wildfires

Wildfire is presently by far the greatest threat to the long-term productivity, genetic wealth and the general health of the semi-deciduous forests in Ghana having significantly altered the composition and structure of more than 30% of the forest (Hawthorne, 1994). Besides, the range of forests damaged by fire has expanded southwards and a number of forest reserves which used

to be tall, dense and rich in biodiversity have now become grasslands of *Panicum maximum*. It is estimated that over 4 million m^3 of timber was lost following the 1983 fires alone. In the past wildfires were estimated to cause an annual loss of 4% of GDP. In the last few years, fire damage to forests appear to have declined but wildfire is still a force to reckon with in forest protection in the country.

1.3.3 Mining and Quarrying

Mining for gold, diamonds, bauxite and iron ore are long standing and important commercial activities in Ghana. Mining activities such as the open cast mining and illegal mining locally called 'galamsey' constitute a serious threat to forest cover in certain areas across the country. Examples include Afao Hills Forest Reserve, Atewa Range GSBA, Cape Three Points GSBA and Tano Ofin GSBA.

1.3.4 Overexploitation

Timber harvesting has impacted heavily on sustainable forest management and is responsible for most of the difficulties facing the forestry sector today. Fuel-wood and other NTFPs are also harvested from the forest but their impacts are felt more in the savanna zone around large settlements. Since 1990, the annual recorded timber harvests have always been higher than the legal AAC with the exception of the year 2000. Added to illegal harvesting which is estimated at about …% it is clear that the sustainable capacity of the Ghanaian forests have been exceeded for a very long time. The forest sector is banking its hope of reversing this trend on the Validation of Legal Timber Programme (VLTP) to improve the Forestry Commission's ability to bring down harvesting within sustainable limits by making it difficult to handle and trade in illegally acquired timber.

1.4 The state of current and emerging technologies

A system of forest information management is maintained by the Forestry Commission to monitor and ensure effective management of forest genetic resources.

1.4.1 Forest Inventories

Periodic national forest inventories have been the main guide for forest resource planning, management and development in Ghana. Two major national forest inventories have been undertaken in forest reserves within the high forest zone of Ghana. These are the Forest Inventory Project of 1986-1992, and the Multi Resource inventory of 2001-2002. The first inventory was aimed at providing static estimates of all tree species in the forest reserves. The success of this inventory is that it provided the basis for managing individual forest reserves within the HFZ. The latter was only targeted at providing static estimates of all commercial species in the timber production areas of forest reserves within the HFZ. It also provided stocking estimates of key NTFPs as well as species composition and relative abundances of wildlife resources. Targeted flora and fauna surveys were also carried out in 30 Globally Significant Biodiversity Areas (GSBAs) in 2004 to determine species composition and diversity for management planning. Under the climate change initiative, a Forest Inventory Project (FIP) is to be undertaken in 2012 in forest reserves in the high forest zone to determine the carbon stock in different forest management regimes..

1.4.2 Geo Information and Database System

Satellite imagery is increasing being used to monitor changes in Ghana's forest cover. The Forestry Commission through its technical wing, the Resource Management Support Center employs Geographic information system technology to provide up to date information on maps and trends in forest cover in the country. It also maintains an integrated database of important forest information: stocks of timber, NTFPs and fauna, forest resources exploitation, plantation development targets and achievements, etc. Also in pursuance of sustainable forest management, under the Voluntary Partnership Agreement between Ghana and the European Union, a computer-based log tracking system has been established and is currently being piloted to track the chain of custody of logged timber in order to reduce illegal exploitation activities.

1.5 Future needs and priorities

For the future progress and effective management and utilization of Ghana's forest genetic resources, the following needs and opportunities have been identified as current national priorities:

- Effective forest management policy review and research development
- Increased investment in natural forest management
- Effective stakeholder participation in forest management
- Provision of incentives for production of value-added processing
- Intensive forest plantation development to reduce pressure on natural forests
- Expanded cold storage facilities and facilities for tissue culture and biochemical characterization of germplasm at Plant Genetic Resource Centre (PGRC), Bunso, Forest Research Institute of Ghana (FORIG), Fumesua and the Botany Department of University of Ghana.
- Provision of plant quarantine facilities at the following stations: National Station at Pokuase, Terminal station at PGRC, Terminal station at Cocoa Research Institute of Ghana (CRIG), Tafo and FORIG.
- Training for all categories of personnel and provision of vehicles for the effective operation of the gene banks.
- Provision of the necessary infrastructure like offices and laboratories for PGRC and FORIG.
- Improvement in identification, protection, regeneration and conservation of endangered species.
- Total characterization, evaluation and documentation of all germplasm under conservation.
- Recruitment and training of requisite complement of staff to effectively manage the gene banks.

CHAPTER 2 The state of in-Situ Conservation

2.0 Introduction

The forest protection strategies in Ghana involve a range of protection measures for forest reserves and national parks to support environmental stability, plant genetic conservation and restoration of degraded reserves. About 4.4% of the forest reserves is wholly dedicated to genetic resource conservation and ecosystem stabilisation, 19.2% to environmental protection for hills, swamps and to particularly vulnerable reserves, 5.2% to fire protection in the dry forest types and 21.1% to degraded areas that need restoration. The protection strategy uses a multi-scale approach involving *fine-grain measures* applied at all times to all forest uses, and *medium to large grain measures* for the protection of large contiguous blocks of forests as a second line of defense.

2.1 Fine-grain Protection Strategy

This strategy aims at maintaining the integrity of the forest eco-system e.g. canopy structure, species distribution, soil structure, and other features of the forest ecosystem. These measures ensure that specific forest species are given differential protection based on a relative conservation priority system. The highest priority species for protection are those that are rare (both nationally and internationally) or endangered. Fine grained protection measures include:

- Complete protection of rare/endemic species (currently 52 species including the endemic *Talbotiella gentii*),
- Restricted use of some species such as the scarlet star species in order to maintain their population,
- Seed tree protection of commercial species to maintain genetic health and ensure regeneration, greater care in yield allocation, with particular attention to the ecology of certain over-exploited (Scarlet and Red star) species, etc.

2.2 Medium & Large-grain Protection Strategies

Medium to large-grain measures are aimed at protecting large contiguous blocks of forest on sensitive parts of the environment more or less as a second line of defense. Larger, constantly protected areas are more likely to be more defensible from fire, logging or the other violations than forest patches. Such protected areas have been demarcated and are patrolled frequently to ensure that they are not encroached upon. Some of these coarse grain approaches are elaborated below.

2.2.1 Globally Significant Biodiversity Area (GSBA)

These are areas within the high forest zone of Ghana found to be outstanding (globally and nationally) repositories of biodiversity. They are considered to have a very High Genetic Heat Indices (GHI) and are a key element of Ghana's protected area network. These areas are broadly synonymous with the High Conservation Value (HCV), a definition adopted by the Forest Stewardship Council.

Through extensive inventories conducted in the early 90s, thirty (30) forest reserves with a total cover of 2001 km^2 have been identified as having exceptionally high levels of biological diversity floristically. The management objective of GSBAs is to increase the ecological security of globally significant biological

resources in Ghana especially within threatened forest reserves of the HFZ primarily to secure the genetic resources in these areas. All the GSBAs have been demarcated and pillared to separate them from ordinary forest reserves and are covered with integrated management plans to promote forest genetic resource conservation.

2.2.2 Protection of Hill Sanctuaries

All areas within forest reserves that have steep slopes (>15 degrees) are mapped out and designated as hill sanctuaries. These areas are excluded from timber exploitation because of the environmental damage associated with the extraction of logs on steep terrain. The vegetation cover in most of these areas has not been disturbed and is classified to have High Genetic Heat Indices due to the presence of rare plant and animal species. Forest fringe communities are permitted to extract non-timber forest products from these areas on permit but other extraction activities are prohibited.

2.2.3 Protection of Swamp Areas

Patches of swamp forests including riverine vegetation are also protected and excluded from any form of human intervention including logging. These areas are kept in their natural state purposely to conserve the fragile but critical genes within these ecotypes.

2.2.4 Protection Areas for Convalescing Forests

Due primarily to over-logging and wildfires some timber production areas have poor condition usually with a basal area below 15 m^2 per ha. Such areas are designated as convalescence protection areas (CPA) for a period not exceeding one felling cycle (40 years) to allow the vegetation to recover to its original state. During this rest period no form of logging activities are allowed within the block. Normally all convalescence areas are protected from wildfires through the establishment of fire breaks and other wildfire management interventions to ensure they fully recuperate within the 40yr felling cycle.

2.2.5 Protection of Provenance Areas

These are designated areas for the protection from exploitation of a population of an economically threatened species (scarlet). The aim is to maintain the population's gene pool as close as possible to the condition prior to human interventions such as logging. This is to ensure the availability of useful source of genetic material for prime economic timbers species for both natural regeneration and artificial multiplication. Currently 42 compartments located in 26 forest reserves have been identified, demarcated and pillared as provenance protection areas (PPAs). The following species have been targeted for protection: *Entandrophragma. cylindricum, Khaya grandifolia, Terminalia ivorensis, Aningeria species, Entandrophragma Utile, Chrysophyllum subdunum, Guibourtia ehie, Pericopsis elata, Milicia regia, Milicia excelsa, Antiaris toxicaria, Cieba pentendra, Mansonia altisma, Guarea cedrata, Piptadenianstrum africanum, Entan. candollei, Garcinia epuntata, Distemonanthus benthamianus, Canarium schweinfurthii, Lophira elata, Petersianthus marcrocarpa, Daniella ogea, Terminalia heckelii, Rhodognaphalon brevicuspe, Terminalia africana, Afzelia bella, Heritiera utilis,*

2.2.6 Restricted and Wholly Protected Species

Other strategies adopted to ensure sustainable management of forest genetic resources include the application of normal yield and reduce yield formulae in allocation of timber for exploitation. Also all exploitable timber species have been classified as indicated in appendix 2 to ensure that the forests' genetic resources are not eroded.

Table 2.1 Categories national in situ protection strategies

Category	Target	Criteria	Implementation
Hill Sanctuaries	Watershed, steep slopes	Slopes > 30%	Identified, verified and removed from the timber harvesting schedules.
Swamp Sanctuaries	Large perennial swamps	Permanently or occasionally flooded	Identified, verified and removed from timber production
Shelterbelts	Narrow vulnerable forest reserves	Linear reserves ≤ 2km width	
Globally Significant Biodiversity Areas	Centers of high floral diversity	High Genetic Heat Index (GHI)	These have been re-designated, pillared and mapped .They are managed exclusively for genetic conservation and environmental protection under integrated management plans.
Provenance Protection	Genetic diversity of prime species	Over-exploited timber species	Forty-two (42) compartments located in twenty-six Forest Reserves have been identified, demarcated and pillared as Provenance Protection Areas (PPAs).
Cultural Sites	Areas with cultural significance	Sacred groves, burial sites, historic and touristic significance	Many identified. Additions as communities request
Fire Protection	Reserves vulnerable to fire	Significant fire history	
Convalescence	Degraded forest reserve areas	*Condition score 5 and above; Areas with tree basal area of less than 15 m^2/ha..	Identified and re-categorized into rehabilitation and conversion areas. These areas are also protected from the annual wildfire through the establishment of fire breaks and other interventions to ensure recuperation within the 40yr felling cycle.

Source: Ghana Forestry Report, 2011 (modified)

Chapter 3: The state of ex-situ Conservation

A number of initiatives have been undertaken to produce, store and maintain seeds of forest trees as a means of conserving forest genetic resources in Ghana. This chapter presents the current state of efforts that have been made in Ghana to conserve, maintain and propagate representative forest genetic resources, ex-situ.

3.1 Enrichment Planting

Enrichment planting is the enriching of a naturally poorly stocked forest by means of partial planting. The objective of enrichment planting is to increase the stock of valuable species. In areas where this method is adopted, the regeneration of the required species is scanty or partially successful or completely absent. It is in effect an artificial regeneration method used to supplement natural regeneration. Enrichment planting plots were established in the Asenayo, BiaTano and Nueng Forest reserves between 1975 and 1978. The aim was to increase the stock of heavily exploited timber species in the forest reserves and produce seeds of native species in a concentrated manner. Species planted included *Pericopsis elata, Entandrophragma utile, E. angolense, E. cylindricum, Khaya anthotheca, K. ivorensis, Nauclea diderrichii, Terminalia ivorensis and Triplochiton scleroxylon.* Currently some guidelines have been developed for carrying out enrichment planting by the Forestry Commission in the Bosomkese, Bia North and the Dome River Forest Reserves. Species planted in 2011 include: *Triplochiton schleroxylon, Khaya ivorensis, Khaya grandifoliola, Periscopsis elata, Tieghemella heckelii, Entand. utile, Entando.angolense, Milicia excelsa, Nuclear diderrichii, Terminalia superba, Terminalia ivorensis and Mansonia altissima.*

3.2 Selection and Genetic Improvement

With the wide array of species that are economically important and used, it might be expected that a sufficient diversity of tree improvement programmes will be generated. However Ex situ forest genetic resource conservation effort in Ghana is generally low. This is principally due to lack of research funding and until about the year 2000, the low priority given to plantation forestry. FoRIG spent several years on collection of important germplasm and their consequent establishment in field trials. However the programmes were not followed through and some of the provenance trials have been destroyed by fire and illegal tree harvesting. There is a need to revamp the interest in this area of research if Ghana is to benefit fully from its plantation programme. Some of the provenance trials are close to the end of their rotation whilst almost all the seed orchards are flowering and fruiting regularly.

3.3 Provenance Trials

A number of provenance trials have been established in Ghana with the aim of conserving genetic pool, providing information on the nature and extent of genetic resources within and between provenance throughout the species native ranges and providing a basis for selection of species for forestation.

Terminalia ivorensis

There are 10 provenances, three from the Ivory Coast, one from Cameroon, and six from Ghana (Table 3.1). These were established in July, 1973 at Neung Forest Reserve and Bemu Forest Reserve but the later was destroyed by fire in 1983. Field assessment of plants in 1991 showed that the provenance from Cameroon was the poorest in growth. Leakey (1992) in his consultancy report commented that the Cameroon provenance comes from an area with very different soil from that of Ghana.

Pericopsis elata and Triplochiton scleroxylon

In 1976 provenance trials of these two indigenous species were established at Ahyiaem in the Bosomkese Forest Reserve (Brong Ahafo) in the Moist Semi-deciduous forest type. They comprised 12 provenances of *P. elata* and seven provenances of *T.scleroxylon*. But these trials were completely destroyed by fires in 1983.

Table 3. 1 Sources of Provenances

	Tectona grandis			*Gmelia arborea*
i)	3021 India (moist)		i)	SC 4017 NE India
ii)	3022 India (dry)		ii)	SC 4028 NE India
iii)	3047 Indonesia		iii)	SC 4016 CE India
iv)	3048 Indonesia		iv)	SC 4036 CE India
v)	3049 Indonesia		v)	SC 4037 CE India
vi)	3055 Laos		vi)	SC 4007 CE India
vii)	3056 Laos		vii)	SC 4009 CW India
viii)	3059 Laos		viii)	SC 4025 CW India
ix)	3044 Ghana landrace-Jema		ix)	SC 4024 CW India
x)	SG01 Ghana landrace-Juaso		x)	SC 4040 Latin America
xi)	SG03 Ghana landrace-Ho Hills		xi)	SL 4024 Ghana landrace
xii)	SG04 Ghana landrace-Pra Anum			
	Cordia alliodora			*Terminalia ivorensis*
i)	10-77 Finca el Chilero, Guatemala		i)	Ivory Coast 300
ii)	20-77 San Franscisco, Honduras		ii)	Ivory Coast 300
iii)	26-77 Waswali, Nicaragua		iii)	Ivory Coast 337
iv)	35-77		iv)	Cameroon, Kumba
v)	13-77 Valle de Cauca, Colombia		v)	Ghana, Ndumfri
vi)	19-77 Finca la Fortuna, Honduras		vi)	Ghana, Mankrang
vii)	9-99 Tree piedras		vii)	Ghana, Bobiri
viii)	14-77 Esteli, Nicaragua		viii)	Ghana, Ankasa
ix)	18-77 Finca la Pineda, Nicaragua		ix)	Ghana, Volta River
x)	1-77 Yapo, Ivory Coast		x)	Ghana Krokosua

3.3.1 International Provenance Trials

Tectona grandis

In August, 1973 provenance trials of teak were established in collaboration with DANIDA Forest Tree Seed Centre, involving four land-races from Ghana and 12 from India, Indonesia and Laos (Table 3.1). These trials were sited at Pra-Anum Forest Reserve with mean annual rainfall of 1650 and altitude of

100m; Tain II Forest Reserve with rainfall of 1140 and an altitude of 100m and Subri Forest Reserve with rainfall of 2030 mm and an altitude of 150m.

Results from Pra-Anum and Tain II presented by Keiding *et al* (1986) indicated that the best provenance in terms of health, production and quality were 3021 and 3049 at Pra-Anum and 3021 and SG01 at Tain II. Overall the best provenances were from India, Indonesia and Laos (3021, 3049, 3055 and 3047).The local provenance had poor quality. A hybrid orchard has been established from Plus trees selected from the best provenances using grafting.

Gmelina arborea

This trial is part of one of DANIDA's international provenance trials: Table 3.1 shows sources of the provenances. It was established in 1973 at Subri, Pra-Anum and Opro. Results presented by Lauridsen *et al*. (1986) showed that SC4040, SC4017 and SC4028 were the best provenances for health and production but SC 4040 had poor quality.

Cordia alliodora

This trial forms part of Oxford Forestry Institute's (OFI) International provenance trials. The provenances are as shown in Table 3.1. The trials were established in July 1978 at Subri, Pra-Anum and Opro. Many of the trees in the trial plots are leaning in one direction which according to Leakey (1991) is not found in Central America, suggesting the unsuitability of this species in Ghana or perhaps the need for much wider spacing. Spacing was 3.6m x 3.6m,

3.4 Clonal Orchard

A clone is any group of plants derived from a single individual by vegetative reproduction. A seed orchard made from such plants is referred to as clonal seed orchard. Clones flower earlier than normal trees of the species. Clonal seed orchards have been established in Ghana using scion material budded/grafted on to seedling rootstocks from selected plus-trees of the following species.

Tectona grandis (landraces)

This orchard is situated at Jimira Forest Reserve with an annual rainfall of 1480 mm and an altitude of 256 m. The orchard was established in 1978/79 and comprises twenty clones. The sources are shown in Table 3.2. The trees started fruiting in 1982 and the seed yield is estimated to exceed 1000kg. Seeds from each mother clone have been tested for their germination capacity and seedling growth rate. Seeds from mother clones that came from Obuasi and Afram Headwaters Forest Reserve had poor germination. Because of increased interest in teak plantations, demand for seeds from the orchard has increased tremendously, but progeny testing is yet to be carried out to remove the undesirable clones.

Tectona grandis (International provenances)

This orchard was established in 1989 from clones of the International provenance origin (Table 3.2). It is also situated at the Jimira Forest Reserve. Fruiting started in 1993.

Terminalia ivorensis

The clonal seed orchard of this species is located at South Formangsu Forest Reserve in the Moist Semi-deciduous Forest zone, with an annual rainfall of 1520 mm and altitude of 210 m. There are two plots of this orchard each consisting of twenty clones (Table 3.2). One was established in 1972 and the other 1973. The trees started flowering and fruiting in 1976, but due to the declined interest in *T. ivorensis* plantations in Ghana as a result of the *T.ivorensis* die-back, there is little request for seeds to date.

Triplochiton scleroxylon

This orchard is located at South Formangsu Forest Reserve. There are two plots each consisting of twenty clones (Table 3.2). Establishment was in 1972 and 1973. Only a few clones have flowered, and trees have

straight stems and do not look like grafts. Only one clone, which first flowered in 1974 (72 established), has flowered regularly like a true graft.

Gmelina arborea

An orchard of *G. arborea* was established at Subri from 32 clones selected from both landraces and the international provenance trials (Table 3.2). Planting started in 1991.

Cedrela odorata

The orchard, consisting of three plots is located at South Formangsu Forest Reserve. The first plot was established in 1971 comprising 12 clones from Pra-Anum. The second plot was established in 1972 and it comprises the 12 clones in plot 1 and 3 together with clones from Dunkwa, Upper Wassa and Pra-Anum. The third plot was established in 1976 using a total of 22 clones, comprising all the clones in plot 1, some of the clones in plot 2 and 3, and other clones from Owam and Tain II forest reserves. Seeds have been purchased from this orchard in the late seventies and early eighties by SODEFOR (Ivory Coast) and in the 90s by the Subri Industrial Plantation Ltd (Ghana).

Table 3.2 Sources of clones in seed orchards

	Tectona grandis			*Tectona grandis*
i)	V 25 Pra Anum		i)	V115 3021
ii)	V 42 Pra Anum		ii)	V116 3021
iii)	V 70 Dunkwa		iii)	V117 3021
iv)	V 87 Bosomoa		iv)	V118 3021
v)	V 89 Ho Hills		v)	V119 3047
vi)	V 90 Ho Hills		vi)	V120 3047
vii)	V 91 Ho Hills		vii)	V121 3048
viii)	V 92 Ho Hills		viii)	V122 3048
ix)	V 93 Ho Hills		ix)	V123 3049
x)	V 94 Ho Hills		x)	V124 3049
xi)	V 95 Ho Hills		x)	V125 3050
xii)	V 96 Ho Hills			
xiii)	V 97 Kpandu			
xiv)	V 98 Kpandu			
xv)	V 99 Obuasi town			
xvi)	V 100 Obuasi town			
xvii)	V 102 Obuasi town			
xviii)	V 102 Afram Headwaters			
xix)	V 96 Ho Hills			
	Gmelina arborea			
i)	S1 Subri FR		xviii)	S28 Subri FR
ii)	S2 Subri SC 4040		xix)	S29 Subri FR
iii)	S3 Subri SC 4040		xx)	S30 Pra Anum 4028
iv)	S4 Subri SC 4040		xxi)	S31 Pra Anum SC 4040
v)	S5 Subri SC 4040		xxii)	018 Opro River SC 4040
vi)	S6 Subri SC 4040		xxiii)	019 Opro River SC 4040
vii)	S7 Subri FR		xxiv)	020 Opro River SC 4028
viii)	S8 Subri FR		xxv)	K33 Kade Plantation
ix)	S9 Subri FR		xxvi)	K34 Kade Plantation
x)	S10 Subri FR		xxvii)	K35 Kade Plantation
xi)	S11 Subri FR		xxviii)	K36 Kade Plantation
xii)	S14 Subri FR		xxix)	K37 Kade Plantation
xiii)	S23 Subri FR		xxx)	B21 Bosomoa River FR
xiv)	S24 Subri FR		xxxi)	B22 Bosomoa River FR
xv)	S25 Subri FR		xxxii)	K33 Kade Plantation
xvi)	S26 Subri FR			
xvii)	S27 Subri FR			

	Terminalia ivorensis			
i)	V6 Dome River		xi)	V60 Upper Wassan
ii)	V8 Pra Anum		xii)	V61 Upper Wassan
iii)	V9 Pra Anum		xiii)	V62 Upper Wassan
iv)	V26 Bia Tano		xiv)	V63 South Formangsu
v)	V34 Pra Anum		xv)	V64 Ayiyiola
vi)	V35 Pra Anum		xvi)	V65 Ayiyiola
vii)	V36 Pra Anum		xvii)	V66 Ayiyiola
viii)	V37 Pra Anum		xviii)	V67 Nkrabea
ix)	V38 Suhuma		xix)	V68 South Formangsu
x)	V34 Upper Wassan		xx)	V25 Nkrabea
	Gmelina arborea			
i)	S1 Subri FR		i)	V4 Bobiri
ii)	S2 Subri SC 4040		ii)	V10 Pra Anum
iii)	S3 Subri SC 4040		iii)	V11 Pra Anum
iv)	S4 Subri SC 4040		iv)	V12 Pra Anum
v)	S5 Subri SC 4040		v)	V15 Pra Anum
vi)	S6 Subri SC 4040		vi)	V18 Pra Anum
vii)	S7 Subri FR		vii)	V27 Tinte Bepo
viii)	S8 Subri FR		viii)	V28 Pra Anum
ix)	S9 Subri FR		ix)	V39 Bia Tano
x)	S10 Subri FR		x)	V40 Bia Tano
xi)	S11 Subri FR		xi)	V41 Bia Tano
xii)	S14 Subri FR		xii)	V43 Boumfum
xiii)	S23 Subri FR		xiii)	V44 Bobiri
xiv)	S24 Subri FR		xiv)	V45 Bobiri
xv)	S25 Subri FR		xv)	V46 Bobiri
xvi)	S26 Subri FR		xvi)	V47 Tinte Bepo
xvii)	S27 Subri FR		xvii)	V72 Bia Tano
xviii)	S28 Subri FR		xviii)	V73 Bia Tano
xix)	S29 Subri FR		xix)	V74 Bobiri
xx)	S23 Subri FR		xx)	V75 south Formangsu
xxi)	P30 Pra Anum 4028			
xxii)	P31 Pra Anum SC 4040			
xxiii)	018 Opro River SC 4040			
xiv)	019 Opro River SC 4040			
xxv)	020 Opro River 4040			

3.5 Clonal Seed Banks

In association with plus-trees selection and clonal seed orchard establishment, small clonal conservation banks were established for all the species that were used in the orchard. Banks are situated at Mesewam, the research nursery of FORIG.

3.6 Seed Storage Banks

In Ghana attempts to store seeds as means of conserving forest genetic resources started in 1971 when a small cold room was built under the Silviculture Branch of the Forestry Department (now Forest Services Division). However, it broke down only after 3 years of use and was never restored. Thereafter FoRIG attempted using deep freezers to store seeds but they could not provide the optimum conditions necessary for prolonged storage (Siaw, 2001). Currently, there are no forest tree seeds under conditions for long term seed storage. A National Seed Centre is now under construction at FoRIG but there is already acold room facility for storing orthodox seeds. Present national demand for forest tree seeds, is estimated at 10,000 kg per annum which is expected to increase due to the intensification of plantation development. Currently, institutions that require large quantities of seeds either do their own seed collection from plantations or depend on FORIG for supply.

3.7 Genetic Resistance in *Milicia* Species

With the support of the International Tropical Timber Organization (ITTO) FoRIG has examined the genetic resistance in *Milicia spp*. to the very serious attack of the psylid *Phytolyma lata.* This attack leads to the failure of *Milicia* spp. plantations. Resistant clones that are less frequently attacked or in which any galls formed do not develop to maturity, have been isolated and replicated.

CHAPTER 4The state of use and sustainable management of forest genetic resources

Over the years, there has been gradual increase in exploited timber species from 10-25 in 1980s, 60 in 1990s to 80+ species at present due mainly to identification of markets for the lesser known species. Likewise the number of species harvested for other uses such as fuel-wood and non-wood forest products has widened but very little has been done to match this in terms of tree breeding and genetic improvement. Breeding capacities of national institutions in Ghana have been increasing but because almost all the institutions concentrate on agricultural crops, very few forest species have benefitted from breeding programs in Ghana. The main users of stored forest genetic material in Ghana are the Forestry Commission, private tree growers, FoRIG and university faculties involved in forestry research. The main plantation species is teak for which there are, improved planting material but other plantation species including both exotics and indigenous are raised from seeds collected from ordinary plantation stands or natural forest due to limited seed production from FoRIG's seed orchards.

4.1 Selection and genetic improvement

Table 4.1 Tree improvement programmes

	Species	Native	Introduced	Main Improvement	Level of improvement
1	*Tectona grandis*		Introduced	Production of improved quality seeds	First Generation
2	*Gmelina arborea*		Introduced	International provenance trial- timber	First Generation
3	*Terminalia superb*	Native		Seed orchard established for seed production	First Generation
4	*Cordia alliodora*		Introduced	Seed orchard	First Generation
5	*Nauclea diderrichii*	Native		International provenance trial- timber	First Generation
6	*Ceiba pentandra*	Native		Provenance trial – timber and seed production	First Generation
7	*Allanblackia parviflora*	Native		Oil production	First Generation
8	*Triplochiton scleroxylon*	Native		Orchard for seed production	First Generation
9	*Khaya ivorensis*	Native		Orchard for production of seeds	First Generation
10	*Cedrella odorata*		Introduced		First Generation
11	*Khaya anthotheca*	Native		Seed orchard	First Generation
12	*Milicia spp*				

13	*Khaya ivorensis*				
14	*Terminalia ivorensis*				

4.2 Clonal and gene banks

Clonal testing on teak is presently ongoing using seedlings from open pollinated trees originating from clonal seed orchards. Half of the plot established in 1978 has been top pruned since 1997. Six clonal banks have been established covering a total area of 1 acre. Species being tried are *Terminalia spp., Khaya ivorensis, Ceiba pentandra, Entandrophragma angolense, Triplochiton scleroxylon* and *Milicia sp.* Five gene banks covering a total area of 10 ha have been established whilst the rooting capabilities of cuttings of some indigenous species have been tested for possible breeding programmes in future.

Despite the low level of tree improvement programmes in the country, there are some important achievements. For example the productivity and quality of West African teak plantations have been improved using the genetic diversity and sustainable management of existing germplasm collections in the country. Similarly, using local germplasm, FoRIG has been able to reduce the impact of the insect pest, *Phytolyma lata on* the successful establishment of *Milicia excelsa plantations.*

Table 4.2 Provenance Trials with both indigenous and exotic species

Species	No. Of Provenance tested	Plus trees	Seedling Progenies	Clones tested	Type	Number	Size/ha	
Tectona grandis	12	12	140	7	Provenance Trial & Progeny test/Grafted	3/5	3/17	
Gmelina arborea	11							
Terminalia superba	34	34	1020	12	Grafted	1	1	
Terminalia ivorensis	10	10						
Cordia alliodora	10							
Nauclea diderrichii	34	34	1020	12	Grafted	1	1	
Ceiba pentandra	9	93						
Allanblackia parviflora	108	53	410	68				
Triplochiton scleroxylon								
Khaya ivorensis	12	12		40	Grafted	1	1	
Cedrella odorata					Grafted	1	1.5	
Khaya anthotheca	20	20		60	Grafted	1	1	

CHAPTER 5 National Forest Programme, Forestry Education, Training and Research in Ghana

5.1 National Forest Programme

Ghana follows a national forest programme (NFP) guided by a Forest and Wildlife Policy (FWP) which was promulgated in 1994 based upon which an implementation document labeled as Vision 2020 Forest Sector Master Plan was formulated. Subsequently projects and programmes such as the Natural Resources Management Programmes I and II (NRMP: 1998-2005), the Natural Resources and Environmental Governance Programme (NREG: 2008 – 2012) have been implemented to ensure achievement of set objectives. Currently, preparatory processes have been initiated for a follow-up project, known as, the Forest Investment Project to further enhance achievement of sustainable forestry goals under the NFP.

Although the state is expected to come out with a new five-year National Forest Plan the first of which was produced for the 1998 – 2002 period, it has not yet done so. Besides the national documents, the Forestry Commission formulates strategic corporate plans to guide its activities on annual basis. Each forest reserve is managed according to forest management plans spanning a period of 20 years. Within the local government context, each district assembly is to formulate a district forestry plan as part of its five-year district development plan. In most cases, however, the district forestry plans are never formulated. All these documents amply provide set goals, recommendations and operational directives on how forest genetic resources should be sustainably managed and utilized. These strategic documents have largely influenced current forestry programmes resulting in moderate level of success in maintaining Ghana's forest integrity in spite of the severe challenges posed by a rapidly expanding population which exerts pressure on forest genetic resources.

5.2 Institutions Involved In Forestry Education and Research in Ghana

The key institutions involved in forestry education and research in Ghana are the Faculty of Renewable Natural Resources (FRNR) and the Faculty of Forest Resources Technology (FFRT) of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi and the Forestry Research Institute of Ghana (FORIG). The University for Development Studies also runs an undergraduate programme in natural resource management including forestry. Higher education in plant genetic resources is available in the botany departments of University of Ghana, University of Cape Coast and KNUST. Besides the state institutions, the private sector and - NGOs are also supporting forestry training and research. The Presbyterian University College, Ghana runs a degree course in forestry while the Tropenbos International, with headquarters in the Netherlands supports research and capacity building on contemporary forestry issues. However, only FoRIG has a sustainable programme on forest genetic resources. Of late it has collaborated with the Faculty of Renewable Natural Resources in training one person at the PhD level in forest genetics.

5.2.1 Forestry Research Institute of Ghana (FORIG)

The Forestry Research Institute of Ghana (www.forig.org) is one of the 13 institutes of the Council for Scientific and Industrial Research (CSIR). It was fully established as a research institute in 1964 and in 1968 placed under the Council for Scientific and Industrial Research (CSIR).
FORIG has ten research outstations distributed amongst the different ecological zones of Ghana. Bobiri Forest and Butterfly Sanctuary which hosts the Bobiri Forest Arboretum- with about 100 indigenous species on 1.7 hectares of land is one of the key outstations. These stations are used as sites for conducting field trials.
The National Tree Seed Centre located at FORIG aims at providing high quality tree seeds for the whole country. Some activities of the Centre include provision of high quality tree seedlings, seed research, training and information, technical collaboration and conservation of forest genetic resources.

Recently completed and on-going research projects of FORIG related to forest genetic resources include the following:

- Alternative pest management strategies for development of indigenous species plantations in Ghana
- Conservation and Utilization of Medicinal Plants in Ghanaian Forests Fringe Communities
- Plant Resources of Tropical Africa - Timbers of Tropical Africa Part II
- Domestication of *Allanblackia parviflora* in Ghana

CHAPTER 6 International collaboration to which Ghana is signatory

Ghana is signatory to several international conventions, treatises and agreements. In this study, the focus is mainly on multilateral environmental agreements in which issues of biological materials or specimens from forests are considered as important sources in contributing to genetic resource management and use.

6.1 The UN Convention on Biological Diversity (CBD)

Ghana ratified the convention on 29 August 1994 and has since contributed to its implementation, including the development of National Biodiversity Strategy and Action Plans (NBSAP) and national reports. The focal ministry in Ghana is the Ministry of Environment, Science and Technology.

6.2 The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The main aim of CITES, which is also called the Washington Convention, is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Ghana ratified the convention on 14 November 1975 and with this ratification, Ghana's participation as a party came into force on 12 February 1976. The focal ministry for this convention is the Ministry of Lands and Natural Resources, and the Focal agency is the Wildlife Division of the Forestry Commission. Ghana has one of its forest tree species (*Pericopsis elata*) listed in CITES Appendix II.

6.3 The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

The objectives of the treaty are the conservation and sustainable use of genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. The treaty entered into force on 29 June 2004 and operates from the FAO offices in Rome. Ghana signed and ratified the treaty on 28 October 2002. The focal ministry is the Ministry of Environment, Science and Technology with the focal agency as the CSIR- Plant Genetic Resources Research Institute located at Bunso.

6.3 The International Tropical Timber Agreement (ITTA).

ITTA is a commodity agreement to facilitate the trade in tropical timber and to ensure exports from sustainable sources. Country membership in the International Tropical Timber Organization (ITTO), which administers ITTA, is restricted to states that are either producers or consumers of tropical timber. The agreement first came into force in 1985, but a renegotiated agreement entered into force in 1997.

6.4 The Ramsar Convention.

This is a wetland convention which was developed and adopted in Ramsar, Mazandaran, Iran on 2nd February 1971. It came into force on 21 December 1975 with headquarters located in Gland,

Switzerland. The purpose of the convention is on the wise use concept of wetlands and their inclusive biodiversity notably the water fowls. The convention vigorously emphasizes that wetlands are not waste lands but with extensive array of benefits in the maintenance of ecosystem services for human well-being. Ghana ratified the convention on 22 June 1988 and there are 6 Ramsar sites already assigned, 5 of which are located along the Ghanaian coastline. The focal ministry is the Ministry of Lands and Natural Resources with the focal agency as the Wildlife Division of the Forestry Commission.

6.5 The World Heritage Convention (WHC).

The Convention links together in a single document the concepts of nature conservation and the preservation of cultural properties. The Convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. The headquarters of the convention is located in the UNESCO head office in Paris. Ghana ratified this convention in July 1975 and the National Commission on Culture is the Focal agency.

As part of national efforts to meet the obligations of these conventions, stakeholders undertook National Capacity Self-Assessment (NCSA) in 2004. Emanating from the NCSA was the recognition that efforts at implementing all three Rio conventions in Ghana under the purview of different institutions are confronted with similar challenges and opportunities. Stakeholders recognized that the setting up of a central body at the national level to coordinate and harmonize various initiatives and strategies operating under the different conventions will lead to better management of Ghana's environment and natural resources.
With funding from the Global Environment Facility (GEF) and the United Nations Development Program (UNDP), the Government of Ghana, through the Ministry of Environment, Science and Technology has implemented the recommendation of the NCSA in establishing the secretariat of Ghana Environmental Conventions Coordinating Authority (GECCA-http://gecca.org/). GECCA is structured to respond flexibly to the political and technical requirements under each Convention, while maintaining a coherent structure and synergies across the various Conventions. Although the secretariat in its current form focuses on the three Rio Conventions, the goal is to ultimately build the capacity to coordinate at the national level all multilateral environmental agreements in Ghana in the near future.

Ghana is also a member of the Genetic Resources Network for West and Central Africa (GRENEWECA), which was established in 1998 under the auspices of the *Conference des Responsables de Recherche Agronomique Africains* (CORAF). The network secretariat is based in the Bioversity International Sub-Saharan Africa office for West and Central Africa in Cotonou, Benin. GRENEWECA's goal is to contribute to sustainable agricultural development in its member countries through the conservation and use of the diversity of local plant genetic resources. The network aims to increase the effectiveness of each of its member country's PGR programmes through regional collaboration. PGRRI represents the country in GRENEWECA (Bennett-Lartey and Oteng-Yeboah 2008).

CHAPTER 7 Access to forest genetic resources and sharing of benefits arising from their use

Access and benefit sharing (ABS) under the Convention on Biological Diversity (CBD) embraces a complex and varied set of issues that are directly relevant to sustainable forest management (SFM).The use of forest genetic resources involves a broad range of stakeholders who are custodians, providers or users of forest resources. Furthermore, the harvesting and consumption of natural forest products is often a significant component of the lives of people who live near forest resources (Cabrera *et al.*, 2010). In Ghana, genetic resources are accessible to all segments of society. Forest fringe communities have access to the non-timber forest products (NTFPs) for domestic use as well as access for commercial purposes under permit except in Globally Significant Biodiversity Areas (GSBAs) and wildlife reserves where commercial extraction of any kind is not permissible. Revenues from timber resources (royalties) are shared among all stakeholders according to a formula prescribed by the constitution of Ghana.

Although the country has ratified many conventions and international agreements related to FGR it is yet to formulate appropriate policies on the conservation and use of FGR. However there is a law, ACT 307 of 1965 which regulates the importation and exportation of PGR in the country (Dixon and Entsie, 1997). This law established the Plant Protection and Regulatory Services Department (PPRSD) within the Ministry of Food and Agriculture (MoFA), which enforces quarantine regulations in the country. Import permits must be obtained for importation of plant materials of any crop. They must be accompanied by relevant phytosanitary certificates and export permits from the country of origin. Certain materials like soil or plants with soil, plant products infested with pests and diseases and specified plants are prohibited. The implementation of the law falls short of expectation since PPRSD lacks adequate facilities for effective discharge of its duties. Laws on other aspects of seed production and plant breeders' rights are also in the process of being formulated by the Ministry of Food and Agriculture (Bennet-Lartey and Oteng-Yeboah 2008)

Chapter 8: The Contribution of Forest Genetic Resources to Food Security, Poverty Alleviation and Sustainable Development.

In Ghana FGR are vital to socio-economic development, health care, cultural and spiritual practices and are recognized as repository for current and future gene use. The forest resources contribute to the production of multiple goods and services that enhance people's lives by providing food, fodder, fuel, building materials as well as ecological services. The forestry sector in Ghana is the fourth largest foreign exchange earner to the national economy. This contribution however comes from only the formal forestry sub-sector under the regulation of the Forestry Commission. The informal subsector is equally economically important and supports the livelihoods of many people especially along the supply chain of the domestic wood market. The contribution of FGR to food security, poverty alleviation and sustainable development is mediated through agricultural sustainability, supplementary food production and support of small and medium forest enterprises.

8.1 Forest and Agricultural Sustainability

The forest reserves and protected areas as natural ecosystems provide the backbone for the country's in situ conservation. These areas contain wild species, medicinal plants and wild relatives of cultivated crops that need to be protected. The species being conserved in situ are expected go through their natural evolutionary processes to generate new variation in the gene pool and to cope with the rapidly changing environmental conditions. In Ghana, forest genetic resources provide a strong support for the sustenance of the agricultural sector. Forests protect soils and influence nutrient cycling for agricultural sustainability and therefore ensure human development and achievement of sustainability goals of reducing hunger and poverty and improving rural livelihoods and human health.

The area of land under agriculture continues to increase due to the extensive system of farming practiced in the country. A large percentage of food production comes from the bush fallow system which involves the slash and burn of forest and other vegetation. Due to the absence of fertilizer application and the appropriate technology for nutrient retention, soils degrade quickly under the bush fallow system. When crop cultivation is temporarily suspended for the soils to regain fertility, it is forests that provide seeds and other propagules to begin the vegetation succession required to build up the nutrient store for cultivation again. The conversion of areas of degraded forest reserves into plantations creates opportunities for farmers to intercrop food crops with forest trees. Through this system the land area available for agriculture has expanded and yields have increased to boost the traditional agricultural production.

A variety of forest trees are tended or planted to provide shade for perennial agricultural crops such as cocoa and coffee. Other trees are also used for erosion control and soil improvement, live posts for fences and protection of watersheds. The forest as an ecosystem influences the local climate and hydrological cycle critical for sustaining the cocoa industry in Ghana. Indeed the

environmental role of forests in agricultural sustainability was the major reason for creating forest reserves in the country. The use of non timber forest products in agriculture technologies is such that in their absence most farming activities may be impaired. Drying mats, tool handles and harvesting poles are a few NTFP uses crucial to agriculture production.

8.2 Food Security and Poverty Alleviation

Local communities in Ghana access a variety of forest foods to supplement agricultural food production and incomes on seasonal basis. Such foods are derived from forests as well as trees deliberately left on farms. The most common supplementary foods are leafy vegetables, nuts and fruits. The leafy vegetables are a good source for vitamins and minerals. For example, in the northern savanna zones, trees such as *Vitellaria paradoxa (s*hea nut tree), *Parkia biglobosa (d*awadawa), *Adansonia digitata (b*aobab tree), *and Blighia sapida* are tended for various usages. These species are proven food crops of great nutritional, economic, environmental and socio-cultural values. In the forest zone the wild oil palm tree and other wild relatives of cultivated crops like *Dioscorea* spp and *Solanum* spp are important sources of food.
The role that forest foods play in household nutrition has changed with their diminishing availability, penetration of new products and markets and changing tastes of the population. Whilst in some rural areas forests still supply readily available source of foods, in others forest foods are no longer consumed, and knowledge about their use is vanishing. However commercialization and rural urban migration, have led to expanded markets for some forest foods. Perhaps the worst impact of the loss of forest foods is that poorer people's food options will be further reduced, especially during seasonal and emergency hardship periods.

NTFPs are still in high demand amongst both rural and urban dwellers. Their commercialization helps to alleviate poverty and diversify people's sources of income, especially during the off farming seasons. Many livelihoods are supported by NTFP related activities such as fire wood gathering, charcoal production, cane and bamboo furniture works, herbal medicine practice etc.

Small and medium forest enterprises (SMFEs) that depend on timber are mostly in the informal sector which constitutes 75% of wood-processing entities. The estimated turnover of the SMFEs in 2007 was considered at par with the various levels of industry integration with a generating turnover of 70% of the formal sector's total export earnings. There is therefore a big significance about SMFEs contribution to growth and poverty reduction in Ghana.

Over-exploitation of forest resources has resulted in a dwindling supply of raw materials for small enterprises and fewer income earning possibilities for the rural poor. The supply of raw materials for both wood and non-wood products is likely to become an increasing problem for many small enterprises since they are rarely able to create or conserve their own resources for future use on a sustained basis. This is an area where involvement of foresters could be most useful: both in terms of managing forests for these locally needed products and in redirecting forest policy and laws to incorporate the needs of small enterprises.

8.3 Sustainable Development

FGR contribute to four out of the eight Millennium Development Goals (MDGs) in Ghana as follows:

8.3.1 Goal 1: Eradicate Extreme Poverty and Hunger

The economic value of Ghana's forest resources lies mainly from exploitation of its wealth of commercial timber and non-timber forest products. Forests and farm trees support livelihoods of many people and contribute a variety of household needs, food and other benefits which help reduce extreme poverty and hunger especially in rural areas where poverty is more acute and economic opportunities are few. Forest related livelihoods such *as* charcoal production, firewood collection, rattan and cane works are major income earners for members of forest communities. The export of timber has reduced but local demand for timber has increased and so is the number of operators on the domestic timber market.

During droughts, failure of food production and or seasonal variations in food supply, forests and farm trees provide critical support to agricultural production; they provide food, fodder and fuel wood, and these also are commodities for sale to provide a means of earning cash income.

8.3.2 Goal 6: Combat HIV/AIDS, Malaria and other Diseases

Despite the expansion of primary health care facilities in the country, plant medicines continue to be commonly used by people. A wide range of FGRs including both wild and cultivated plants, are patronized for a variety of ailments especially those perceived not to respond favourably to conventional medicine. Some have been incorporated into 'conventional' medicinal practice; others remain as 'indigenous knowledge'. The surge in medicinal plant use has resulted in illegal removal of tree barks at a rate forestry officials consider threatening to the conservation of certain species. Given this trend, there is the need to review the management of certain key species in order to sustain their populations and genetic diversity

8.3.3 Goal 7: Ensure Environmental Sustainability

Forests in Ghana contribute substantially to environmental sustainability. A lot of fragile sites like hill tops, steep slopes, river catchment areas and river banks have been successfully protected by forest reserves. About 15% of the reserved forest area lies over steep slopes and most of this are among the best protected forests. The contribution made by Ghanaian forests towards global carbon sequestration is not well studied. However it could be substantial bearing in mind that with the past logging history most of the forest will be recovering and therefore far from reaching equilibrium in carbon intake and output. The use of fast growing species in plantations and the moderate rate of planting will combine to improve carbon sequestration by forests in the country.

8.3.4 MDG 8: Develop Global Partnership for Development

Ghana's forest resources are not only of national relevance but also of global interest in terms of trade, biodiversity and climate change. To this end, the country seeks to use forest resources to develop global partnerships for development. Key among these partnerships are Reduced Emissions from Deforestation and Degradation (REDD) plus, Natural Resources and Environmental Governance (NREG), UN Forum on Forests UNFF), Non-Legally Binding Instrument (NLBI), and Forest Investment Programme (FIP). Through these partnerships substantial financial and technical assistance are expected to be made available to Ghana for sustainable management of its forest resource endowments.

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Annexes.

Annex. I Values and use of savanna trees and other woody species

Scientific name	Native(N) OR Exotic (E)	Value code	Present, future or potential use											
			ti	po	wo	nw	pu	Fo	fd	sh	ag	co	am	xx
Acacia nilotica	N	2		X	X	X							X	X
Acacia campylacantha		2		X	X	X								
Acacia dudgeonii		2		X	X	X								X
Acacia gourmaensis		2		X	X	X							X	
Acacia sieberiana	N	1		X	X	X							X	X
Acacia chariensis	E	2		X	X	X							X	X
Adansonia digitata	N	1			X	X		X						X
Afrormosia laxiflora	N	2		X	X									
Afzelia africana	N	1	X	X	X									X
Albizzia lebbeck	E	1		X	X								X	
Andira inermis	E	1	X	X	X									
Anogeissus leiocarpus	N	1		X	X	X								X
Annona senegalensis	N	1				X								
Azadirachta indica	E	1	X	X	X	X		X					X	
Balanites aegyptiaca	N	3		X	X	X		X					X	
Bauhinia refescens	N	1			X	X							X	
Bombax costatum	E	2		X	X			X						
Borassus aethiopum	N	2	X	X				X					X	
Boswellia dalzielii	E	2		X	X	X								
Bridelia ferruginea	N	2		X	X	X								
Bridelia micrantha	N	2			X	X								
Burkea africana	N	2	X		X	X								
Calotropis procera	N	2				X								
Ceiba pentandra	N	1	X		X	X							X	X
Celtis integrifolia	N	1		X	X	X		X					X	
Hexalobus monopetalus	N	2	X	X	X									
Hymenocardiaacida	N	3	X	X										
Heeria insignis	E	2			X									
Isoberlinia dalzielii	N	3	X		X			X						
Isoberlinia doka	N	2		X	X			X						
Khaya senegalensis	N	1		X				X						
Kigelia africana	N	3				X		X						
Lannea acida	N	2			X	X		X						
Lannea afzelli	N	3		X		X								
Lannea barteri	N	3				X		X						
Lonchocarpus laxiflorus	N	2			X	X	X	X						
Mangifera indica	E	1		X	X	X		X						X
Manilkara multinervis	N	2	X		X								X	

Maytenus senegalensis	N	3		X	X	X							X	
Mitragyna inermis	N	2			X			X						
Moringa oleifera	N	3		X		X								
Nauclea latifolia	N	2		X		X								
Ostryoderris chevalieri		2		X				X						X
Parinari curatellifolia				X		X								
Parkia clappertoniana	N	1		X		X								
Piliostigma reticulatum	N	3				X								
Piliostigma thonningii	N	2		X		X								
Poupartia birrea	E	2		X		X								
Prosopis africana	E	2		X				X						
Pseudocedrela kotschyi	E	1	X	X		X								X
Pteleopis suberosa	E					X							X	
Pterocarpus erinaceus	N	1	X	X		X							X	X
Quisqualis indica	E	3												
Sclerocarya birrea	E	2		X	X	X							X	
Securidaca longepedunculata	N	3			X	X					X	X		
Securineaga virosa	E	3		X							X	X		X
Senna siamea	E	1		X					X				X	
Sesbania sesban	E	2				X		X					X	X
Spondias monbin	N	2		X									X	
Sterculia setigera	N	3			X								X	
Stereospermum kunthianum	N	2		X		X								
Strophantus hispidus	N	3		X	X	X								
Strychnos triclisioides	E	2		X	X			X					X	X
Swartia madagascariencis	E	3		X	X	X							X	X
Tamarindus indica	N	1		X	X									X
Tectona grandis	E	1	X	X	X	X				X	X			
Terminalia avicenioides	E	2		X	X	X								
Terminalia macroptera	E	2	X		X	X								
Trichiliaroka	N	2		X	X	X							X	X
Vitellariaparadoxa	N	1		X	X	X		X		X	X			X
Vitex doniana	N	2			X			X						
Vitex chrysocarpa	E	3												
Vitex simplicifolia	E	3			X			X					X	
Ximenia americana	N	2			X			X					X	
Ziziphus mauritania	N	2			X								X	
Ziziphus mucronata	N	2												

Annex. II Values and use of forest trees and other woody species

Scientific name	Native(N) OR Exotic (E)	Value code	Present, future or potential use											
			ti	Po	wo	nw	pu	fo	fd	sh	ag	co	a m	xx
Albizia ferruginea	N	2	x											
Entandrophragma candollei	N	1	x											
Entandrophragma cylindricum	N	1	x											
Entandrophragma utile	N	1	x											
Garcinia kola	N	1					x							
Khaya grandifoliola	N	1	x				x							
Khaya anthotheca	N	1	x				x							
Khaya ivorensis	N	1	x				x							
Milicia excelsa	N	1	x			x								
Milicia regia	N	1	x			x								
Nauclea diderrichii	N	1	x	x										
Pericopsis elata	N	1	x											
Terminalia ivorensis	N	1	x											
Tieghemella heckelii	N	1	x				x							
Triplochiton scleroxylon	N	1	x											
Afzella bella	N	2	x											
Afzella africana	N	2	x											
Aningeria altissima	N	1	x											
Anopyxis klaineana	N	2	x											
Antrocaryon micraster	N	2	x											
Copaifera salikounda	N	1	x											
Entandrophragma angolense	N	1	x											
Garcinia afzelii	N	1					x							
Garcinia epunctata	N	1					x							
Guibourtia ehie	N	1	x				x							
Hallea ledermannii	N	2												
Hallea stipulosa	N	1	x									x		
Heritiera utilis	N	1	x											
Lophira alata	N	1	x											
Lovoa trichilioides	N	1	x											
Pterygota bequaertii	N	1	x											
Pterygota macrocarpa	N	1	x											
Rhodognaphalon brevic	N	1	x											
Thaumatococcus daniellii	N	2					x							wrapping
Aframomum melegueta	N	2					x							
Antiaris toxicaria	N	1	x											mat
Calamus deeratus	N	2											x	furniture
Canarium schweinfurthii	N	1	x											

Chrysophylium subnudum	N	1	x											
Chrysophyllum albidum	N	1	x					x						
Chrysophyllum giganteum	N	1	x											
Cola nitida	N	2					x	x						
Cordia platythyisa	N	2	x											drum
Cynometra ananta	N	1	x											
Daniellia ogea	N	1	x											
Daniellia thurifera	N	1	x											
Distemonanthus benth	N	1	x											
Elaeis guineensis	N	1					x	x				x		
Eremospatha hookeri	N	1												basket
Eremospatha macrocarpa	N	1												basket
Erthrophieum ivorensis	N	2				X								basket
Funtumia elastica	N	1				X								
Guarea cedrata	N	1	x				x							
Guarea thompsonii	N	2	x											
Laccosperma opacum	N	2												basket
Laccosperma secundiflorum	N	2												basket
Mamme aafricana	N	1	x											
Mansonia altissima	N	1	x											
Nesogordonia papav	N	1	x											
Piptadeniastrum africanum	N	1	x											
Pycnanthus angolensis	N	1	x				x							
Scottellia klaineana	N	1	x											
Streculia reinopetala	N	1	x											
Terminalia superba	N	1	x											
Turraeanthus africanus	N	1	x											
Tectona grandis	E	1	x	X										

Key

Value:

1. Species of current socio economic importance
2. Species with clear potential or future value
3. Species of unknown value given present knowledge and technology

Utilization:

ti timber production
po posts, poles, round wood
pu pulp and paper
wo fuelwood, charcoal
nw non-wood products (gums, resins, oils, tannins, medicines, dyes...)
xx other (specify)

fd fodder
sh shade, shelter
ag agroforestry systems
co soil & water conservation
am amenity, aesthetic, ethical values

Annex III. List trees and other woody species that are important in your country for food security or livelihoods

Species		**Use for food security and other important uses**	**Use for poverty reduction**
Scientific name	**Native (N) or Exotic (E)**		
Vitellaria paradoxa	N	Cooking oil, cosmetic products, fuelwood	Livelihood Support, Food, Health Care
Parkia biglobosa	*N*	Powder as source of sugar, seed processed into soup condiment/spice, health care	Food, Livelihood Support, Health Care
Adansonia digitata	N	Beverage, food	Livelihood Support, Food
Blighia sapida	*N*	Food, fuelwood	Food, Livelihood Support
Elaeis guineensis	*N*	Soup, cooking oil, soap making, beverages, bedding material, mushroom , roofing, broom, firewood	Food, Livelihood Support
Ceiba pentandra	*N*	Food, health care, timber, mushroom bedding material	Food, Livelihood Support, Health Care
Vitex doniana	*N*	Food, writing ink	Livelihood Support, Food
Afzelia africana	*N*	Timber, mortar, fuelwood	Livelihood Support
Ficus exasperata	*N*	Fuelwood, cleaning cooking utensils, fodder	Livelihood Support
Entada africana	*E*	Fuelwood, fodder	Livelihood Support
Astonia booniei	*N*	Health care	Health Care
Chrysophyllum Subnudum	*N*	Food, timber	Food, Livelihood Support
Raphia hookeri	*N*	Beverage, roofing material , mat, fish trap, mushroom, bedding material	Food, Livelihood Support
Dacryodes klaineana	*N*	Food, firewood, timber	Food, Livelihood Support
Chrysophyllum albidum	*N*	Food, timber	Food, Livelihood Support
Bombax buonopozense	*N*	Food, health care, timber	Food, Livelihood Support, Health Care
Guibortia ehie	*N*	African incense, timber	Livelihood Support
Aningeria spp.	*N*	Timber	Livelihood Support
Chrysophyllum perpulchrum	*N*	Food, timber	Food, Livelihood Support
Spondias mombin	*N*	Food, health care, firewood	Food, Livelihood Support
Canarium schweinfurthii	*N*	Cosmetic product, timber	Livelihood Support
Cola nitida	*N*	Health care, beverage	Livelihood Support, Health Care
Anthocleista nobilis	*N*	Health care, timber, roofing material	Livelihood Support, Construction Material

Piptadeniastrum africanum	*N*	Health care, timber	Livelihood Support, Health care
Cylicodiscus gabunensis	*N*	Fuelwood, timber, roofing, rail slippers, fodder	Livelihood Support
Chrysophyllum pruniforme	*N*	Food, timber, fodder	Food, Livelihood Support
Entandrophragma angolense	*N*	Health care, timber	Health Care, Livelihood Support
Celtis spp.	*N*	Timber, fuelwood, roofing, pestle, food	Livelihood Support, Food
Petersianthus macrocarpus	*N*	Health care, timber, fodder	Health Care, Livelihood Support, Food
Garcinia kola	*N*	Chewing stick, health care	Livelihood Support, Health Care
Gryphaea brevis	*N*	Food, preservation of food	Food Preservation
Anogeissus leiocarpus	*N*	Fuelwood	Livelihood Support
Morinda lucida	*N*	Health care, timber, mortar	Health Care, Livelihood Support
Guarea cedrata	*N*	Health care, timber	Health Care, Livelihood Support
Garcinia afzelii	*N*	Chewing stick and health care	Livelihood Support, Health Care
Trilepisium madagascariense	*N*	Health care, food	Health Care, Food, Livelihood Support
Tetrapleura tetraptera	*N*	Health care, food	Health Care, Livelihood Support
Allanblackia floribunda	*N*	Cooking oil, bio-diesel production	Food, Livelihood Support,
Tectona grandis	E	Timber, electricity and telephone poles, health care	Livelihood Support, , Health Care
Cordia millenii	*N*	Timber, local drum frame	Livelihood Support,
Albizia ferruginea	*N*	Timber	Livelihood Support
Albizia zygia	*N*	Timber, fuelwood	Livelihood Support
Amphimas pterocarpoides	*N*	Timber, fuelwood	Livelihood Support
Anopyxis klaineana	*N*	Timber	Livelihood Support
Antiaris toxicaria	*N*	Timber	Livelihood Support
Antrocaryon micraster	*N*	Timber	Livelihood Support
Rhodognaphalon buonopozense	*N*	Timber	Livelihood Support
Cynometra ananta	*N*	Timber	Livelihood Support
Daniellia ogea	*N*	Timber, African incense	Livelihood Support
Dialium aubrevillei	*N*	Timber	Livelihood Support
Distemonanthus benthamianus	*N*	Timber	Livelihood Support
Erythropleum guineense	*N*	Timber, trap material	Livelihood Support

Guarea thompsonii	*N*	Timber	Livelihood Support
Heretiera utilis	*N*	Timber	Livelihood Support
Khaya spp	*N*	Timber, health care, beverages	Livelihood Support, Health Care,
Klainedoxa gabonensis	*N*	Timber	Livelihood Support
Lophira alata	*N*	Timber	Livelihood Support
Lovoa trichilioides	*N*	Timber	Livelihood Support
Mammea Africana	*N*	Timber	Livelihood Support
Mansonia altissima	*N*	Timber	Livelihood Support
Milicia excelsa	*N*	Timber	Livelihood Support
Mitragyna spp	*N*	Timber	Livelihood Support
Nauclea diderrichii	*N*	Timber	Livelihood Support
Nesogordonia papaverifera	*N*	Timber	Livelihood Support
Parkia bicolor	*N*	Timber	Livelihood Support
Pericopsis elata	*N*	Timber	Livelihood Support
Pterygota macrocarpa	*N*	Timber	Livelihood Support
Pycnanthus angolensis	*N*	Timber, roofing material, health care	Livelihood Support, Construction Material
Sterculia rhinopetala	*N*	Timber	Livelihood Support
Strombosia glaucescens	*N*	Timber, electricity poles	Livelihood Support
Terminalia ivorensis	*N*	Timber	Livelihood Support
Terminalia superba	*N*	Timber	Livelihood Support
Triplochiton scleroxylon	*N*	Timber, food	Livelihood Support, Food
Turraeanthus africanus	*N*	Timber	Livelihood Support
Morus mesozygia	*N*	Timber, household items	Livelihood Support
Sterculia oblongata	*N*	Timber	Livelihood Support,
Zanthoxylum gilletii	*N*	Timber, health care	Livelihood Support, Health Care,
Cola gigantea	*N*	Timber, food	Livelihood Support, Food
Hannoa klaineana	*N*	Timber	Livelihood Support
Parinari excelsa	*N*	Timber	Livelihood Support
Albizia adianthifolia	*N*	Timber, fuelwood	Livelihood Support
Gilbertiodendro limba	*N*	Timber	Livelihood Support
Lannea welwitschii	*N*	Timber, health care	Livelihood Support, Health Care,
Ricinodendron heudelotii	*N*	Timber, health care	Livelihood Support, Health Care