THE STATE
OF THE WORLD's
FOREST GENETIC RESOURCES
COUNTRY REPORT

MALAWI

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.

THE STATE OF FOREST GENETIC RESOURCES IN MALAWI

Executive Summary

CHAPTER 1: INTRODUCTION

Background to this document

At its Eleventh Session in June 2007, the Commission on Genetic Resources for Food and Agriculture (CGRFA) of FAO acknowledged the urgency to conserve and sustainably utilize forest genetic resources. The Commission requested that a State of the World's Forest Genetic Resources (SOW-FGR) report be prepared and presented at its Fourteenth Session, in 2013. At the Nineteenth Session (March 2009), the Committee on Forestry (COFO) discussed and supported the preparation of the SOW-FGR, urging member countries to collaborate with FAO and partner organizations in producing the Report. The COP10 of the Convention on Biological Diversity, meeting in October 2010, also recognized the importance of forest genetic diversity for the conservation and sustainable use of forest biodiversity, including in the context of addressing climate change and maintaining the resilience of forest ecosystems; and in this context welcomed the preparation by FAO of the country driven report on the SOW-FGR; and invited Parties, Governments, and other relevant organizations to support the preparation of the country-driven first report of the SOW-FGR.

The Forestry Research Institute of Malawi (FRIM) has been designated the National Focal Points (NFP) for the preparation of the Malawi Report. FRIM participated in a regional workshop which was organized in Nairobi in April 2012, to support the preparation of country reports for Africa. During the workshop, guidelines for the preparation of the country reports were presented and discussed.

The various chapters of this first draft report have been compiled by teams of scientists at FRIM based on information gathered from previous FGRs, other relevant reports and some personal consultations with stakeholders.

Location, Physio-Geographic and Climatic Features

Malawi is located in Southern Africa, between latitude 9° 45' and 17° 16' South and longitude 33° and 36° East (Figure 1). It is a landlocked country, surrounded by Tanzania to the North and North-East, Mozambique to the East, South and South-West and Zambia to the West. The length of the country from south to north is 900 km with a width that varies between 80 km and 160 km, covering 12.3 million ha (118,484 sq km, including 2.4 million ha. of water bodies).

According to Pike and Remington (1965), Malawi can be roughly divided into four major physiographic classes: the high-altitude plateaus, the medium-altitude plain, the Lakeshore plain and the lower Shire valley. The high-altitude plateaus consist of a number of isolated mountains

such as Mulanje, Dedza, Zomba/Malosa, the Nyika and the Vipya (altitude 1,350 to 3,000 meters). The topography varies from precipitous to undulating.

The soils are mostly lithosols and highly leached latosols. The flat to rolling upland sites have deep well-drained latosols while poorly drained hydromorphic soils are found in the lowland sites commonly known as “dambos”. The Lakeshore plain areas along Lake Malawi (altitude 450 to 600 meters) are characterized by flat to gently undulating plains with mostly deep soils, calcimorphic alluvials and colluvials, with some hydromorphic soils in isolated depressions. The soils of the wide flat lower Shire valley (altitude 35 to 105 meters) are mostly calcimorphic alluvials with some extensive areas dominated by hydromorphic and vertisols.

The country experiences two climatic seasons, a distinct dry season between May and October and a wet season between November and March. The two seasons are characterized by large seasonal variations in temperature and rainfall. The average rainfall is about 1,200 mm per annum with the highest rainfall being recorded in Nkhata Bay and Mulanje. The Shire valley receives the lowest rainfall (below 900 mm per annum). The mean annual temperatures range from 12^0C to 32^0C. Temperatures are highest during October in the rift valley and along the lakeshore where they can be as high as 38^0C. The lowest temperatures are experienced in high altitude areas, particularly the Viphya and Nyika Plateaux, and the Dedza, Zomba and Mulanje Mountains.

Figure 1: Map of Malawi, Showing its location in Africa

Demographic and Socio-Economic Features

Malawi supports one of the highest population densities in Africa, its inhabitants numbering nearly 14 million (NSO 2008). About 85% of the population is in rural areas, thus, making Malawi one of the least urbanised countries in Africa. As the population increases (3.2% per year), forests are cleared for settlement and energy supply. It is recognized that high and rapidly growing human population is one of major causes forest degradation in Malawi, leading to a retrogressive trend over the years due to deforestation.

Agriculture is the mainstay of the country's economy. The sector accounts for about 36% of the Gross Domestic Product (GDP), 87% of the total employment, and supplies more than 65% of the manufacturing sector's raw materials. Agriculture is also the main livelihood of the majority of rural people. Malawi's agriculture is characterized by a dual system consisting of the smallholder sub-sector and the estate sub-sector. The smallholder sub-sector operates on 4.83 million ha of customary land and contributes 80% of Malawi's food and 10% of exports. The estate sub-sector concentrates on tobacco, tea and sugar, which accounts for 80% of all agricultural exports.

The forestry Ecosystem

Malawi's forestry ecosystem is dominated by the miombo woodlands comprising mostly of indigenous *Branchystegia, Jubernardia* and *Isoberlinia* and *Acacia-Piliostigma-Combretum* wooded savanna in the medium-altitude plains. The higher altitude plateaus are dominated by montane grassland vegetation, savanna bush-grasslands and savanna bush-grassland and a thicket with *Acacia* spp., *Sterculia* spp., *Cordyla africana* and scattered *Adansonia digitata* (baobab) and *Hyphaene ventricosa* (doum palm) dominate the Lakeshore plains and the lower Shire Valley. The vegetation in Malawi can be classified as i) Zambezian Woodland (Divided into miombo, mopane, and undifferentiated woodlands), ii) Transition woodland, iii) Deciduous forests and thickets, iv) Evergreen forest (subdivided into riparian, lowland, mid altitude and Afromontane rain forests), v) Undifferentiated Afromontane forests, such as *Hagenia abyssinica* forest, *Juniperus procera* forest, Widdringtonia whytei forest, vi) Afromontane Bamboo, vii) Afromontane evergreen bushland and thicket, viii) Afromontane shrubland. Most of the forests are found in National Parks and Wildlife Reserves, Forest Reserves, and protected hill slopes and natural woodland on customary land which are currently under severe threat of depletion. It is estimated that the forest cover is declining at the rate of 1.0 t0 2.8% annually.

Forestry Legislation and Policy

The original Forest of the 1960s did not permit exploitation of any forest resources in forest reserves, national parks and game reserves as these were perceived to be for conservation and catchment protection only. The Act however was not effective on Customary Land where

traditional leaders held title for the land. Therefore forests in customary land were the most accessible to the rural majority of Malawians and are under pressure from a rapidly growing human population. Unfortunately three quarters of indigenous forests are found on customary land (Gowela and Masamba, 2002).

Realizing the rate of deforestation and genetic erosion of indigenous species that was taking place on customary land and other parts of the country, the Government decided to amend the Forest policy in 1996 that takes into account human development and environmental protection. The current Forest Act was amended in 1997 to contain broad basic principles for the management of the forest resources, including providing for the establishment of forest reserves, use and control of cutting, removal and trading of forest produce, from both public and customary land, with the participation of local communities. The local people participate in management of forest resources by forming Village Natural Resource Management Committees that look after the village forest areas on customary land or demarcated blocks in forest reserves. These committees get technical advice from the Forestry Department on how to protect, control and manage their forest resources. The 1997 Forest Act allows people living on customary land to develop a sense of ownership so that they can manage their own forest resources sustainably and hence, curb deforestation.

CHAPTER 2: THE CURRENT STATE AND USE OF FOREST GENETIC RESOURCES

Tembo Chanyenga

Forest Reserves

About 38 percent of the total land area of Malawi that contain most of the forest cover are National Parks and Forest Reserves. Natural forest areas cover about 3.3 million hectares, (FAO, 2010, Ministry of Natural Resources, 1996), including 87 gazetted forest reserves (about 879,430 ha) (table 1), National Parks and Game Reserves (just over 1 million hectares) and 2,565 Village Forest Areas (VFAs). In addition, there are 32 government plantations across the country, covering an area of about 90,000 hectares.

The natural forests are dominated by indigenous miombo woodlands, lowland rainforests, tropical rainforests and Afromontane evergreen forests. The Miombo woodlands are recognized for their floristic richness and the widespread occurrence of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia*. These constitute the major vegetation type covering large areas of the country. Lowland rainforest is rare in Malawi and only occurs on limited sites in Thyolo and Mulanje Plains, interspaced with tea plantations. The common species in lowland rainforests are are *Newtonia buchananii, Khaya anthotheca, Chrysophyllum gorungosanum, Prunus africana, Suregada procera* and *Xymalos monospora.* Afromontane evergreen forests have a patchy distribution countrywide, comprising *Widdringtonia* spp (endemic Malawi cedar) *Olea capensis, Drypetes gerrardii, Ekebergia capensis, Cassipourea malosana* and *Podocarpus, Ilex mitis, Philippa benguelensis, Syzygium cordatum, Helichrysum whyteanum* (endemic) and tree ferns (*Cyathea dregei*).

Plantations

About 110,000 ha of the country's forests are in industrial plantations, of which about 90,000 ha is planted and managed by the government. Twenty government plantations (75,472.81 ha) are for timber production while 11 (14,527.19 ha) are managed as government fuelwood plantations. The major timber and fuelwood species are *Pinus patula, P. elliottii, P. oorcapa, P. taeda, P. psudostrobus, Eucalyptus grandis. Eucalyptus camaladulensis, E. tereticorni* and other eucalyptus species are mostly found in fuelwood plantations.

Table1: List of Some Gazetted Forest Reserves in Malawi

Name of Reserve	District	Area(Ha)*	Year Gazetted
Northern region			
Chikhang'ombe	Chitipa	500	2002
Mafinga Hills	Chitipa	4260	1976
Mahowe	Chitipa	5916.8	2002
Matipa	Chitipa	1062	1948
Mughese	Chitipa	673	1948
Jembya	Chitipa	13764	1981
Musisi	Chitipa	6734	1948
Wilindi	Chitipa	907	1948
Karonga North Escarpment	Karonga	7907.6	2002
Karonga South Escarpment	Karonga	13050.2	2002
Vinthukutu	Karonga	2227	1948
Mtangatanga	Mzimba	8443	1948
Perekezi	Mzimba	14760	1935
Bunganya	Mzuzu	3470	1973
Kawiya	Nkhata Bay	643.9	
Chisasira	Nkhata Bay	3390	1935
Kalwe	Nkhata Bay	210	1956
Kaning'ina	Nkhata Bay	16555	1935

Name of Reserve	District	Area(Ha)*	Year Gazetted
Ruvuo	Nkhata Bay	4792.9	1935
Kuwilwe	Nkhata Bay	699	1935
Mkuwadzi	Nkhata Bay	2668	1927
South Viphya	Nkhata Bay/ Mzimba	114780	1958
Uzumara	Rumphi	596	1948
Central Region			
Chongoni	Dedza	12640	1924
Dedza Mountain	Dedza	3260	1926
Dzenza	Dedza	829	1948
Msitolengwe	Dedza	58	1974
Dedza-Salima Escarpment	Dedza/ Salima	32600	1974
Mua-Livulezi	Dedza/ SAlima	12147	1924
Mua-Tsanya	Dedza/ Salima	1062	1932
Dowa Hills	Dowa	2420	1974
Kongwe	Dowa	1813	1926
Ngara	Dowa	2253	1958
Chimaliro	Kasungu/Mzimba	16078.7	1926
Dwambazi	Nkhotakota/Nkhata Bay	76309.6	1996
Dzalanyama	Lilongwe/Dedza/ Mchinji	98934	1922
Nalikule	Lilongwe	104	1948
Thuma	Lilongwe/Salima	16395	1926
Mchinji	Mchinji	19166	1924

Name of Reserve	District	Area(Ha)*	Year Gazetted
Bangwe	Ntcheu	1348	1948
Chirobwe	Ntcheu	1068.6	1960
Dzonzi	Ntcheu	4020	1924
Mvai	Ntcheu	4268	1924
Kaombe	Ntchisi	3890	1992
Ntchisi Mountain	Ntchisi	9712	1924
Mdirasadzu	Ntchisi	15500	1974
Malele Islands	Salima	207	1930
Senga Hills	Salima	1688.1	1958
Southern Region			
Chigumula	Blantyre		1925
Michiru	Blantyre		1970
Milare	Blantyre		1989
Mudi	Blantyre		1922
Ndirande	Blantyre		1922
Soche Hill	Blantyre		1922
Chiradzulu	Chiradzulu		1924
Marabvi	Chiradzulu		1927
Liwonde	Machinga		1924
Malosa	Machinga		1924
Mangochi	Mangochi		1924
Mangochi Palm	Mangochi		1980
Namizimu	Mangochi		1924

Name of Reserve	District	Area(Ha)*	Year Gazetted
Phirilongwe	Mangochi		1924
South Nyasa Island	Mangochi		1980
Mulanje Mountain	Mulanje	55209	1927
Sambani	Mulanje	129	1948
Thuchila	Mulanje	2434	1925
Masatwe hills	Mwanza		1927
Michiru mountain	Mwanza		1948
Mkanya hills	Mwanza		1925
Mlindi hills	Mwanza		
Nankhwazi hills	Mwanza		
Neno escarpment	Mwanza		
Nkula/Tedzani	Mwanza		
Phirilanjoka	Mwanza		19
Thambani	Mwanza	10670	1927
Tsamba	Mwanza	32	1928
Twiti Mountain	Mwanza	1032	
Zaka Hills	Mwanza	56	
Zomba Mountain	Zomba	5937	1913

*** data not available for some reserves in the southern region missing**

Other Vegetation Types

Wetlands: There are four major wetlands in Malawi, the Ndindi, Elephant and Vwaza marshes and Lake Chilwa wetland. These are dominated by herbaceous vegetation.

Grasslands: Grasslands are mostly found on mountain tops such as Mulanje Mountain, Nyika Plateau, Viphya Plateau and Zomba Plateau. The Mulanje Plateaus are the only sites in Malawi, high enough to support unique heathland vegetation. Among the prevalent species in these high altitude sites are some unique and endemic species such as *Erica milanjiana*, *Phylica tropica* and *Aloe arborescens* (which grows up to 5m tall). The sites are also occupied by tussock grasslands of the species *Festuca costata* and *Danthonia davyi* interspersed with cushions of *Eragrostis volkensii* and *Alloeochaete oreogena* (an endemic that grows up to 3 m tall with a tree trunk-like structure).

Shrublands: Shrublands that are mostly found on mountain tops such as Nyika Plateau are characterized as grasslands with scattered small shrubs and other woody vegetation.

Utilization of Forest Genetic Resources

The majority of Malawians draw a wide variety of goods and services in their daily lives from forests and forest resources. More than 95% of household energy in Malawi is derived from fuelwood and charcoal that is obtained from the forests. Many other useful products are also obtained from forests, including construction poles, timber, traditional medicine, indigenous fruits, mushrooms, honey, bamboos, curios, palms, reeds, grass, game, edible insects and latex (table 2). Indigenous forests have few commercially exploitable species but widely scattered groups or trees of *Pterocarpus angolensis*, *Terminalia serricea* and *Adina microcephala*, *Khaya anthoteca*, *Widdringtonia cupressoides*, *Burtdavya nyasica*, *Afzelia quanzensis* are in high demand for commercial timber. The most preferred hardwood species is *Pterocarpus angolensis* which is liked for its stability. *Khaya anthotheca* appears to be the next most used hardwood. *Widdringonia coprissoides*, the national tree of Malawi, a high-grade softwood, is now very scarce and is only used for special purposes, such as boat building. These are mostly processed by pit sawyers, often illegally or under government licence. *Dalbergia melanoxylon*, *Pericopsis angolensis* and *Khaya anthotheca* are the main indigenous woods used for wood carving (curios). *Diospyros mespiliformis*, which used to be a favorite species for this purpose is no longer readily available due to overexploitation (Gowela and Masamba, 2002).

Plantations on the other hand are largely used for harvesting trees to produce timber and poles for the construction industry..

Table 2: Some of the Commonly Used Forest Tree Species In Malawi

Use(s)	Forest Plant Species

Use(s)	**Forest Plant Species**
Medicinal	*Prunus Africana, Strophanthus kombe, Zanha africana, Steganotaenia araliacea, Annona senegalensis, Cassia abbreviata, Dichrostachys cinerea, Piliostigma thonningii, Acalypha villicaulis, Ziziphus mucronata, Pterocarpus angolensis, Catunaregam spinosa, Securidaca longipedunculata, Cassia abbreviata, Pericopsis angolensis, Azanza garckeana, Pterocarpus angolensis, Flacourtia indica, Afzelia quanzensis, Psedolachnostylis maprouneifolia, Markhamia acuminata, Burkea africana, Erythrina abyssinica, Dichrostachys cinerea, Erythrophleum suaveolens, Dalbergia nitidula,* Rothmannia engleriana, Ochna schweinfurthiana, and *Strychnos innocua, Acacia karroo, Albizzia harveyi, Kigelia Africana*
Fuelwood, charcoal, construction polewood and curios	*Brachystegia species, Julbernardia species, Terminalia serecia, Pericorpis angolensis, Eucalyptus grandis, E. tereticornis* and *E. camaldulensis*
Timber	*Khaya anthotheca, Afzelia quanzensi, Pterocarpus angolensis, P. patula, P. elliottii P. psudostrobus, P. taeda, P. oorcapa, P. kesiya,* and *E. grandis, Widdringtonia whytei, Newtonia buchananii, Adina microcephala*
Water and soil conservation	*Adina microcephala, Parkia filicoides, Khaya athotheca, Syzygium cordatum, S. guineense*
Food, fruits and vegetables	*Adansonia digitata, Treculia Africana, Trichilia emetic, Parinari curatellifolia, Elaeis guineensis, Moringa oliefera Uapaca kirkiana, Anona senegalensis, Azanza garckeana* and *Tamarindus indica, Uapaca kirkiana, Garcinia buchananii, Parkia filicoides, Diospyros kirkii, Vangueria infausta, Vitex payos, Ximenia caffra, Ziziphus mauritiana, and Strychnos species.*
Animal fodder	*Pennisetum uniseta, Cynodon dactylon, Eriosema ellipticum, Vernonia adoensis Piliostigma thonningii, Dichrostachys cinerea, Droogmansia pteropus, Mucuna stans Cussonia arborea, Ficus sycomorus, Hyparrhenia filipendula, Julbernardia paniculata, Phragmites mauritianus, P. maprouneifolia, Steganotaenia araliacea Strychnos spinosa Ectadiopsis oblongifolia* and *Z. Africana*
Dyes/tannins, adhesives	*Voacanga africana, Faidherbia albida, Acacia polyacantha, Brachystegia bussei, Diplorynchus condylocarpon, Burkea africana, Cordyla africana* and *Loranthus species Acacia nilotica,*

Use(s)	Forest Plant Species
	*Cocculus hirsutus, Euclea fructuosa, Harungana madagascariensis, Maclura africana, Pseudolachnostylis maprouneifolia a*nd *Indigofera* species

Major Threats to Forest Genetic Resources and Impacts

Selective Harvesting of Trees in Natural Forests: Extensive and selective tree felling for fuelwood and charcoal production and other specific uses is one of the major threats to forestry genetic resources in Malawi. In the Miombo forests, preference varies from site to site but some species are being preferentially felled country-wide. The most preferred tree species (eg for charcoal production, medicine etc) tend to be removed from the forest more rapidly than others, causing local extinctions, low diversity and population defragmentation. This pattern has pushed some of the preferred species into "threatened species category". These include *Pterocarpus angolensis, Khaya anthotheca, Newtonia buchananii, Adina microcephala, Dalbergia melanoxylon, Colophosermum mopane, Milicia excels, Burttdavya nyasica, Afzelia quanzensis, Diospyros mespiliformis, Widdringtonia whytei* (Mulanje cedar) and *Erythophleum sauveolens* (Mwavi). It is believed that the resulting defragmentation interferes with mating systems, collapses pollination webs, and results in population-wide failure of seed production for the involved species (Pauw 2007).

In many cases, it is also the best trees that are harvested and removed from the forest environment, leaving the poorer individuals to reproduce. This ultimately causes a shift in gene frequencies because selection determines which trees are left to grow and reproduce, it has a directional effect on the genetic make-up of trees in a population or species. In Mulanje Mountain for example, only poor quality Mulaje cedar trees are left standing in the forest, the most vigorous individuals having been harvested, often illegally. In addition, inbreeding may occur due to restricted numbers of productive individuals or neighbourhood size. Inbreeding may result in reduced seed yields, height growth and stress tolerance. Hence the forest genetic resources in Malawi are currently being negatively affected by poor protection coupled with selective over-exploitation of trees and species.

Unsustainable Tree Harvesting Methods: Unsustainable harvesting methods such as complete bark and root removal for medicinal use, complete tree felling to produce charcoal and curios and excessive fruit harvesting are major threats to the survival of most tree species. There is particular concern on the rapid commercialization of natural forest products such as traditional medicines, charcoal etc without proper management of the resource base and sustainable harvesting methods. Increasing commercialization of forest products to supply urban demand

coupled together with a lack of management and harvesting systems as well as fragmentation of forests are significantly contribution to forest genetic resource degradation.

Uncontrolled and Over-Harvesting of Plantation Species: In Malawi, the harvesting of timber plantation trees is based on demand and not on "allowable cut" or mean annual increment (MAI). This has resulted in the over-harvesting of most plantations. Over the past ten years for example, nearly 60,000 ha out of the available 90, 000 ha of pine and eucalyptus plantation has been harvested and is bare. There has been no replanting of the cleared areas.

Wild Fires: Wildfires are very common in both natural forests and timber plantations during the dry seasons (July to November) in Malawi. On Mulanje Mountain, for example, 360 fires were recorded between 2001 and 2006 (Nangoma and Bayliss, 2006). Fire is considered as one of the main reasons for changes in forest ecosystems and loss of forest biodiversity. in 2009, fires destroyed approximately 8489.78ha of plantation forests (GOM/FD Report 2009). During the past ten years, nearly 449 forest fires were recorded in timber plantations destroying approximately 28,091.68ha..Wildfires may have similar effects as clearing a forest especially when fires are very intense. Fires have resulted in extensive tree mortality in natural regenerations. Repeated fires may alter the gene pools of the naturally regenerated forests.

Drought: Drought is becoming common and is restricting natural regeneration of some species such as *W. whytei* on Mulanje Mountain. The survival of planted tree seedlings has been very low in drought years in timber plantations and community forests compared to normal rainfall years. It is suspected that drought stressed plant are under serious threat from pathogens, insects and diseases outbreaks.

Alien Invasive Pests: The invasion of many alien invasive species such as the European cypress aphid *Cinara cupressi* is causing tree deaths of *W. whytei* on Mulanje Mountain. Many *Khaya anthotheca* trees have been deformed due to the shoot borer *Hypsipyla robusta* attacks during its early life-stages.

Agricultural expansion: Malawi is an agriculture-based economy country with about 90% of its human population deriving their livelihoods from small land holdings of 0.5-2 ha per household. Agriculture contributes over 40% of the Gross Domestic Product and accounts for about 90% of the foreign exchange earnings. Most of the agricultural production is done on customary land. However, pressure from the rapidly increasing human population has necessitated clearing of forest land to create new farming areas. Forest land clearing to create land for agricultural has become a very common practice and even gazetted forest reserves are experiencing heavy encroachment. Almost all gazetted and proposed forest reserves have been encroached in Malawi with most of the proposed forest reserves (about 138,000 ha.) completely deforested and converted into gardens e.g. Ighembe Proposed Forest Reserve (455 ha.) in Karonga District.

Forest Invasive species: Forest invasive alien invasive species are organisms that are intentionally or accidentally introduced and threaten forest indigenous biodiversity through consuming and preying on them, competing with them, or hybridising with them. More than 30 invasive forest alien species have been recorded in Malawi (table ....). Studies have shown that alien invasive species such as Central American mesquite (*Prosopis juliflora*) has overgrown and replaced indigenous vegetation in some parts of Lake Chilwa wetland (Swang'oma area). The cypress aphids which wiped out many trees in the general *Cupressus* and *Widdringtonia* in the mid 1980s have now been brought under control by a biological control agent, *Pauesia juniperorum* which was introduced in the 1990s. Forest invasive species pose the biggest and most problematic threats to the long-term integrity of forest reserves and tree plantations worldwide (Foxcroft, 2001).

Forest Inventories

Several forest inventories involving satellite imagery and geographic information systems (GIS) have been carried out to determine the species composition, wood biomass and vegetation composition plus other general forest growth characteristics have recently been carried out in the major forest reserves in Malawi. A combination of fieldwork and forest stand height measurements derived from ALOS PRISM and digital photogrammetry systems are being applied in order to estimate forest carbon stocks. The results will be used to develop management plans and other related activities for the forest reserves, determine the current status of the forest genetic resources, quantify carbon level changes and predict changes over long periods. To date, 60 permanent sample plots have been established and assessed in Chimaliro and Liwonde miombo woodlands and inventories have been carried out all the major forest, including Mulanje Mountain Forest Reserve. It is clear from the results that the various forest reserves have significantly different species compositions, tree stocking densities and general structure. Notable from the results from Mulanje Mountain forest reserve is the shrinking of *Widdringtonia whytei*, area from 1872 hectares in 2004 to less than 863 ha.

CHAPTER 3: THE STATE OF IN-SITU AND EX-SITU CONSERVATION OF FOREST GENETIC RESOURCES IN MALAWI

Robert Mzumara, Eric Mbingwani and Michael Likoswe

Introduction

Malawi is a botanically diverse country, with a wide range of ecosystems and variety of habitats for plants. According to the International Union for Conservation of Nature (IUCN), the country is a habitat to almost 6,000 plant species, 122 of which are endemic, mostly found in the Nyika and Viphya, Zomba and Mulanje Mountain Forest Reserves (Golding, 2002).

These forests are a vital renewable resource that provides various important services and goods (GoM 2000). The government has therefore delineated several sites for forest protection and conservation. Unfortunately all the forests are now under severe threat from excessive exploitation, expansion of agriculture land, wild fires and other factors.

In-Situ Conservation in Forest Reserves

Forest Reserves (table 3), including game reserves and national parks, have been established in hilly areas, steep slopes, water catchment areas and other fragile sites with unique vegetation as in-situ conservation areas for forest genetic resources in Malawi. Around 90,000 ha of government plantations have been established in these forest reserves. The largest Government plantation is the Viphya Plantation which covers 53,500 hectares and the other major ones are Chongoni, Dedza, Zomba, Michiru, Dzalanyama, Dzonzi-Mvai, Chigumula and Mulanje plantations.

Table 3: Forest Reserves in Malawi

Type of forest	Area in Ha (approximate)	Percentage of forest cover
Evergreen	82,620	3
Miombo	2,418,960	92
Plantations	136,430	5

Source: GoM, 1993.

Arboreta and Botanic Gardens

Conservation of forest genetic resources in Malawi is carried out in arboreta and botanic gardens located in Lilongwe, Mzuzu, Dedza, Mulanje and Zomba (table 4).

Table 4: The botanic gardens and arboreta in Malawi

Name of Botanic Garden/ Arboretum	Area (Ha)	Estimated tree species
Zomba National Botanic Garden	> 50	224
Lilongwe National Botanic Garden	118.255	186
Mzuzu National Botanic Garden	554.64	695 (Regeneration)
Mulanje Arboretum	Not assessed	105

The species in the arboreta and botanic gardens include socio-economically important (eg medicinal) and endemic indigenous plant species such as *Encephalatos gratus*, *Dalbergia melanoxylon*, *Erythrophleum suaveolens* species, *Aloe duckeri*, *Aloe swynnertonii*, *Ozoroa reticulata* subspecies *foveolata*, *Croton megalobotyrs*, *Darbegia melanoxylon*, *Brachstegia spiciformis, Brachystegia longifolia, Julbernadia globiflora, Pericopsis angolensis, Parinari curatifolia, Combretum* species and *Vishera* species. Arboreta and botanic gardens in Malawi serve as;

a. systematic collections of the representatives of the major plant families and vegetation types of economic and medicinal value, threatened, endangered and endemic indigenous plant species of Malawi,
b. as environmental and educational facilities for use by schools, colleges, universities and the general public,
c. areas for carrying out research on the flora and vegetation of Malawi including testing of various species, including introduced ones,
d. as areas for the promotion of greater knowledge and expertise in horticulture.
e. areas of public amenity and pleasure.

Sacred Forests and Graveyards

Traditionally, some forest areas are preserved by communities as sacred sites , believed to be the home of the dead spirits, ancestors and gods. In the past, communities used to offer prayers and sacrifices in specially preserved sacred forest such as at Khuluvi and Mbona for the rains to come. Such sites are still protected and preserved through a mechanism of beliefs, taboos, prohibitions and restrictions. Sacred graveyards and forests are still found in the Lower Shire and Southern Region, and these are no go areas for tree harvesters, forest fires and destructive activities. These practices have resulted in in-situ preservation of many tree and shrub species all in the country.

Seed Orchards and Short Term Storage at the National Tree Seed Centres

The Forestry Research Institute of Malawi (FRIM) has established seed orchards all over the country where improved seed of commonly grown timber, fuelwood and multipurpose species are conserved and obtained for distribution to the public (table 5). Seed collection areas have also been identified where elite (mother) species of endangered fine hard woods from which tree seed can be collected. To maintain genetic diversity and ensure availability of seed for sale and future establishment and enrichment planting, the NTSC stores seeds of endangered fine woods such as *Pterocarpus angolensis* (mlombwa).

Seeds are normally stored for short term (up to five years) in a cold room at 4-8°C, usually in air tight glass or hard plastic containers. Viability test are conducted on seed lots sold to customers in order to furnish the buyers with information that can be used in determining germination rate and hence the total amount of seed required. Of late, local communities are also being engaged in seed collection on behalf of the NTSC. The communities are trained in identifying elite tree provenances from which to collect seed and they are taught safe seed collection techniques. This not only provides a regular source of income for the rural communities but also reduces the temptation to cutting down well-formed (seed collection) indigenous trees and thus assist in preserving genetic diversity by actively discouraging others from cutting down mother trees.

Small quantities of trees seeds are kept by small seed distributors such as Total Land Care for specific projects and uses such as agroforestry.

Table 5: Tree seed species commonly supplied by NTSC and locally exchanged in Malawi

Species	**Local name**	**Average germinables per kg**
Acacia karoo	Mfungo	9100
Acacia nigrescens	Mkunkhu	4200
Acacia nilotica	Chisiyo	2550
Acacia polyacantha	Mthethe	9000
Adansonia digitata	Mulambe	3000
Afzelia quanzensis	Msambamfumu	350
Albizia lebbeck	Mtangatanga	6200
Albizia zimmermannii	Mkalankhanga	171000

Species	**Local name**	**Average germinables per kg**
Azadirachta indica	Neem	4000
Azanza garkeana	Matowo	5870
Bauhinia thonningii	Chitimbe	5000
Bauhinia petersiana	Mphandula	2160
Brachystegia boehmii	Mombo	5420
Brachystegia speciformis	Tsamba	800
Burkea Africana	Mkalati	4520
Burtt-davya nyasica	Mvule	798800
Colophospermum mopane	Tsanya	3480
Combretum imberbe	Mkolong'onjo	3000
Combretum molle	Chinama	3400
Combretum zeyheri	Chinama	40900
Cupressus torulosa	Mkungudza	31840
Cupressus lusitanica	Mkungudza	52160
Dalbergia melanoxylon	Phingo	1660
Delonix regia	Mchekeche	16700
Dichrostachys cinerea	Mphangale	13400
Diospyros kirkii	Mchenje	1720
Erythrina abyssinica	Muwale	1380
Eucalyptus camaldulensis	Bulugama	686670
Eucalyptus citriodora	Bulugama	131000
Eucalyptus cloeziana	Bulugama	301500
Eucalyptus grandis	Bulugama	468550
Eucalyptus maidenii	Bulugama	251360
Eucalyptus microcorys	Bulugama	268770
Eucalyptus saligna	Bulugama	566400
Eucalyptus tereticornis	Bulugama	1063060
Eucalyptus urophylla	Bulugama	639500

Species	**Local name**	**Average germinables per kg**
Faidherbia albida	Msangu	5750
Gliricidia sepium	Gililisidiya	6175
Gmelina arborea	Malayina	1080
Grevelia robusta	Giliveliya	36500
Khaya anthotheca	Mbawa	2300
Jacaranda mimosaefolia	Jakalanda	28810
Lanchocarpus capassa	Chimphakasa	3400
Leaucaena leucocephala	Lukina	12650
Melia azederach	Indiya	2250
Milicia excels	Bvule	264160
Moringa oleifera	Chamwamba	5030
Parinari curatelifolia	Muula	A/O
Parkinsonia aculeate	Pakisoniya	6970
Pericopsis angolensis	Muwanga	2720
Pinus elliottii	Paini	11960
Pinus kesiya	Paini	49450
Pinus oocarpa	Paini	45700
Pinus patula	Paini	79790
Pinus pseudostrobus	Paini	26580
Pinus taeda	Paini	15530
Pinus tecunumannii	Paini	47110
Pterocarpus angolensis	Mlombwa	3660
Senna siamea	Keshya wa milimo	17240
Senna spectabilis	Keshya wa maluwa	29880
Sesbania macrantha	Jerejere	11710
Sesbania sesban	Jerejere	36650
Sterculia Africana	Mgoza	500
Sterculia appendiculata	Njale	9020

Species	Local name	Average germinables per kg
Tamarindus indica	Bwemba	2700
Tephrosia vogelii	Mthutu/Wombwe	14650
Terminalia ivorensis	Mkuryungu	6220
Terminalia sericea	Naphini	2900
Toona ciliate	Sendeleya	251650
Widringtonia whytei	Mkungudza	25530
Zizyphus mauritiana	Masawo	1940
Zizyphus mucronata	Kankhande	2000
Trema orientalis	Mphefu	

Long Term Seed Conservation (Seed Banks)

Since 2003, the NTSC and National Plant Genetic Resource Centre (NPGRC) have been collaborating with the Royal Millennium Botanic Gardens (Kew) under the Millennium Seed Bank Project to collect seeds of threatened, endemic, and economically important flowering forest plant species in Malawi. To date about 1,017 forest species have been stored at the National Genetic Resource Centre (NPGRC) gene bank with duplicates at the Millennium Seed Bank (Kew) in United Kingdom. Ex-*situ* living collections of some of the stored species have also been established in the country.

Genetic Resource Improvement Programs

Selected Trees (ST): The NTSC has been carrying out a genetic improvement and conservation program, where superior trees are identified and conserved for seed collection. The sources are often pre-selected trees with desirable traits. This is common for high valued indigenous species such as *Pterocarpus angolensis and Khaya anthotheca, Afzelia quanzensis, Brachystegia species,*

Research Trials (RT) plots: Experimental research areas have been established for Pines, Eucalyptus, *Grilicidia sepium* and *Atelelia herbatismithii* in Dedza, Chikangawa, NkhataBay, Machinga and Mangochi districts to provide temporary seed sources for newly introduced species/provenances that have been planted in research trials. Research trial seed sources have been established in many parts of the country.

Seedling Seed Orchards (SSO): These are seed sources that are established from trees of known high genetic quality/origin and managed as a seed sources from the beginning. The NTSC has established SSOs of Pine and Eucalyptus species in Dedza and Chikangawa forests.

Clonal Seed Orchards (CSO): These are seed sources that are established from clones of high genetic quality with desirable traits useful for major industrial species. A CSO of *Pinus patula* has been established in Dedza Plantation.

Provenance Trial Plots: The Forestry Research Institute of Malawi (FRIM) has established provenance and clonal experimental plots in most of the forest reserves in the country. One of the aims of this is to conserve the gene pool and provide information on the genetic variation within and between provenances of the various plantation species, thus providing a basis for selection of species for afforestation programs. Provenance plots have been established for *Pterocarpus angolensis, Faidherbia albida, Pinus patula and Pinus kesiya,* and *Eucalyptus* species

CHAPTER 6

THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

Dave Moyo and Vincent Chithira

Introduction

This chapter lists some of the national, regional and global networks, forums that Malawi has been associating with to promote conservation of forest genetic resources. The chapter also deals with international funding mechanisms that have continually supported the country in the various FGR related activities. An assessment of the major needs, gaps and priorities that relate to international collaboration is given at the end of the chapter.

Regional and Sub-regional Networks on Forest Genetic Resources

Issues related to plant genetic resources in Malawi are handled by various institutions and organizations such as the Department of Agriculture Research (DAR), the Tea Research Foundation (TRF), the National Herbarium and Botanical Gardens (NHBG), the University of Malawi, the Sugar Corporation of Malawi, the Forestry Research Institute of Malawi (FRIM), the Department of Parks and Wild Life coordinated by the Department of Environmental Affairs. Through this network, the country also links to various regional and sub-regional level, political and economic groups and research networks (table 6)

Table 6: Research Networks

FORNESSA	Forestry Research Network for Sub-Saharan Africa	Federation of forestry research institutions
AFORNET	African Forestry Research Network	Extended area
ASARECA	Association of Agricultural Research in East and Central Africa.	Strengthening agricultural research
GFIS	Global Forestry Information Service	Information system, research
OAU-STRC	Scientific, Technical and Research Commission	General
SADC-FSTCU	Forestry Sector Technical Coordination Unit.	General

International agreements.

- **The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)**:- In 2003, Malawi adopted and ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The objectives of the Treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use. The Treaty covers all plant genetic resources for food and agriculture, while it's Multilateral System of Access and Benefit-sharing covers a specific list of 64 crops and forages.
- **The Global Plan of Action (GPA)** for the conservation and sustainable utilization of Plant Genetic Resources for Food and Agriculture (PGRFA). The International Treaty on Plant Genetic Resources for Food and Agriculture complements the Global Plan of Action.
- **Kyoto Protocol** –Malawi has signed and ratified the Kyoto protocol.
- Southern African Development Community(SADC), Intergovernmental Authority on Development (IGAD), Common Market for Eastern and Southern Africa COMESA, East African Community (EAC) and New Partnership for Africa's Development (NEPAD).

The key challenges in implementing biodiversity related conventions in Malawi include:

- Meeting the increased demand for biological resources.
- Building adequate expertise and experience on biodiversity.
- Improving policies and legislative guidelines and fiscal measures for the regulatory use of biodiversity.
- Strengthening coordination within and between governments.
- Building political support for changes necessary to ensure biodiversity conservation.

CHAPTER 7: THE STATE OF ACCESS AND BENEFIT SHARING OF FOREST GENETIC

Gerald S Meke and Clement Z Chilima

Malawi's Forest Genetic Resources are governed by three different resource tenure systems; the public or government resources, customary resources and private resources. These arrangements influence how the benefits and accessibility are derived.

Tenure Systems

Public/government tenure- the resource is directly managed by government on behalf of the citizens of Malawi. Government owns the land and the forest resources. In the case of city and town assemblies the government owns the land but may lease it out land to city or town dwellers but the forest resources belong to the assemblies. Most of the forest resources that are under government/public land tenure system are in forest reserves that are managed by the forest department or in game reserves and national parks that are managed by the Department of Parks and Wildlife. Access by the general public is restricted and is only allowed under special permission by the government. Extraction of FGR in game reserves and national parks is limited to non-timber forest products.

Private forest resource tenure: this may be freehold or leasehold tenure. In either case, access and extraction of forest genetic resources is strictly by permission by the private resource owners. In special cases government may have to be consulted when resources are being extracted, such as from fragile areas or if the resource is believed to house special genetic resource of national interest.

Customary forestry resource tenure: these are all forest resource area that are found on un-allocated land and all land under traditional leaders (chiefs and village headmen). When segregated, these parcels of land are include sacred land (eg graveyards), land allocated to village residents and land set aside as village forest areas. Ownership or usufruct rights rest with individual villagers or group of individuals who the customary authority have appointed or delegated temporary ownership to, otherwise all authority rests with the customary leaders. Issues of access and benefit sharing arising from the forest resources under customary tenure are not very clear, however, generally individuals and groups that have been given ownership have powers to permit or restrict other people to access and extract resources. All un-allocated land and sacred forest areas are under the charge of the customary leaders and therefore permission to access and extract resources rests with the village head or customary leader or his lieutenants.

National Regulations and Policy

In Malawi, issues of access and benefits sharing (ABS) for plant genetic resources are coordinated by the Department of Environmental Affairs which drives the country's efforts to align with the African Union, the SADC region and the United Nations Convention on Biological Diversity (CBD). Currently, Malawi is in the process of developing policy guidelines on ABS. In the absence of a central policy country uses the SADC protocol and is also guided by article 15 of the CBD to make decision on ABS.

Foreign Prospectors and Researchers: The Forest Department and The Department of Parks and Wildlife play some role in guiding how the benefits from forest resources are accessed and shared. However, bio-prospecting and research involving FGR is regulated and monitored by the National Commission of Science and Commission, through a committee called the National Plant Genetic Resource Committee (NPGRC). The NPGRC was established to deal with issues relating to Access and Benefit sharing of forest and other biological genetic resources. The committee has developed Access and Benefit Sharing Guidelines that relate to research and bio-prospecting for plant genetic resources in Malawi. The guidelines ensure that i) research of Malawi's genetic materials does not lead to loss of biodiversity; ii) exchange of genetic resources germplasm and commercialisation of research results are done in such a way that Malawi benefits economically from whatever is exported; iii) there is establishment of gene banks and genetic gene banks (in-situ and ex-situ) and formation of strong linkages with the banks including the SADC gene bank; iv) research projects that involve exchange of genetic resources and germplasm are effected in a manner that encourages collaboration with foreign researchers; v) expatriate researchers/collectors work closely with competent local researchers to safeguard Malawi's interests; and vi) research projects on genetic resources are only those that are geared towards Malawi's socio-economic development and that their execution does not lead to fragmentation and duplication of research efforts. The guidelines apply to: i) Foreign scientists and research institutions that plan to conduct research involving the collection of genetic resources; ii) Local scientists and research institutions that plan to collect and export genetic resources for analysis or as part of an exchange programme with a foreign institution, scientists; iii) Local scientists and research institutions that are funded by external sources on research projects involving the collection of Malawi's genetic resources; iv) Malawi government officials and ports of entry. The procedure of approval of research and bio-prospecting involves certification by several institutions that are members of the NPGRC. These certifying institutions, are designated by the government to control certain sectors of genetic resources and review research proposals prior to submission to the NCST.

Further, all foreign or local researchers wishing to export genetic resources need to obtain an export license from the Minister responsible for Natural Resources and Environmental Affairs.

Currently, the Department of Environmental is in the process of developing Access and Benefit Sharing regulations using article 15 of CBD as a guide.

CHAPTER 8 : THE CONTRIBUTION OF FOREST GENETIC RESOURCE TO POVERTY REDUCTION AND SUSTAINABLE DEVELOPMENT

Wille Sagona

Forest Genetic Resource (FGR) is at the heart of food security. This is not only for the obvious reason that the agriculture sector which in its widest sense include pastoral production, forest products and fisheries, is the only source of the food we eat (Maxwell 2001) in Malawi. It is also because of the multiple roles played by the agricultural sector as a source of employment and livelihood, and as one of the main engine of economic activity.

Agriculture is the mainstay of the economy in Malawi. The sector contributes about 36% of the Gross Domestic Product (GDP), 87% of the total employment, supplies more than 65% of the manufacturing sector's raw materials, provides 64% of the total income of the rural people, and contributes more than 90% of the foreign exchange earnings. It is the main livelihood of the majority of rural people, who account for more than 85% of the current, estimated 14 million people.

Malawi's economy and human society is entirely dependent and based on the biological diversity and services provided by the ecosystems. Extrapolated from the contribution of biodiversity components to the national economy (the Gross Domestic Product) it has been proved that the biodiversity of Malawi is instrumental in providing sources of livelihood needs in form of food and fibre, fuel wood, medicine and shelter. The economy also depends on the use of biodiversity as sources of raw materials for agro-industrial development and exports. It is the purpose of this chapter to discuss the contribution of Forest Genetic Resource to food security, poverty reduction and sustainable development.

FGR Contribution to food security

The prospects of meeting food demand in Malawi, which depends mainly on rain-fed, smallholder agriculture, will likely remain bleak in the absence of major efforts to reverse current unfavourable trends in productivity. Central to the food security equation is the rapid decline of soil fertility, which affects crop productivity and rural poverty (Conway & Toenniessen 2003). Although mineral fertilizer can restore soil fertility, most smallholder farms in Malawi may have little access because of high price especially when farm input subsidy programme (FISP) is not in place. The dramatic increases in world fertilizer prices recorded recently are especially damaging to Malawian farmers' hope of improving their productivity (Hargrove 2008).

Trees in agro-forestry systems

Both indigenous and exotic tree species are used in Malawian agroforestry systems. The species are either deliberately planted or are managed within their natural habitat to improve their productivity. Among the most important indigenous tree species include the African acacias (*A. karroo* and *A. nilotica*), *Faidherbia albida* and *Sesbania sesban.* Exotic agroforestry species which are used include *Gliricidia sepium, L. diversifolia* and *Tephrosia vogelli*.

The hard reality confronting poor farmers in Malawi creates the urgent need to develop a wide range of options for replenishing soil fertility as quickly as possible. Over the decades, scientists have evaluated various woody and herbaceous legumes, or green fertilizers, to improve soil fertility and thereby strengthen household food security in Malawi. The approach harnesses biological nitrogen fixation, the process by which legumes, either in a rotational fallow or in an intercropping system, draw nitrogen from the air to produce compounds that enrich the soil when the plants are ploughed under (WAC 2009). However, the effects of green fertilizers on maize yield vary widely, generating debate on their usefulness for raising maize productivity and strengthening food security.

The results from a meta-analysis on maize yield benefits from using green fertilizers conducted by World Agroforestry Centre showed that green fertilizers increased the average yield by up to 1.6 tonnes per hectare in smallholder farmers (Sileshi *et al*. 2008). At the estimated rate of maize consumption of 1.5 kilograms per person per day, the incremental maize yield provided by green fertilizers contributes the equivalent of 6 months' worth for a farm family of five. Under this system the production risk with respect to maize yield is therefore lower in fields using green fertilizer than in those under conventional farmers' practice.

Green fertilizers are compatible with mineral fertilizers, and their combined use has synergistic effects. The results by WAC indicate that maize yield can go up to 30% higher when green fertilizer were amended with half of the recommended dose of mineral fertilizer, compared with similar plots that were not amended. The result indicates that legume trees and shrubs can play important roles in reducing the cost of meeting fertilizer requirements, with implications for local food security and national budgets (WAC 2009).

Trees used for fodder

Several exotic and indigenous tree species are regarded as important fodder tree species in Malawi. The indigenous tree species cited as being widely used for fodder include the African acacias (*A. erioloba, A. karroo, A. nilotica, A. robusta*) *F. albida, Julbernadia paniculata*. Exotic tree species used as fodder include *A. angustissima, C. calothyrsus, Ceratonia siliqua, L. leucocephala, L. pallida, L. diversifolia, Gliricidia sepium, Prosopsis glandiflora,* and *T. vogelli.*

Human nutrition and food production

Forest foods tend to be considered less important than other forest products largely because they are seasonal in nature and cannot be relied upon as a staple. Forest foods can be categorized into four rather loose groups such as famine foods, foods to vary the diet, foods to sell and fodder for livestock which subsequently provide food or income. Mushrooms, although consumed in normal years, are not usually thought of as food, but during times of intense food shortages they might be the only foods consumed for days at a time. In normal years they are considered a cheap and tasty relish and when plentiful are often preserved for later use (Lowore 2006). However, if there are suitable market opportunities for sale of mushrooms and the proceeds can be used to buy maize then this can probably contribute more to food security than mushroom consumption.

Forest genetic resources are an insurance against hunger and malnutrition. They provide much needed dietary diversity which avails both macro and micro nutrients necessary for good health. Malawi is faced with problem of HIV and AIDS and consumption of diverse diets boost immunity. Provision of nutrients to infected persons is being encouraged by government and nongovernmental organizations. Mushroom is one of the forest products that is being promoted in the nutrition of HIV/AIDS patients. In some other parts of the country such as Kammwamba in Neno, forest tree species are being processed into other food products. Indigenous fruits, for example are processed into a variety of products that store well and therefore readily available in periods of food shortage. For instance some women in villages use wild fruits for production of juice, jam and wine. *A. digitata* and *T. indica* are among fruits that are being used for cottage industry production.

Many edible indigenous fruits that grow in indigenous woodlands are nutritionally rich, and play a central role as sources of nutrients for humans. For example, Mwanjuma (1982), while investigating the potential of using local fruits to meet the dietary requirements of vitamin A and C and calcium, revealed that wild species were high in fibre and minerals. Various studies have stressed the importance of edible wild plants in the diet of rural people (Muok 2001). Research that has been conducted on the role of IFTs in rural livelihoods has found that indigenous fruits help to provide food security (Muok 2001; FAO 1983), as they are used as a food supplement. According to Maghembe (1995), IFTs are receiving attention by researchers due to their value in this regard. Research shows that rural populations use indigenous fruit to supplement their diets in many different ways, depending on the fruit, the part of the fruit being utilised, and/or the ethnic group of the users. The use of indigenous fruit trees also vary from one area to another in Malawi.

Indigenous fruits are important in remote areas especially during times of famine (Campbell 1987; Coote *et al* 1993b). They provide an alternative source of good nutrition, particularly for communities in arid and semi-arid areas, where crop failures are a regular occurrence, and often result in the poor nutrition of the local people, who are mainly subsistence farmers (Muok 2001). Indigenous fruits are also used as fodder for livestock and as medicine, and many rural households in the Southern Africa Development Community (SADC), including Malawi, rely on IFTs as sources of cash (Akinnifessi *et al* 2006).

Various studies have affirmed that edible indigenous fruits are nutritionally rich and are sources of minerals and nutrients for humans (Muok 2001; FAO 1983). Wild fruit contribute greatly to diet quality, rather than quantity (Packham 1993). Saka (1995), who studied the chemical composition of edible fruits of wild plants in Malawi, discovered that *Adansonia digitata*, *Bauhimia thonningii* and *Vitex doniana* are excellent sources of calcium, and consumption of them would meet the individual daily requirement for this mineral. Further, *Adansonia digitata*, *Bauhimia thonningii*, *Diospyros usambarensis*, and *Vitex payos* were found to be excellent sources of vitamin D.

Although there are more than a hundred indigenous tree species found in the SADC region that produce edible fruits, the following species are regarded as the most important in this diverse region and specifically for Malawi: *A. digitata, Annona senegalensis, , Azanza garckeana, B. discolor*, *Cassia petersiana*, *Diospyros mespiliformis*, *Encepharlatos goetzi*, *Englophton* spp. *Eugenia capensis*, *Faidherbia albida*, *Ficus sycomorus*, *Grewia* spp. *Hyphaene petersiana*, *Kigelia africana*, *Mimusops zeyheri*, *Parinari curatellifolia*, *Phoenix reclinata*, *S. tautenenii*, *Sclerocaryea birrea*, *Strychnos madagascariensis*, *S. cocculoides*, S. *spinosa*, *Syzygium cordatum*, *Tabernaemontana elegans*, *Tamarindus indica*, *Trichilia emetica*, *Uapaca kirkiana*, *Vangueria infausta*, *Ximenia spp.* and *Ziziphus* species. Thus, it is very clear that forest genetic resources greatly contribute to food security in the region and specifically Malawi.

FGR contribution to poverty reduction

Poverty is the deprivation of well-being related to lack of material income or consumption, low levels of education and health, vulnerability and exposure to risk, no opportunity to be heard and powerlessness (World Bank 2001). Thus, poverty alleviation can be defined as successfully lessening deprivation of well-being. Malawi is one of the poorest countries in the world being listed 163 out of 174 in the United Nations Development Annual Report for the year 2009. About 52% of the 13 million people live below the poverty line whilst 22% live in dire poverty.
According to World Bank criteria for classifying countries, Malawi is therefore a low income country (World Bank 2009). Services and agriculture contribute a significant proportion of the GDP of Malawi. Measured at constant market prices, services, agriculture and industry contribute 52%, 33% and 15% respectively. Agriculture is defined to include crop and animal

production, hunting and related service activities (forestry and logging; fishing and aquaculture) (GoM 2010). According to the new series national accounts, forestry and logging contributed 1.0% and fishing and aquaculture contributed 0.7% to GDP in 2008 (GoM 2009). More recent research has suggested that forestry contributes significantly more to GDP than was previously estimated: roughly 5.3% of the total in 2008 (Yaron *et. al.* 2010).

Forest-based employment

In Malawi, the distribution of employment shows that in 2008, 84% of the employed (aged 15 years and above) were engaged in agriculture, forestry and fishing (NSO 2009) indicating direct dependence on natural resources. Shortage of food and poor nutrition are seen as two major problems facing contemporary Africa with acute malnutrition, food insecurity and low income levels found especially among the rural and peri-urban populations of southern African countries (Akinnifesi *et al.* 2004). This is particularly true for Malawi, which has had a myriad of economic problems in recent times emanating from shortage of forex, is ranked as one of the least developed countries in the world.

Forestry activities and the operations of the forest industries offer a lot of job opportunities. Sources of forest-based employment are many and diverse but only a few of them are recorded. The different stages of log harvesting, transportation and sawing are labour intensive and many people in the rural area are employed. The present level of technological development in Malawi necessitates that most tree felling and processing operations are done manually.

The total annual production of individual timber and fuelwood in Malawi has been estimated at 160 000 m^3 and 3.1 million m^3 respectively. While the demand for industrial timber can be fully met from the industrial plantations, there is a gap between the demand and the production of fuelwood (Gowela & Masamba 2002). Sawmills are the most widespread forest-based industries and one of the largest employer of rural labour. In the secondary wood processing industries, the furniture, boat building and pole treatment factories also offer employment to rural dwellers. Forest services such as recreation, hunting and tourism also offer new sources of forestry employment. The statistics of the number of jobs provided by the forestry sector is usually compromised due to the patrimonial nature of some forestry activities and the fact that crafts play a major role in the secondary forest industry. Estimation is also made complicated by the number of self-employed people who are involved in collection, processing and marketing of non-timber forest products and illegal charcoal production. All in all, the contribution of forestry to national economy in macro-economic terms is usually undervalued in Malawi due to GDP peculiar accounting system.

Forest-based enterprises

For the rural poor in Malawi, making a living is a matter of daily struggle. Sale of forest produce is often a supplementary activity in an attempt to make ends meet and the motive is rarely to make a profit. Studies on micro-enterprises in Malawi have shown that most people who sell forest produce do so as individuals or as small family operations, start off with little, if any, capital outlay, produce small quantities of mainly unprocessed or crudely processed goods and make little profit (NSO 2000). The money earned is used almost entirely to meet immediate domestic needs and little is saved and/or reinvested in the business. This is particularly true for the primary producers. Those who engage in bulk trading need more capital to start with and must be in a position to save some of the proceeds in order to buy more goods for resale otherwise their business is unsustainable. The business of the primary producer is sustainable only as long as the raw material remains freely available from forest or common land. It is important to take note that primary producers are motivated by an urgent need to reduce their vulnerable status whilst the traders are more likely to be motivated by the awareness of a profit making opportunity. The degree to which sale of forest produce assists different people varies along a continuum from mere survival to coping with vulnerability to making profit.

A great many forest products are now traded in Malawi. Some have always been traded within communities but are now traded in greater quantities and across greater distances than ever before, e.g. mats and baskets. Others are relatively “new” products such as bamboo furniture, and some products, wild mushrooms for example, although always widely used have only recently gained a market value in Malawi. The status of the trade in forest-derived products, therefore, has not been static. Evidence would suggest that sale of many items is on the increase due to two main factors; the rise in urban population and an increase in alienation between urban people and forests. There are of course other factors such as a relaxation in access to protected forests and perhaps an increase in the cash needs of the rural poor (Lowore 2006). One problem with trying to understand the value of the forest products used domestically is that the goods are ‘free’ to community members. However, it is sometimes possible to assign a monetary value to each product based on what a person without access to the free good is prepared to pay for it. One study revealed that by using this method a year’s supply of home-used firewood for one household was enough to buy 416 kg of maize (using prices of 1996) or almost half a year’s supply, and that the value of poles consumed by a household in a year was equivalent to 120 days of maize supply for the same household (Lowore 2006).

In Malawi, the firewood and charcoal trade is the largest and most integrated of the forest product markets. For the majority of Malawians having access to wood fuel is a matter of necessity; 84 % of the urban population use wood fuels for cooking (NSO 2000). This urban demand drives the rural communities who have access to indigenous woodlands to “cash in” and liquidise their natural resources. The marketing of the produce may involve villagers selling

firewood at the roadside directly to urban-dwelling passers-by or via a pronounced market chain consisting of collectors, traders and vendors.

Making and selling curios is a specialist but vibrant small scale industry in Malawi thought to be generating income for over 5000 people (Marshall *et al.* 2000; Lowore 2006). Initially curio markets emerged in tourist sites and the carvers relied on local woody resources. As these resources have become limited the carvers have moved to the resource-rich sites opening up opportunities for vendors to buy in bulk from the resource-rich sites to sell in the traditional tourist locations. Markets are unpredictable and profit margins tricky. Some traders undertake bulk trading to South Africa which is a major international market for Malawian carvings.

Interest in forest based enterprises has been growing in Malawi. The emphasis is on those products which are less easy to overexploit, are high in value or have potential for added value through processing e.g. honey, tree oils, jams, juices, handicrafts, dried fruits and mushrooms. It is nevertheless important to think of the sustainable production of wood fuels for the simple reason that demand remains high and the market is well developed. Despite this growing interest in the non-timber forest product trade in Malawi there are few examples where interventions by development bodies have led to increased incomes or an increased incentive to conserve woodlands (Lowore 2006). The problem is that selling forest produce is an activity which is accessible by poor people and is therefore basically a subsistence activity motivated by poverty rather than profit. This fact alone makes it difficult to find ways of upgrading the activity from an income generating activity to a real business. Lack of skills, capital, interest and ability to invest in the production base as well as general attitude are all constraints which need to be addressed. In the interests of equity and social inclusion some of the efforts which have been made to increase income through natural resource based enterprises have worked through groups and community ventures. Increasingly it is becoming obvious that this approach is not working and that targeting individual entrepreneurs might be more appropriate.

The role of Non-timber Forest Products (NTFP) in poverty reduction

NTFPs provide a wide range of goods for domestic use and for the market, among which are charcoal, fuelwood, game, fruit, nuts, medicinal herbs, forage, and thatch for roofs. The poor generally use various types of NTFPs so are able to spread risk among different activities. They are a source of emergency sustenance in times of hardship such as, when crops fail, or when floods wash away homes. NTFPs tend to be seasonal and perform a gap-filling function.

In rural areas, earnings from forest based products are often important as a complement to other income. Large numbers of households generate some of their income from selling NTFP especially when farm production is not sufficient to provide enough food all the year round. This

income is often used to obtain inputs for other activities that contribute to poverty reduction. The rural poor often produce, process and sell forest products (e.g. making mats and baskets) in the absence of other employment opportunities often as a part-time activity within farming households.

Malawi has a large pool of indigenous fruit resources (Kwesinga 1995). This is particularly true for the *miombo* woodlands, which despite the semi-arid conditions in which the *miombo* is found, have been reported to be rich (in terms of both diversity and quantity) in indigenous fruit trees (Maghembe *et al* 1995; Campbell 1987). Their open and sparse woodlands also contain a wealth of other renewable resources, such as timber poles and fuel wood, as well as non-timber forest products (NTFP), such as beeswax, honey, mushroom, and edible caterpillars. It may be argued that the majority of the rural population in Malawi lives in the vicinity of apparently abundant indigenous forest resources. Thus forest genetic resources contribute to poverty reduction through various livelihoods strategies that they offer.

However, the role of NTFPs which include Indigenous Fruit Trees (IFTs) in rural livelihoods has not been extensively researched in Malawi despite their contribution to household income and poverty reduction. This is because most research institutions view IFTs in a larger context of multipurpose trees within agroforestry systems, hence specific focus on them has been on domestication and IFTs interaction with other crops in agroforestry systems (Ambe & Malaisse 2001). Packham (1993) highlighted that, although there is growing understanding of the importance of wild fruits and other non–timber forest products in the diet of rural households, there is little knowledge about their importance in sustaining households through financial and nutritional stresses. Muok (2001) echoed similar sentiments, as he identified that, although the potential role of IFTs in providing food security in arid and semi-arid areas has been identified, little information is available on communities' actual use, management and preferences in this regard. Similarly, information on the role of indigenous fruits in the livelihoods of the rural communities in Malawi is scanty.

Throughout the *miombo* region, the woodlands supply many products and services essential to the well-being of the rural communities (Clarke *et al* 1996), with some products (e.g., browse and leaf mulch) acting as subsidies for agriculture, while others provide for basic needs, such as food, shelter and health. The products that are supplied by the *miombo* include mushrooms (Pegler & Pearce 1980), medicine, leaf litter, tannins, dyes, oils resins, and indigenous fruit. Leaky (1999) observed that such NTFP play an important role in alleviating poverty in the tropics. It is therefore evident that forest genetic resources contribute to poverty reduction in Malawi. Thus, the economy of Malawi is linked to the forest genetic resource in many important ways. This underscores the need to examine the contribution of FGR to poverty alleviation to

determine the impact of economic activities in Malawi and, conversely, how prudent use of the FGR can promote sustainable development.

FGR contribution to sustainable development

Genetic resources are the basis of food security and sustainable agricultural development as they comprise diversity of genetic material contained in traditional varieties, modern cultivars, wild and weedy relatives of crop plants. The importance of biological diversity and increasing threat of genetic erosion was internationally acknowledged at the United Nations Earth Summit at Rio de Janeiro in 1992 when majority of the world's governments signed the Convention on Biological Diversity (CBD) which came into force in 1993. However, the pressure being exerted on the forest genetic resource in Malawi greatly threatens their continued contribution to sustainable development.

The Malawi Growth Development Strategy (MDGS) aims at achieving sustainable development. In order to achieve this, the MGDS identify some thematic areas namely agricultural sustainability, food security and conservation of natural resources which includes forest genetic resources. Sustainable development focuses on environmental sustainability and is concerned with preservation or enhancement of the productive forest genetic resource base, particularly for future generations. Despite the contributions of forest genetic resource to food security and poverty reduction, there are enough straws in the wind to indicate that FGR contributions may not be sustainable in Malawi. This could be attributed to high environmental cost and concerns about the future progress of technical change. According to Moorehead & Wolmer (2001), debate around food security and environment linkages which is often tied to concerns about population growth and climate change, has been artificially polarized between two questionable extremes:

- That population growth, climate change and environmental degradation constitute unprecedented challenges to world food security; or
- That population and income growth will drive technological change so as to remove the food production constraints and reach an economically and environmentally sustainable growth path.

In Malawi, at the current FGR usage rate, there is little to be gained from singling out environmental sustainability from a host of conflicting and overlapping development challenges.

Inherent challenges to sustainable development

Despite the high economic value of FGR and their role in the economy of Malawi, they are not used in a sustainable manner. There is evidence that forestry resources are degrading at a fast rate of 2.6% per year (World Bank 2002). The main cause of this is agricultural expansion

caused by rapid population growth. Inadequate electricity generation, which results in electricity rationing, contributes to forest degradation by increasing firewood and charcoal demand in the major centers of Blantyre, Lilongwe, Limbe, Zomba and Mzuzu. Many FGR stocks continue to show declining trends, with significant economic ramifications that have yet to be accurately valued. In addressing FGR degradation, a pertinent consideration is the organization of the economy, especially the agricultural sector (GoM 2010). This sector is dominated by the small-scale sub-sector with many producing enterprises. The proliferation of small scale operations without access to modern means and techniques of production puts the FGR at risk. At the same time it makes it difficult to enforce forestry laws and regulations which is a hindrance to sustainable development.

The high rate of increase in population, urbanization and demand for other forms of land use has put the forests and its genetic resource under pressure. The rate of reduction of land under forest has been very rapid and alarming. The natural forest in Malawi can no longer sustain the demand on it for timber, food and other forms of livelihood. It is important that the forest should be managed on sustained yield basis for the production of goods and services. The concept of sustainability in all its facets: ecological, economic and social is vital to forest management in order not to jeopardize the other goods, services and benefits of the forests. However, in Malawi, environmentally sound FGR management may be impossible under conditions of high population growth, scarce resources and the absence of alternatives to subsistence agriculture. Furthermore, tenure systems, especially common property regimes, are regarded as inevitably creating the conditions under which FGR will be over exploited and degraded, elaborated in the 'tragedy of the commons' thesis (Hardin 1968). Most common in Malawi is the contention that poor people are forced to degrade their FGR in order to cope with food insecurity.

Coping strategies which have particularly deleterious effects on the FGR include abusive tree-cutting to make charcoal, over-harvesting of wild foods, overgrazing of and increased farming in marginal areas. People are often aware of the consequences of their actions for the resource and for the future sustainability of their own livelihoods, but have no alternative but to adopt short-term solutions to survive. Poor rural people will seek to maintain their future productive capacity when trying to cope with drought and the threat of famine, but if the choice is between selling remaining livestock or abusive exploitation of FGR, they are likely to hold onto the few remaining private assets they have and clear forests which house abundant genetic resources. Thus, unsustainable use of FGR adversely impacts on the rate of economic growth and sustainable development in Malawi. Yaron *et. al.* (2010), for example, have estimated that Malawi's GDP would be higher by 5.3% per year were it not for unsustainable use of natural resources. They have also discounted the cost of damage over 10 years and found the present value of this to be 21.4% of GDP. At 2007 prices, they have estimated an annual loss of K26, 574 million. According to GoM (2010), the main contributors to the annual revenue loss due to

resource degradation are forestry degradation (47.8%) and soil degradation (33.8%), followed by unsustainable fisheries (14.7%).

Conclusion

In conclusion, poor rural Malawians have not seriously considered the implications of the existing inter linkages among food security, poverty alleviation, sustainable development and forest genetic resources, but are instead forced to juggle immediate needs against longer-term ones. Analyses of contributions of FGR to food security, poverty reduction and sustainable development have tended to be conceptualized as either inherently conflicting or, less often, complementary. FGR contribution to food security, poverty reduction and sustainable development can only be sustained when the resource is not undermined through undervaluing or usage. The contributions of FGR may be meaningful only when people who depend on them for their livelihoods are taken into account, including their immediate food needs. An understanding of the trade-offs and strategies by which poor people attempt to develop sustainable livelihoods should provide policy makers with a better platform from which to tackle food security and poverty reduction for sustainable development in mutually reinforcing ways.