THE STATE
OF THE WORLD's
FOREST GENETIC RESOURCES

COUNTRY REPORT

ETHIOPIA

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 OF ETHIOPIA

INSTITUTE OF BIODIVERSITY CONSERVATION (IBC)

COUNTRY REPORT SUBMITTED TO FAO ON THE STATE OF FOREST GENETIC RESOURCES OF ETHIOPIA

AUGUST 2012

ADDIS ABABA

IBC

TABLE OF CONTENTS Page

ACRONYMS

ABS	Accesses and Benefit Sharing
CDM	Clean Development Mechanism
CRGE	Climate Resilient Green Economy
CSA	Central Statistical Agency
EIAR	Ethiopian Institute of Agricultural Research
EPACC	Ethiopia's Program of Adaptation to Climate Change
FGR	Forest Genetic Resource
FRA	Forest Resources Assessment
FRC	Forestry Research Center
GIZ	German International Cooperation
GTP	Growth and Transformation Plan
GTZ	German Technical Cooperation
IBC	Institute of Biodiversity Conservation
INBAR	International Network on Bamboo and Rattan
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MTA	Material Transfer Agreement
MERET	Managing Environmental Resources to Enable Transition
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Program of Action
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non Governmental Organization
NTFP	Non Timber Forest Product
NWFP	Non Wood Forest Product
PIC	Prior Informed Consent
PFM	Participatory Forest Management
REDD	Reduction of Emissions from Deforestation and Forest Degradation
SLMP	Sustainable Land Management Program
SNNP	South Nations, Nationalities and Peoples
SUPFM	Scaling-up Participatory Forest Management Project
WBISPP	Woody Biomass Inventory and Strategic Planning
WGCFNR	Wondo Genet College of Forestry and Natural Resources

EXECUTIVE SUMMARY

Ethiopia is located between 3º and 15º N and 33º and 48º E, and has an area of 1,113,677 km^2. The majority (83%) of the people, out of the estimated 84.3 million total population size, are rural. The per capita GDP stands at 392 USD in 2010/11, and the share of agriculture to the GDP in the same year accounted 46%, whereas the rest was contributed by the service sector (43.5%) and the industry (10.5%).

Ethiopia has 11% forest cover, which has showed a great leap from widely known figure of 3.65% owing to the accounting of high woodland areas into forest areas during the forest resources assessment (FRA) report preparation in 2010. Forest trees and shrubs are the major suppliers of energy and wood based products of national consumption in Ethiopia. Articles of wood and wooden furniture, bamboo, Khat (leaves of *Catha edulis*), forest coffee, natural gums and resin and charcoal have been some of the export commodities of the country in the last decade.

Ethiopia hosts the Eastern Afromontane and the Horn of Africa hotspots of biodiversity, and owns an estimated 6000 species of higher plants. Woody plants constitute about 1000 species, out of which 300 are trees. Hence, conservation of forest genetic resources is one of the priority areas of biodiversity conservation in Ethiopia. A number of *in situ* and *ex situ* conservation sites, including the forest gene bank in Addis Ababa, have been established targeting conservation and sustainable use of important tree and shrub species such as natural forest coffee populations of Ethiopia. In addition, the development of forest genetic resources conservation strategy and studies conducted on diversity, structure and socioeconomics conditions in Afromontane forests in southwestern, eastern and northern parts of the country were instrumental in identifying the *in situ* conservation sites. Notable examples of *in situ* conservation sites in Ethiopia include nature reserves (Yayu Coffee Forest Biosphere Reserve, Kafa Biosphere Reserve and Sheka Forest Biosphere Reserve), national/regional parks, forest *in situ* stands for various tree species, forest areas managed under participatory forest management, National Forest Priority Areas (NFPA), area exclosures, church forests, sacred forests and community forests. Efforts with implications on forest genetic resources conservation and sustainable utilization in Ethiopia include development of Climate Resilient Green Economy (CRGE) strategy and other development plans such as the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) and Growth and Transformation Plan (GTP), the Conservation Strategy of Ethiopia, the Environmental Policy of Ethiopia, the National Biodiversity Strategy and Action Plan (NBSAP) the Forest Development, Conservation and Utilization Proclamation and the Proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights.

The Institute of Biodiversity Conservation (IBC) is the lead government institution mandated for conservation of plant, animal and microbial genetic resources in Ethiopia. Currently some of the 31 public universities and all the eight federal and regional agricultural research institutes are engaged in forest genetic resources utilization, management and conservation related programs and activities. Furthermore, a number of networks are currently addressing one or more aspects of forest genetic resources conservation and management. In the past ten years, few agreements

have been ratified internationally, and Ethiopia has recently ratified the Nagoya Protocol on Access and Benefit Sharing (ABS).

The major factors influencing the state of forest genetic diversity of native tree species in Ethiopia are deforestation and forest fragmentation, taking over of habitats by invasive species such as *Prosopis juliflora*, expansion of exotic plantations and forest fire. The noticeable conflicts of interest and lack of integration among sectoral activities are severely affecting forest conservation and utilization measures. Other factors with adverse effect on conservation and sustainable management of forest genetic resources include fire hazards, illegal logging and encroachment, pest and disease infestations. Weak institutional capacity and lack of coordination among actors in the forest sector are also hampering effective and long term conservation of forest genetic resources. Failure to take proactive measures for improving the status of forest genetic resources may lead to further deterioration of the resource, which would mean loss of multiple environmental, social and economic benefits and potentials.

The following strategic directions are proposed for overcoming the challenges and addressing the identified issues in conservation and management of forest genetic resources of Ethiopia: (1) Strengthening the tree seed production-supply system for satisfying needs for quality seeds and collection and conservation of germplasm, (2) Creating policy alignment among various sectors and improving the integration of the conservation and sustainable use of forest resources into relevant sectoral or cross-sectoral plans and programs, (3) Improving the effectiveness of regulations that are important for the conservation of forest genetic resources within or outside protected areas, (4) Promoting the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings, (5) Rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species, (6) Ensuring benefit-sharing mechanisms and empowerment of local community to manage and conserve forest genetic resources, (7) Regulating the introduction of, and controlling or eradicating invasive species which threaten ecosystems, habitats or species, (8) Strengthening forestry education and training, (9) Capacitating the responsible institutions for forest genetic resources conservation and management with human, technical, material and financial resources, (10) Promoting new techniques and technologies for forest genetic resources assessment, understanding the state of diversity and multiplication and conservation and (11) Putting in place pragmatic and targeted forest genetic resources information monitoring and evaluation systems

INTRODUCTION TO THE COUNTRY AND FOREST SECTOR

Physiogeographic and climatic features

Ethiopia is located in the tropics in the Horn of Africa between 3º and 15º N, 33º and 48º E,longi[t]ude and covers a land surface area of 1,113,677km^2. The country has great topographical diversity with flat-topped plateaus, high mountains, river valleys, deep gorges, rolling plains, and with great variation of altitude from 116 meters below sea level in some areas of Kobar Sink, to 4620 meters above sea level at Ras Dashen. The Great Rift Valley runs from northeast to southwest of the country and separates the western and south-eastern highlands. The highlands on each side of the rift valley give way to extensive semi-arid lowlands to the east, south and west of the country.

Ethiopia is a tropical country with varied macro and micro-climatic conditions. The influence of high altitudes modifies mean temperatures and leads to a more moderate Mediterranean type climate in the highlands. The country is broadly divided into three major climatic zones: Cool highlands (> 2300 masl.); temperate highlands (1500-2300 masl.) and hot lowlands (<1500 masl.) The rainfall distribution is seasonal and governed by the inter-annual oscillation of the surface position of the Inter-Tropical Convergence Zone (ITCZ) that passes over Ethiopia twice in a year. Mean annual rainfall patterns range from below 200 mm to above 2 800 mm. with the the South western region receiving the heaviest annual rainfall that goes above 2800 mm in some areas. The central and northern central regions receive moderate rainfall that declines towards northeast and eastern Ethiopia. The southeastern and northern regions receive an annual rainfall of about 700 mm and 500 mm, respectively.

Population and socio-economic conditions

Ethiopia's population is estimated at 84.3 million with a density of 114 persons per square kilometer. About 83% of the people dwell in rural areas, and are mainly engaged in agriculture (CSA, 2012). The majority of the rural population in the mid highlands and highlands are small holder farmers and those in the lowlands are pastoralists and agropastoralists. The majority (82.5%) of the farmers, excluding pastoralist inhabited areas, own less than 2 ha of land. The per capita GDP (nominal) has improved from 123 in 2002 to 392 USD in 2011 (CSA, 2012).

Land cover types and forest resources

The major land cover types in Ethiopia are rain fed cultivation, woodlands and scrublands (Figure 1). However, as of the forest resources assessment report preparation in 2010, the high woodlands have been categorized as forests, and hence the forest cover has showed a leap jump from the usually cited 3.65% (WBISPP, 2004) to 11%. Ethiopia currently has 12.3 mill.ha of forests (comprising forests, planted forests, woodland areas) and 44.6 million ha of other wooded grasslands (Table 1). Out of the forests, planted forests constitute over 972 000 ha (Million Bekele, 2011). Besides, there are trees and shrubs on farm lands whose extent is not clearly known. Currently, about 12 major natural vegetation types have been identified in the country (Friis et al., 2010). Out of these, the following six vegetation types are categorized as forest

types: *Acacia-Commiphora* woodland, *Combretum-Terminalia* woodland, Dry Afromontane forest and grassland complex, Moist Afromontane forest, Transitional rain forest and Riverine vegetation.

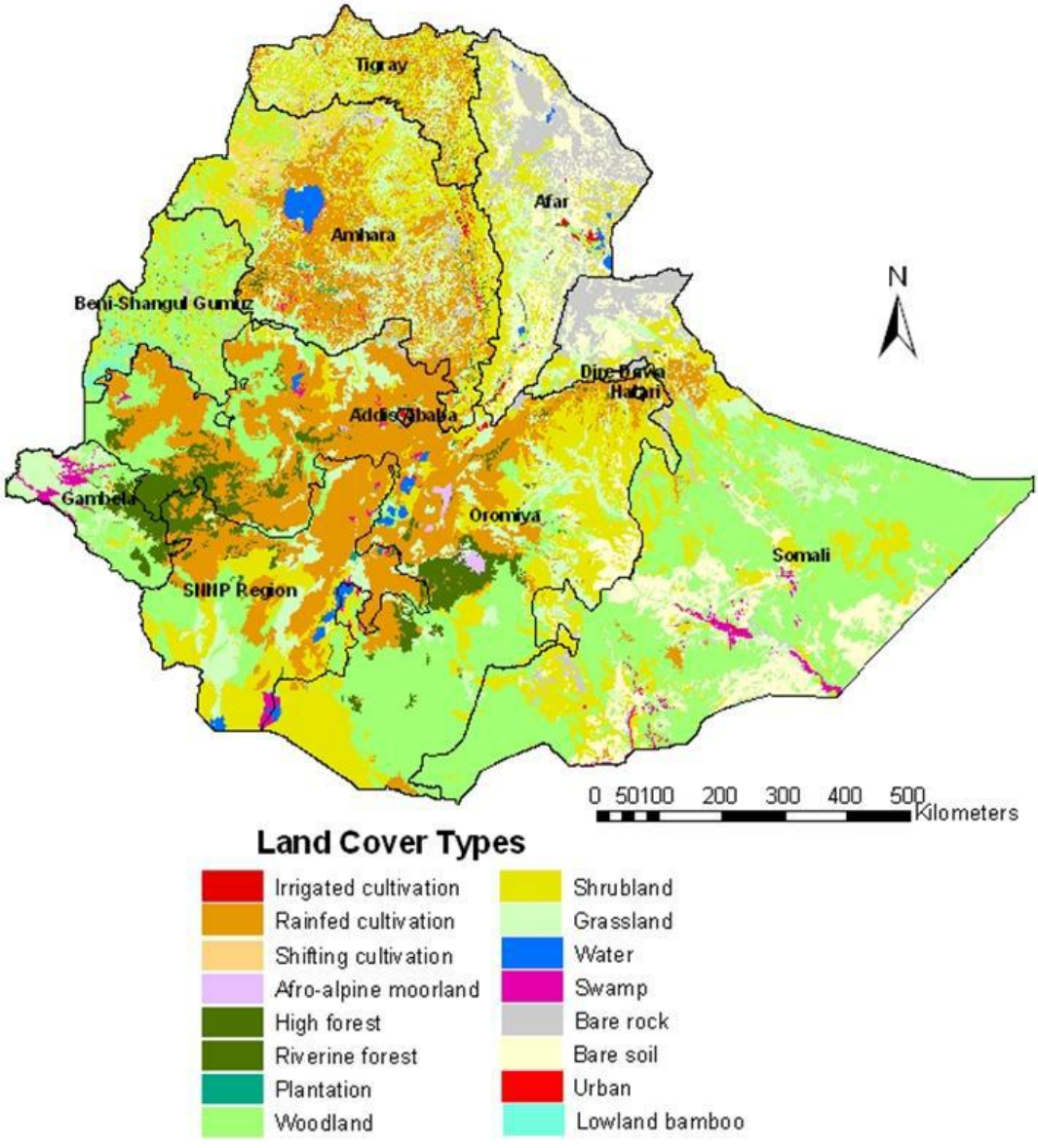

Figure 1. Dominant land cover types in Ethiopia (WBISPP, 2004)

Table 1. Forest characterstics and areas

Main forest characterstics	Area (1000 ha)
Forest	12296
Other wooded land	44650
Other land	52685
Portion of othr land with tree cover	NA

Source: (FRA, 2010).

Status of the forestry sector

The forest resources in Ethiopia are depleting due to deforestation and forest degradation. The bulk of the tree plantings are not successful either due to technical and other constraints. The mean contribution of the forestry sector to the national GDP over the last ten years (2002-2011) was 4.5%. Its contribution to the GDP has been steadily declining from 6.3% in 2002 to 3% in 2011 (CSA, 2012). The contribution of the forest sector is undervalued due to the fact that its other indirect contributions such as wild coffee and medicinal plants might have not been accounted properly. Forests in Ethiopia are private and state owned; the latter being dominant. Private forests can be developed by private individuals, associations, GOs, NGOs and business organizations etc. Private forests need to have clear management plans, but most of the farmer owned woodlots are managed by a traditional way. Almost all natural forests and majority of planted forests belong to the government. However, the extent of privately owned plantations is not precisely known (Table 2). Currently, some of the state owned forests are entering into a Participatory Forest Management (PFM) system. In addition, the forest management in pastoral and agropastoral areas includes traditional community management without the involvement of the government.

Table 2. Forest ownership

Forest ownership	Area (1000 ha)
State	12296
Private	ND*
Total	12296#

**Data not available on extent of private forests; #almost all reported forest cover considered as state owned*

Source: State of World Forests (FAO, 2011)

CHAPTER 1: THE CURRENT STATE OF THE FOREST GENETIC RESOURCES DIVERSITY

1.1 Introduction

Ethiopia is one of the top 25 biodiversity-rich countries in the world (WCMC, 1994), and hosts two of the world's 34 biodiversity hotspots, namely the Eastern Afromontane and the Horn of Africa hotspots. It is also among the countries in the Horn of Africa regarded as major centre of diversity and endemism for several plant species. The Ethiopian flora is estimated to about 6000 species of higher plants of which 10% are considered to be endemic (Hedberg *et al.*, 2009). Woody plants constitute about 1000 species out of which 300 are trees.

Forests form the major constituents of vegetation resources and thus conservation of forest genetic resources (FGRs) is among the priority areas of biodiversity conservation in Ethiopia. Efforts have been made to conserve and sustainably utilize FGRs in the country. Notable examples of such efforts are floristic, structure and socio-economic studies of woody plant species in Afromontane forests of the country; FGR conservation strategies and establishment of *in situ* and *ex situ* conservation sites. The objective of the studies was to develop a list of priority

tree and shrub species for conservation purposes. The outputs of the study gave way to the development of FGR conservation strategy of Ethiopia that gradually entered into implementation through the establishment of *in situ* and *ex situ* conservation sites. This chapter gives the current state of FGRs in terms of their status, future needs and priorities.

1.2 Types of forest genetic resources

The forest types in Ethiopia are classified as natural high forests, woodlands and planted forests (Table 3). Apart from the natural forests and the planted forests of the country, the forest genetic resources also include trees outside natural forests, which are mainly found in traditional agroforestry systems. The natural forests and woodlands include: i) *Acacia-Commiphora* woodlands, ii) *Combretum-Terminalia* woodlands, iii) Dry Afromontane forests, iv) Moist Afromontane forest v) Transitional forest and vi) Riverine forest. Species richness varied across forests depending on environmental factors characterizing the forests. Similarly, woodlands and shrub lands of Ethiopia comprise different vegetation types with diverse tree and shrub species.

Table 3. Major forest and characterstic species

No.	Major forest types	Area	Main charactestic species	Geographical distribution in Ethiopia
1	Moist Afromontane forests	*No Data*	*Podocarpus falcatus, Albizia schimperiana, A. gummifera, Apodytes dimidiata, Celtis africana*	Southwest parts of northwestern and southeastern highlands
2	Dry Afromontane forests	*No Data*	*Juniperus procera, Olea europaea, Acacia abyssinica, A. negrii, Podocarpus falcatus*	Northern, central, southern and southeastern
3	*Acacia-Commiphora* woodland forests	*No Data*	*Acacia tortlis, A.mellifera, Commiphora africana, C. myrrha, Boswellia microphylla, B. neglecta*	Southern and central rift valley low lying areas
4	*Combretum-Terminalia* woodland forests	*No Data*	*Boswellia papyrifera, Terminalia schimperiana, Oxytenanthera abyssinica, Anogeissus leiocarpa, C. collinum*	Northwestern, western and southwestern
5	Transitional forests	*No Data*	*Milicia excelsa, Celtis integrifolia, C. gomphophylla, C. philippensis, Baphia abyssinica, Diospyros abyssinica*	Southwestern
6	Riverine forests	*No Data*	*Ficus sycomorus, Acacia polycantha, Celtis africana, Mimosops kummel*	Across all Ethiopia
7	Planted forests	972 000	*Eucalyptus globuls, E. camldulensis, Cupressus lusitanica, Juniperus procera, Grevillea robusta*	Across all Ethiopia

A number of forest tree and shrub species are listed as priority species in Table 4 for their economic, social, and invasiveness (priority for removal). Based on socio-economic values and the degree of threat as criteria, a priority setting of woody species was carried out in moist Afromontane forests of southwest Ethiopia and 136 species were identified as priority species for conservation (Appendix 1). A species priority setting exercise carried out in eastern Africa also shows that species like *Adansonia digitata, Cordeauxia edulis, Vitellaria paradoxa, Balanites aegyptiaca, Sclerocarya birrea, Tamarindus indica* and *Ziziphus mauritiana* are the top priority

fruit trees in Ethiopia. A number of tree species and their uses and ecological benefits are listed in Tables 5 and 6. Furthermore, a total of 103 tree and shrub species are considered as endangered species in the IUCN red list (Appendix 2). Other threatened species and the level of threats are presented in Table 7.

Table 4. List of priority forest tree and shrub species

No.	Scientific name	Tree (T) or shrub (S)	Native (N) or Exotic (E)	Reasons for priority
1	*Acacia albida*	T	N	Agroforestry tree species
2	*Acacia drepanolobium*	T	N	Invasive
3	*Acacia senegal*	T	N	Economic, gum and resin production
4	*Adansonia digitata*	T	N	Economic, high value fruit tree in the lowlands
5	*Arundinaria alpina*	S	N	Economic value, multipurpose
6	*Boswellia paprifera*	T	N	Economic, gum and resin production
7	*Catha edulis*	S	N	Economic and social, stimulant and medicinal, agroforestry, export commodity
8	*Coffea arabica*	S	N	Economical and social, stimulant and medicinal
9	*Commiphora myrrha*	T	N	Economic, gum and resin production
10	*Cordeauxia edulis*	S	N	Economic, high value fruit tree in the lowlands
11	*Cordia africana*	T	N	Economic, timber and agroforestry species; threatened
12	*Cupressus lusitanica*	T	E	Economic, timber
13	*Eucalyptus camaldulensis*	T	E	Economic, construction and fuelwood
14	*Eucalyptus globulus*	T	E	Economic, construction and fuelwood
15	*Grevillea robusta*	T	E	Economic, multipurpose
16	*Hagenia abyssinica*	T	N	Economic, timber, medicinal and agroforestry species; threatened
17	*Juniperus procera*	T	N	Economic, timber; threatened
18	*Moringa stenopetala*	T	N	Economic, multipurpose
19	*Oxytenanthera abyssinica*	T	N	Economic, multipurpose
20	*Podocarpus falcatus*	T	N	Economic, timber; threatened
21	*Pouteria adolfi-friederici*	T	N	Economic, timber
22	*Prosopis juliflora*	T	E	Invasive Alien Species
23	*Prunus africana*	T	N	Economic, timber and medicinal;threatened
24	*Rhamnus prinoides*	T	N	Economic, beverage
25	*Tamarindus indica*	T	N	Economic, high value fruit tree in the lowlands
26	*Vitellaria paradoxa*	T	N	Economic, high value fruit tree in the lowlands
27	*Ziziphus mauritiana*	T	N	Economic, high value fruit tree

Table 5. The main forest tree and shrub species currently used in Ethiopia

No.	Scientific name	Native (N) or Exotic (E)	Current uses	Type of management system	Area managed (ha)	Remark on NWFPs and other uses
1	*Acacia albida*	N	3, 4, 5	Agroforestry	ND	fodder
2	*Acacia abyssinica*	N	3, 4, 5	Agroforestry	ND	fodder
3	*Acacia decurrens*	E	3, 5	Agroforestry	ND	
4	*Acacia nilotica*	N	3, 4	Natural forest	ND	fodder
5	*Acacia saligna*	E	3, 4, 5	Agroforestry, plantation	ND	fodder
6	*Acacia senegal*	N	3,4	Natural forest	ND	Gum
7	*Acacia tortilis*	N	3, 4, 5		ND	fodder
8	*Adansonia digitata*	N	4	Natural forest	ND	food
9	*Albizia gummifera*	N	1,3,4,5	Agroforestry	ND	Coffee shade, bee forage
10	*Albizia schimperiana*	N	1,3,4,5	Agroforestry	ND	Coffee shade, bee forage
11	*Arundinaria alpina*	N	1,3, 4	Natural forest	ND	food, fodder
12	*Azadirachta indica*	E	1,3, 4, 5	Agroforestry	ND	medicinal
13	*Boswellia microphylla*	N	4	Natural forest	ND	frankincense
14	*Boswellia neglecta*	N	4	Natural forest	ND	frankincense
15	*Boswellia ogadensis*	N	4	Natural forest	ND	frankincense
16	*Boswellia paprifera*	N	4	Natural forest	ND	frankincense
17	*Boswellia rivae*	N	4	Natural forest	ND	frankincense
18	*Carica papaya*	E	4, 5	Agroforestry	ND	food
19	*Catha edulis*	N	6	Agroforestry	ND	stimulant
20	*Citrus sinensis*	E	4,5	Agroforestry	ND	food
21	*Coffea arabica*	N	6	Natural forest, plantation	ND	stimulant
22	*Commiphora africana*	N	4	Natural forest	ND	Gum
23	*Commiphora guidotti*	N	1, 4	Natural forest	ND	Gum
24	*Commiphora myrrha*	N	4	Natural forest	ND	myrrh
25	*Cordeauxia edulis*	N	4	Natural forest	ND	food
26	*Cordia africana*	N	1,4, 5	Natural forest, agroforestry	ND	Food, fodder
27	*Croton macrostachyus*	N	1,4,5	Agroforestry	ND	medicinal, bee forage
28	*Cupressus lusitanica*	E	1	Plantation	ND	
29	*Erythrina brucei*	N	4,5	Agroforestry	ND	
30	*Eucalyptus camaldulensis*	E	1, 3	Plantation	ND	
31	*Eucalyptus globulus*	E	1, 3,	Plantation	ND	

32	*Grevillea robusta*	E	1, 3, 5	Plantation, agroforestry	ND	
33	*Hagenia abyssinica*	N	1, 4, 5	Natural forest, plantation	ND	medicine
34	*Juniperus procera*	N	1	Natural forest, plantation	ND	
35	*Leucaena leucocephala*	E	4, 5	Agroforestry	ND	fodder
36	*Malus domestica*	E	4,5	Agroforestry	ND	food
37	*Mangifera indica*	E		Agroforestry	ND	
38	*Millettia feruginea*	N		Agroforestry	ND	Coffee shade
39	*Moringa stenopetala*	N	4, 5	Agroforestry	ND	food, medicine
40	*Olea europaea ssp cuspidata*	N	1, 3, 4	Natural forest, agroforestry	ND	seasoning, medicine
41	*Oxytenanthera abyssinica*	N	1, 3, 4	Natural forest	ND	food
42	*Persia americana*	E	4,5	Agroforestry	ND	food
43	*Pinus patula*	E	1	Plantation	ND	
44	*Podocarpus falcatus*	N	1	Natural forest	ND	
45	*Pouteria adolfi-friederici*	N	1	Natural forest	ND	
46	*Prunus africana*	N	1, 3, 4	Natural forest	ND	medicine
47	*Rhamnus prinoides*	N	4	Agroforestry	ND	beverage
48	*Schefflera abyssinica*	N	4,5	Natural forest, agroforestry	ND	honeybee forage
49	*Sesbania aculeata*	E	4,5	Agroforestry	ND	fodder
50	*Tamarindus indica*	N	4, 5	Natural forest, plantation	ND	food
51	*Vitellaria paradoxa*	N	4	Natural forest	ND	food
52	*Ziziphus mauritiana*	N	4	Natural forest	ND	food

Current use:

1 Solid wood products
2 Pulp and paper
3 Energy (fuel)
4 Non wood forest products (food, fodder, medicine, etc.)
5 Used in agroforestry systems
6 Other uses (stimulant)

Table 6. Forest species providing environmental services or social values

No.	Scientific name	Native (N) or Exotic (E)	Environmental service or social value
1	*Acacia abyssinica*	N	1,5
2	*Acacia albida*	N	1,2,3
3	*Acacia decurrens*	E	1
4	*Acacia saligna*	E	1,7
5	*Acacia senegal*	N	1 , 3
6	*Acacia seyal*	N	1,7
7	*Acacia tortilis*	N	1,7
8	*Cajanus cajan*	E	1
9	*Celtis africana*	N	7
10	*Coffea arabica*	N	1, 4
11	*Cordeauxia edulis*	N	1
12	*Cordia africana*	N	1, 2,3,4, 5,7
13	*Croton macrostachyus*	N	1
14	*Ekebergia capensis*	N	1,7
15	*Erythrina abyssinica*	N	1
16	*Erythrina brucei*	N	1
17	*Ficus carica*	N	3
18	*Ficus sur*	N	3
19	*Ficus sycomorus*	N	1
20	*Grevillea robusta*	E	1
21	*Hagenia abyssinica*	N	1,5
22	*Juniperus procera*	N	3, 5
23	*Leucaena leucocephala*	E	1
24	*Moringa stenopetala*	N	1
25	*Piliostigma thonningii*	N	1
26	*Podocarpus falcatus*	N	3, 4, 5,7
27	*Pouteria adolfi-friederici*	N	1
28	*Prunus africana*	N	1,7
29	*Sesbania sesban*	E	1,7
30	*Tamarindus indica*	N	1, 2,3,7
31	*Terminalia brownii*	N	7
32	*Vitellaria paradoxa*	N	1,7
33	*Warburgia ugandensis*	N	7
34	*Zizyphus mauritiana*	N	1

Services and values include:

1. Soil and water conservation including watershed management
2. Soil fertility
3. Biodiversity conservation
4. Cultural values
5. Aesthetic values
6. Religious values
7. Shade

Table 7. List of trees and other woody forest species considered to be threatened in Ethiopia

No.	Species	Distribution in the country: widespread (W), Rare (R) or Local (L)	Type of threat (code)	Threat categories
1	*Acacia pseudonigrescens*	R		Low
2	*Acacia venosa*	R	1	Medium
3	*Albizia malacophylla*	R	1, 5	Medium
4	*Arundinaria alpina*	W	5	Medium
5	*Baphia abyssinica*	R	1, 5	
6	*Boswellia papyrifera*	R	1,5	High
7	*Combretum hartnannianum*	R	1,5	
8	*Combretum rochetanum*	R	1, 5	
9	*Cordeauxia edulis*	R	1,13	
10	*Cordia africana*	W	1, 2, 3, 5	High
11	*Dicraeopetalum stipulare*	L	2	High
12	*Dracaena ombet*	R	1	High
13	*Hagenia abyssinica*	W	1, 3,5,7	High
14	*Juniperus procera*	W	1, 3,5	High
15	*Maytenus arbutifolia*	W	1	Medium
16	*Okotea kynensis*	R	1, 3	Medium
17	*Oxytenanthera abyssinica*	W	5, 12	Medium
18	*Podocarpus falcatus*	W	1, 3,	High
19	*Pouteria adolfi-friederici*	R	1, 3, 5	High
20	*Prunus africana*	W	1, 3	High
21	*Teclea borenensis*	W	1	High
22	*Vitellaria paradoxa*	L	1,5	High

Type of threat:

1 Forest cover reduction and degradation

2 Forest ecosystem diversity reduction and degradation

3 Unsustainable logging

5 Competition for land use

7 Habitat fragmentation

12 Forest fires

13 Drought and desertification

The mean seed distribution by the sole supplier of tested tree seeds, the FRC, in the last five years (2006/07-2010/11and the resulting amount of seedling calculated taking into account number of seeds/kg, purity percentage, germination percentage is given in Table 8. It is assumed that the 7.2 tones seed distributed annually has a capacity of giving a total of 878.7 million seedlings, however, it is estimated that only 571.2 million seedlings could be planted taking a nursery recovery factor of 0.65 arbitrarily. There are also some private vendors, who are involved in tree seed distribution. , and further farmers and GOs are involved in local collection, and hence the amount of seedling produced can be much higher than the figures provided in Table 8.

Table 8. Annual quantities of seeds of woody species produced and number of seedlings planted in Ethiopia

No.	Species	Native (N) or Exotic (E)	Mean quantity Of seeds used (kg)	Quantity of seeds from documented sources	Potential number of seedlings to be produced
1	*Acacia abyssinica*	N	294.5	√	3186834
2	*Acacia albida*	N	232.8	√	2148579
3	*Acacia decurrens*	E	258.2	√	15736872
4	*Acacia melanoxylon*	E	84.0	√	6724278
5	*Acacia nilotica*	N	18.7	√	99707
6	*Acacia polycantha*	N	40.7	√	146710
7	*Acacia saligna*	E	447.5	√	21986737
8	*Acacia senegal*	N	137.9	√	1266270
9	*Acacia seyal*	N	4.5	√	1442806
10	*Acacia tortilis*	N	33.5	√	437011
11	*Albizia grandibracteata*	N	15.3	√	73043
12	*Albizia gummifera*	N	27.0	√	159330
13	*Albizia lebbeck*	E	62.0	√	303659
14	*Albizia schimperiana*	N	66.0	√	384714
15	*Azadirachta indica*	E	12.5	√	28512
16	*Calliandra calothyrsus*	E	1.0	√	112
17	*Callistemon citrinus*	E	5.2	√	3516191
18	*Casuarina cunninghamiana*	E	1.2	√	372947
19	*Casuarina equisetifolia*	E	226.4	√	120976035
20	*Chamaecytisus palmensis*	E	78.2	√	2178995
21	*Cordia africana*	N	793.6	√	2760830
22	*Croton macrostachyus*	N	1.9	√	3320
23	*Cupressus lusitanica*	E	411.4	√	43988449
24	*Cupressus pyramidalis*	E	2.3	√	68548
25	*Delonix regia*	E	69.7	√	91066
26	*Dodonaea angustifolia*	N	1.4	√	27980
27	*Dovyalis abyssinica*	N	12.3	√	306828
28	*Dovyalis caffra*	E	141.6	√	3143528
29	*Ekebergia capensis*	N	21.2	√	22014
30	*Entada abyssinca*	N	33.4	√	90984
31	*Erythrina brucei*	N	0.4	√	940
32	*Eucalyptus camaldulensis*	E	515.3	√	450270952
33	*Eucalyptus citriodora*	E	149.3	√	20790393
34	*Eucalyptus globulus*	E	179.7	√	50607540

35	*Eucalyptus grandis*	E	11.5	√	15148622
36	*Eucalyptus saligna*	E	83.1	√	43572735
37	*Eucalyptus viminalis*	E	24.9	√	8161041
38	*Grevillea robusta*	E	5.0	√	329598
39	*Hagenia abyssinica*	N	61.2	√	9004788
40	*Jacaranda mimosifolia*	E	37.9	√	3472549
41	*Jatropha curcas*	E	0.3	√	169
42	*Juniperus procera*	N	89.8	√	1789985
43	*Leucaena leucocephala*	E	523.9	√	8909564
44	*Mearua aethiopica*	N	0.9	√	9767
45	*Melia azadarach*	E	553.9	√	713305
46	*Millettia ferruginea*	N	262.9	√	427072
47	*Moringa stenopetala*	N	151.3	√	227361
48	*Olea europaea var. africana*	N	80.2	√	355434
49	*Parkinsonia aculeata*	E	27.1	√	258773
50	*Phoenix reclinata*	N	10.1	√	22459
51	*Pinus patula*	E	7.8	√	286184
52	*Podocarpus falcatus*	N	196.8	√	174257
53	*Prunus africana*	N	39.7	√	69533
54	*Pterolobium stellatum*	N	2.3	√	1695
55	*Schinus molle*	E	213.1	√	5054218
56	*Sesbania aculeata*	E	383.0	√	22731571
57	*Spathodea nilotica*	E	36.8	√	4621920
58	*Tamarindus indica*	N	60.7	√	53523
	SUM		7244.8		878738837

1.3 Diversity within and between forest tree species

Molecular characterization studies have been made for very few tree species in Ethiopia (see section 4.5). The studies reported high level of genetic diversity for the species investigated: *Coffea arabica, Hagenia abyssinica, Cordia africana* and *Juniperus procera*. On the other hand, several studies have been made on morphological characterization of tree species including provenance and progeny evaluation trials. Forestry Research Center (FRC) and other federal and regional agricultural research centers have made efforts in provenance studies in order to explore genetic variation for conservation and tree improvement (Table 9).

Table 9. List of forest species for which genetic variability has been evaluated

No.	Species	Native (N) or Exotic (E)	Morphological traits	Adaptive & production characters assessed	Molecular characterization
1	*Accacia senegal*	N		√	
2	*Coffea arabica*	N			√
3	*Cordia africana*	N	√		√
4	*Eucalyptus camaldulensis*	E		√	
5	*Eucalyptus globulus*	E		√	
6	*Eucalyptus grandis*	E		√	
7	*Eucalyptus saligna*	E		√	
8	*Hagenia abyssinica*	N	√		√
9	*Jatropha curcas*	E		√	
10	*Juniperus procera*	N	√	√	√

1.4 The role of forest genetic resources

Forest resources of Ethiopia serve for economic, ecological and social purposes. Their biodiversity plays a vital and diverse role to ensure food security, and sustainable livelihoods for millions of households throughout Ethiopia. Ecosystem services provided by the forest biodiversity include provisioning, regulating, supporting and cultural services.

1.5 Factors influencing the state of forest genetic diversity

Few studies have been conducted on genetic diversity of forest tree species in Ethiopia. Genetic diversity of a tree species can be influenced by several factors including breeding system, seed dispersal mechanism, successional status and geographic range. Accordingly, the most important threats to genetic diversity comes from deforestation and forest fragmentation, which can result in total loss of genetic information and disturbance in the genetic structure, respectively. However, several studies on tropical and Neotropical forest tree species including the above ones did not report significant losses in genetic diversity due to deforestation and forest fragmentation. Ecological heterogeneity should result in high level of population differentiation, hence the formation of populations with distinct genetic structures/high genetic distance. However, this force is counteracted by gene flow (through seed dispersal and pollination) that minimizes population differentiation. The factors influencing the state of forest genetic diversity in Ethiopia are the following: deforestation and forest fragmentation, exotic and invasive species and forest fire

1.6 The state of current and emerging technologies

The national capacity in characterizing forest tree species employing molecular markers is not yet built. Some of the existing molecular laboratories in Ethiopia are currently dealing with crop species. To date, some molecular characterization works have been conducted employing Inter-Simple Sequence Repeat on *Coffea arabica* and *Hagenia abyssinica*, Amplified Fragment Length Polymorphisms on *Juniperus procera* and Chloroplast microsatellites on *H. abyssinica* and *Cordia africana*. However, these studies were carried out abroad.

1.7 Future needs and priorities

The following intervention areas are important to improve the management and conservation of FGRs on sustainable manner.The needs and priorities also apply for the other sections. These include:

- Establishing and strengthening a system for the provision of indigenous and exotic tree species and seed inputs that are suitable for the different agro-ecological zones.
- Integrating the conservation and sustainable use of forest resources into relevant sectoral or cross-sectoral plans, programmes and policies.
- Regulating or managing forest genetic resources important for the conservation of biological diversity within or outside protected areas.
- Promoting the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings.
- Promoting environmentally sound and sustainable development in areas adjacent to protected areas and high forest areas
- Rehabilitating and restoring degraded ecosystems and promoting the recovery of threatened species
- Demarcation and development of management plans for protected areas
- Ensure the gazettement of all protected areas
- Ensure benefit-sharing mechanisms and empowerment of local community to manage and conserve forest genetic resources
- Regulating the introduction of, and controlling or eradicating those alien species which threaten ecosystems, habitats or species
- Enhancing capacity building and training in areas of FGRs.
- Promoting tissue culture for mass propagation
- Strengthening collection and conservation of germplasm
- Enhancing forestry extension and conservation education
- Establishing pest, diseases and forest fire management mechanisms
- Establishment of stable and workable organizational forestry structures
- Effective implementation of policies and laws
- Awareness raising on FGRs
- Data base establishment
- Research activities in relation to biology, ecology, storage behavior and characteristics of tree/shrub species
- Developing methods for monitoring and evaluating conservation activities

CHAPTER 2: THE STATE OF IN SITU GENETIC CONSERVATION

2.1 Introduction

The *in situ* conservation of the forest genetic resources of the country is improving through the development of Protected Areas, National Forest Priority Areas (NFPA), and other *in situ* conservation sites like area exclosures, church forests, sacred forests and community forests. The country has developed the strategy for the conservation of its forest genetic resources. The strategy has incorporated the prioritization of the broad vegetation types for conservation. Based on the level of threats and socio-economic importance, 5 priority vegetation classes were

identified. Subsequent forest inventory and socio-economic survey have been conducted to identify priority species in the most threatened vegetation types; upon which *in situ* conservation sites have been selected and established.

2.2 Forest genetic resources inventories and surveys

An integrated forest inventory and socio-economic survey have been carried out in different vegetation types of the country: the Moist and Dry Afromontane, Transitional Forest, *Acacia-Commiphora* and *Combretum-Terminalia* Woodlands, Afroalpine and Subafroalpine areas to identify the priority tree/shrub species for conservation. About sixty five forests and woodlands (including church forests) have been surveyed (Appendix 3).

2.3 Conservation of FGRs within and outside protected areas

All protected areas which were primarily designed for the protection of wildlife resources exclusively and the National Forest Priority Areas (NFPAs) of the country are hosting various forest plant species that are economically, ecologically and socio-culturally important. At present, these protected areas are considered as *in situ* conservation sites. In addition, there are several areas of exclosures, community forest, church and sacred forests that are considered as *in situ* conservation sites outside PAs.

Conservation of forest genetic resources within protected areas

The total protected areas cover about 14% of the area of the country, which is above the global average for protected area coverage. The Ethiopian Protected Area System includes National Parks, Wildlife Reserves, Controlled Hunting Areas and Sanctuaries, which were primarily designed for the protection of wildlife resources exclusively. To date, there are 20 national/regional parks, four sanctuaries, 7 wildlife reserves and 26 controlled hunting areas (Appendix 4).

The country has classified 58 of the most important high forest areas National Forest Priority Areas (NFPAs). Among the 58 NFPAs, 37 have been identified as protected forests. The establishment objective of the NFPAs was production, protection and conservation. However, because of the increasing human and livestock pressure on the resource base and lack of sustainable management, at present the status of protected areas including the NFPAs is deteriorating. In response, the forests in Yayu, Kafa and Sheka were designated as Biosphere reserves by UNESCO.

Conservation of FGRs outside protected areas

In situ conservation sites have been established in various parts of the country. Most of the sites were intended for the conservation of threatened and socio-economically and ecologically important woody species within the broad vegetation types of the country. In addition, there are several area exclosures, community, church and sacred forests that are considered as *in situ* conservation sites outside PAs.

In situ conservation sites

Six *in situ* conservation areas have been established in different parts of the country. The specific *in situ* conservation sites were established in Benishangul Gumuz, in SNNP and Oromia Regions

(Table 10). The *in situ* sites are shrinking from time to time in extent and degrading in species diversity and frequency. Urgent measures are needed for sustainable management of the *in situ* conservation sites.

Table 10. Target forest species included within *in situ* conservation programmes/units

No.	***Species***	**Purpose for establishing conservation unit**	**Number of populations or stands conserved**	**Total area (ha)**	**Locations**
1	*Coffee arabica*	Gene conservation	6	ND	Boginda, Bonga, Geba-Dogi-Yayu, Kontir-Birhan
2	*Arundinaria alpina*	Gene conservation	1	65	Masha
3	*Ficus ovata*	Gene conservation	1	85	Bishan-Gari
4	*Hagenia abyssinica*	Gene conservation	1	110	Bonga
5	*Oxytenanthera abyssinica*	Gene conservation	1	15	Mandura
6	*Podocarphus falcatus*	Gene conservation	2	125	Bishan-Gari and Sigmo-Setema
7	*Poutria adolfi-friedericii*	Gene conservation	1	120	Tiro-Boter-Becho

Community Forests

Although current data is not available, it is believed that substantial forest and woodland resources are being managed effectively by local communities, which exercise diverse traditional management and conservation practices either communally or privately. The local communities in different parts of the country have developed diverse indigenous knowledge and well-organized indigenous institutions to manage and conserve their forest resources.

Area exclosures

In several degraded lands across the country, area exclosure have been launched. In the Tigray Region alone about one million hectares of land has been closed so far and effective results have been achieved through the restoration and rehabilitation of the vegetation. Likewise, in the Oromia Region, 916,766 ha of land have been set aside for area exclosure. In addition, extensive areas have been closed from livestock and human encroachment in the Amhara and SNNP Regions and significant results have been achieved through the restoration/rehabilitation of the natural vegetation and the fauna resources. The establishment and development of the area exclosures and the restoration activities have helped the conservation of some indigenous woody species and their habitats.

Church and sacred forests

Significant forest patches are conserved and managed in and around churches, monasteries, graveyards, mosque compounds and other sacred sites in several parts of Ethiopia. For instance, it was reported that 28 Orthodox churches in northern Ethiopia cover a total of 500.8 hectares of remnant forests. There are 35,000 similar churches throughout Ethiopia that are likely to contribute to the conservation of considerable remnant dry forests. Similarly, sacred forests are found mainly in south west Ethiopia in Kefa, Masha and Sheka forests.

2.4 Sustainable management of FGRs within and outside protected areas

The conservation and sustainable management of the FGRs of the country, contribute to the socio-economic development, ecosystem maintenance, species recovery, climate stability, and other social and cultural services through their physical and environmental goods and services. The forest management systems of the country include: State management (the Federal and Regional States), PFM through the participation of communities, governmental and non-governmental organizations, Community based forest management and Private forest management. However, sustainable management of FGRs is undertaken through participatory approach and community based traditional management systems.

Forest genetic resources management within PAs

Participatory Forest Management

At present, over 640,857 ha of forest land in the country is being managed under PFM. These pilot PFM projects have attempted to promote among others: sustainable utilization of the forest resources for livelihood diversification such as: NWFP like forest coffee, honey, spices and others, employment opportunity and income generation through the establishment and promotion of Bamboo product based micro enterprises. It is worth enough to assess, monitor and evaluate the existing progress and success achieved through the practice of PFM in different pilot project areas in order to contribute to and sustain the conservation and management of the FGRs of the country.

Forest genetic resources management outside PAs

Traditional Community-based Forest Management

Traditional Community Based Forest Management (TCBFM) systems involve communal efforts such as forests and woodlands managed by the Borana people with the Geda institution and the management of Afromontane forests in the southwest for non-timber forest product extraction by the Kobo system. Other forest areas that are smaller in extent are privately managed through various forms of traditional forest management such as Gedeo and Sidama agroforestry system. The Kobo system is a forest (tree) tenure institution that grants first claimers an exclusive use right to a block of forest, usually for collection of forest coffee, hanging beehives and the use of other NWFPs. Once claimed, the forest block is de facto individual property, respected by fellow citizens of the area, and the owner has the right to exclude others. This way, the system has resolved what could have been an open access system. The Borana Gada system imbeds different hierarchical rangeland management institutions within it. The most important part of the rangeland management institution is the regulation of animal movement according to the range plant availability, condition and seasonal carrying capacity of the Borana range lands to avoid degradation. It is through this system that the traditional institution has managed and conserved the rangeland and its resources for generations.

Home gardens

Home gardens are among the traditional agroforestry systems practiced in Ethiopia. They are habitats for different indigenous and exotic tree/shrub species, where the upper storey is dominated by multipurpose tree/shrub species and the under storey is dominated by enset, coffee, fruit trees, medicinal plants and other food and cash crops. To date, there is no comprehensive information on the extent of home gardens in Ethiopia. However, reports indicate that about 576,000 ha of land in the dry areas of South and Southwest Ethiopia are managed as home

gardens and other forms of traditional agroforestry systems. On the other hand, studies are being undertaken on species diversity and richness in home gardens found in different parts of the country. A considerable number of species are managed in most of the home gardens. For example, a case study in southern Ethiopia showed that 78 cultivated and 120 tree and shrub species are found home gardens with 83 %indigenous species. Similarly, 133 plant species were ported from selected home gardens in Gamu Gofa zone of southern Ethiopia.

2.5 Criteria for *in situ* genetic conservation site identification

According to the Forest Genetic Resources Conservation Strategy of Ethiopia, the general criteria for establishment of *in situ* conservation sites are:

- Availability of viable number of genotypes of the target species
- Number of priority species existing in the forest
- The presence of unique/endangered/endemic species within the population
- Accessibility of the forest
- Degree of disturbance (threat) of the forest
- Species richness of a given site/population
- Attitude of the rural community/local people towards conservation

2.6 Use and Transfer of Germplasm

Forest germplasm has considerable benefits to many small-scale farmers and other private seedling growers and forest owners. Small-holder farmers collect and plant seedlings or sow seeds of various trees for their own use or for sale. In central and south western part of the country, farmers grow germplasms of agroforestry trees in rows, in patches as woodlots, or scattered on farmlands, farm boundaries, and pasture lands. The most common tree/shrub species include *Acacia albida, Arundinaria alpina, Acacia abyssinica, Acacia tortillis, Croton macrostachys, Albizia gumifera* and *Cordia africana*.

Local communities especially the youth are being benefited from production and sale of seedlings of certain forest species. In different regions of the country, many small holder farmers, youth, women and other private seed dealers/nursery operators are engaged forest germplasms business. In Ethiopia, forest seeds/germplasms movement involves a range of stakeholders from governmental, non-governmental organizations, local people, private seed dealers, and nursery operators. There is no restriction regarding the movement of germplasms within the country. The sources of the germplasms/seeds supply are farmers, private seed dealers, and FRC. The seeds often obtained from the informal seed sources are of low quality and quantity. FRC is the only supplier of tested forest tree seeds in the country. It collects the forest germplasms from identified and established stands. The center sells the forest germplasms collected from the stands to governmental organizations mainly bureaus of agriculture, NGOs and private seed growers. FRC collects the germplasms of native species listed in Appendix 5.

2.7 Challenges and opportunities

The forest conservation and utilization measures specified in the various policies and laws are not integrated on the ground with other sectoral activities that have an impact on forest resources, such as, agriculture, investment and trade. Shrinking trends of forest resource base and land demand the urgent needs for conservation and sustainable use of these resources. High

and rapid population growth beyond the carrying capacity of the national economy is continually adding pressure to an already declining forest resource base. Declining standard of livelihood or poverty of the farming communities and their close dependence on forests have led to clearing/burning of the forest resources for subsistent farming, cutting of trees/shrubs for fuel wood and charcoal production (both for consumption and sale). Similarly, increasing demand and rise in market value of forest products such as office and household furniture resulted in selective harvesting pressure on some forest trees particularly indigenous species such as *Cordia africana* and *Hagenia abyssinica*.

Institutional instability and weak collaboration among different stakeholders and institutions working on forestry sector is also considered as bottleneck for effective conservation of forest resources. Another challenge facing forest conservation in Ethiopia is increased demand for arable land followed by inadequately studied settlement programs. According to information from regional sources, the criteria for selection of settlement areas are appropriateness for agriculture, availability of pasture and water. The impact on the forest biodiversity is not considered during settlement sites selection. Lack of management plans and insufficiently marked or demarcated forest boundaries have all encouraged encroachment into protected forests. There is generally lack of awareness on policies and legislations related to forestry among stakeholders including law enforcement bodies. Climate change related recurrent drought has also impacted natural regeneration of forest. Lack of benefit sharing arrangements for communities surrounding forest is another source of conflict over the forest resources.

Despite the challenges, there are ample opportunities for *in situ* conservation of forest genetic resources in Ethiopia. These opportunities are: the development and promotion of CRGE; watershed protection; extensive area for forest development (identified and demarcated); increasing demand for organic forest products; involvement of NGOs and donor support for *in situ* conservation of biodiversity; establishment of forest tree seed source for provision of tree seeds, which can help plantation forest or forest restoration; payments for environmental services such as carbon financing from REDD+; conducive land use planning policies and tenure system; ecotourism development; ABS regulation mechanisms and new initiatives on livelihood opportunities (e.g NWFPs).

CHAPTER 3: THE STATE OF EX SITU GENETIC CONSERVATION

3.1 Introduction

Ex situ conservation is where the seeds or the plant parts are preserved outside their area of growth habitats. This depends on the seed characteristics, where orthodox seeds (moisture reduction non-sensitive) are conserved in the gene bank/cold room storage and recalcitrant seeds (moisture reduction sensitive) are planted in the field gene bank.

3.2 *Ex situ* Conservation in the Gene Bank and Storage Facilities

The *ex situ* conservation in gene bank/cold room by using cold storage facilities help for conservation of orthodox seeds. Ethiopia has a gene bank/cold room with storage volume of 385 m^3 for conservation of plant genetic resources since 1976. This includes one new forest gene bank (Figure 2) with cold room which is adjusted at -20 ^{0} C (for forest genetic resources). There

are also another three cold rooms -10 ^{0} C (for cultivated plants) and one more cold room + 4 ^{0} C (for temporary storage).

Germplasm collection, documentation and distribution

Seeds of priority and conservation worthy forest plant species had been collected to be conserved *ex situ*, both in the cold room and in the field gene banks. A total of 498 accessions of 93 forest species have been collected out of which 468 are conserved (Table 11). A total of 42 medicinal and forage plant species are collected and conserved in the *ex situ* field gene banks. In addition, 5238 accessions of coffee have been conserved in two field gene banks. Moreover, information on 468 conserved accessions has been organized and documented. On the other hand, about 85 accessions of the conserved tree and shrub species have been distributed to Governmental and Non-governmental Organizations, Agricultural Research Centers, Higher Learning Institutions, Community Organizations, and individuals for research and development.

Figure 2. Ethiopian Forest Gene Bank

Table 11. *Ex situ* conservation

No.	Species		Field collections		Germplasm bank	
	Scientific name	Native (N) or exotic (E)	Collections, provenance or progeny tests, arboreta or conservation stands		Seed banks	
			No. stands	No. acc.	No. Banks	No. acc.
1	*Acacia abyssinica*	N	13	17	1	17
2	*Acacia albida*	N	2	3	3	3
3	*Acacia albida*	N	1	4	1	4
4	*Acacia dolichocephala*	N	1	1	1	1
5	*Acacia etbaica*	N	4	4	2	4
6	*Acacia etbaica*	N	26	39	2	39
7	*Acacia hochrii*	N	2	2	1	2
8	*Acacia lahai*	N	2	3	1	3
9	*Acacia oerfota*	N	1	1	1	1
10	*Acacia persiciflora*	N	3	3	1	1
11	*Acacia polyacantha*	N	8	10	1	3
12	*Acacia Senegal*	N	4	4	4	4
13	*Acacia seyal*	N	10	14	3	14
14	*Acacia siberiana*	N	5	5	1	1
15	*Acacia tortilis*	N	6	8	2	8
16	*Aeschynomene abyssinica*	N	6	10	1	10
17	*Aeschynomene schimperi*	N	2	2	1	2
18	*Aeschynomene sensitira*	N	1	1	1	1
19	*Albizia grandibracteata*	N	1	1	1	1
20	*Albizia gumifera*	N	6	6	1	3
21	*Albizia spp.*	N	2	4	1	4
22	*Anogeisus leocarphus*	N	2	4	1	2
23	*Bersama abyssinica*	N	1	1	1	1
24	*Bothuodna schimperi*	N	1	1	1	1
25	*Brucea antidysentrica*	N	1	1	2	1
26	*Calpurnia aurea*	N	8	8	3	8
27	*Capparis tomentosa*	N	1	1	1	1
28	*Carissa spinarum*	N	1	2	1	2
29	*Celtis africana*	N	1	1	1	1
30	*Cordia africana*	N	27	40	6	40
31	*Croaaophy pebripuga*	N	1	1	1	1
32	*Croton machrostachyus*	N	2	3	3	3
33	*Dichrostachys cinerea*	N	3	3	1	2
34	*Dichrostachys sp.*	N	1	1	1	1
35	*Dodonea angustifolia*	N	3	4	3	4
36	*Dombia sp*	N	2	4	1	4
37	*Embelia schimperi*	N	1	1	1	1
38	*Entada abyssinica*	N	6	10	1	6
39	*Erythrina abyssinica*	N	1	1	1	1
40	*Erythrina spp.*	N	3	4	1	4
41	*Eucalyptus globules*	E	1	10	1	10

42	*Ficus ovate*	N	1	1	1	1
43	*Ficus sp*	N	1	1	1	1
44	*Ficus sur*	N	2	3	2	3
45	*Ficus sycomorus*	N	1	1	1	1
46	*Ficus vasta*	N	1	1	1	1
47	*Galiniera saxifrage*	N	3	3	1	3
48	*Gardenia turnifolia*	N	1	1	1	1
49	*Grewia ferruginea*	N	2	2	1	2
50	*Grewia spp*	N	1	2	1	2
51	*Grewia villosa*	N	1	1	1	1
52	*Hagenia abyssinica*	N	4	7	5	7
53	*Hypericum revolutum*	N	1	1	1	1
54	*Juniperus procera*	N	4	11	5	11
55	*Lannaschaleintunthii*	N	1	1	1	1
56	*Luffacylindica*	N	1	1	1	1
57	*Measa lanceolata*	N	4	5	2	5
58	*Millettia ferruginea*	N	6	9	4	9
59	*Morinaga olifera*	N	2	2	1	2
60	*Morinaga stenopetala*	N	9	40	2	40
61	*Mucuna pruniens*	N	1	1	1	1
62	*Myrsine africana*	N	1	1	1	1
63	*Ocimum gratissimum*	N	1	2	1	2
64	*Olea europaea ssp cuspidate*	N	3	7	4	7
65	*Oxytenethera abyssinica*	N	5	20	3	20
66	*Papaver*	N	1	1	1	1
67	*Petrolobium stellatum*	N	2	2	1	1
68	*Phoenix reclinata*	N	2	3	1	3
69	*Phytolaca dodecandra*	N	19	59	3	59
70	*Pillostigma thoningi*	N	6	9	3	9
71	*Pithecellobium dulce*	N	1	1	1	1
72	*Pittosporum viridiflorum*	N	2	2	1	2
73	*Podocarphus falcatus*	N	3	5	6	5
74	*Premna shimperi*	N	2	2	1	2
75	*Prunus africana*	N	2	3	3	3
76	*Rhamnus prinoides*	N	1	2	1	2
77	*Rhus susplii*	N	1	1	1	1
78	*Rubia cordifolia*	N	1	1	1	1
79	*Rumex sp.*	N	1	1	1	1
80	*Sarcocephatur latitolive*	N	2	3	1	3
81	*Securidaca longipedunculata*	N	1	1	1	1
82	*Senna petersiana*	N	1	1	1	1
83	*Sesbania sesban*	N	1	1	1	1
84	*Solanium spp.*	N	3	5	2	5
85	*Sterculi africana*	N	2	2	1	2
86	*Tamarindus indica*	N	6	8	1	5
87	*Terminalia sp*	N	1	2	1	2
88	*Terocarphus lucease*	N	1	1	1	1
89	*Tricompetala biachycesas*	N	1	1	1	1

90	*Vernonia amygdalina*	N	2	3	1	3
91	*Vitex doniana*	N	1	2	2	2
92	*Ziziphus mucronata*	N	2	4	1	1
92	*Ziziphus spina-christi*	N	3	5	2	5

3.3 *Ex situ* conservation in the field

Field gene-banks have been established for *ex situ* conservation of priority species in different parts of the country. Fourteen field gene-banks (eight forest and two coffee stands, three botanical gardens and arboreta) in four Regions and one city administration are currently hosting different tree/shrub species (Appendix 6).

3.4 Challenges and opportunities

The strategy document has identified the threats, challenges, research gaps and the way forward for conservation.

Challenges/Threats:

- Natural and human induced fire hazards
- Human encroachment for wood and Non Timber Forest products (NTFP)
- Livestock and wildlife encroachment
- Lack of commitment and collaboration among stakeholders in the management of the *ex situ* conservation sites
- Pest and disease infestation
- Resource limitations (human, material, financial and etc.)
- Lack of sustainable management
- Inadequate/lack of data base relevant to *ex situ* conservation
- Lack of or inadequate mechanisms for monitoring and evaluation of conservation activities
- Lack of duplicate gene bank
- Gap in technology development (pollen, clone, tissue culture development and conservation, protein and molecular markers)
- Research gaps in the identification of the biology, ecology, storage behavior and germplasm characterization of forest plant species
- Seasonal shift in the flowering and fruiting of forest tree and shrub species

Opportunities:

- Conducive policies (National and International) and state commitment at all levels, though far below the need
- The growing concern and commitment of the international, national and local community towards the conservation of forest genetic resources
- Due consideration given to environmental and climate change issues at all levels (global, national and local)

- The growing need for FGRs germplasm
- The development and promotion of CRGE

3.5 Research needs and priorities

A national strategy document for research on forest genetic resources (FGRs) of Ethiopia was developed by the Forest Genetic Resources Conservation Project. The strategy proposed a series of main and sub-thematic areas for research on FGRs of Ethiopia (Appendix 7).

CHAPTER 4: THE STATE OF USE AND SUSTAINABLE MANAGEMENT OF FGRS

4.1 Introduction

In Ethiopia there are three nature reserves (Yayu Coffee Forest Biosphere Reserve, Kafa Biosphere Reserve and Sheka Forest Biosphere Reserve), 20 national/regional parks, four sanctuaries and six supplementary *in situ* forst stands. In addition, there is a national Forest Gene Bank in Addis Ababa, and there are genetic test plantations for *E. globulus* (Holetta), *E. camaldulensis* (Mankussa) *E. saligna* and *E. grandis* (Wondogenet) *Juniperus procera,* (Enjibara and Kulumssa) and *Jatropha curcas* (Shewa Robit, Kemise, Mieso and Bishola). Furthermore, community protected landscapes (e.g. the Konso landscape and the Gedeo agroforestry systems), Shashemene and Gulele Botanic Garden as well as the various urban parks in Addis Ababa and other cities, arboreta in various academic and research institutions, seed stands and church forests serve the purpose of conserving forest genetic resources. Several of the forest resources are currently under PFM, which includes the integrated forest management projects of Adaba- Dodola and FARM-Africa/ SOS Sahel assisted PFM at Chilimo, Bonga and Boranna.

4.2 Utilization of conserved forest genetic resources and major constraints to their use

The forest genetic resources serve as cash crops (e.g. forest coffee), as sources of non-wood forest products (e.g. gums and resins, food and feed), and as sources of germplasm (most of the seeds of indigenous tree species are coming from natural forests) for afforestation and reforestation and tree improvement efforts. However, the sustainable utilization of the forest genetic resources is constrained by:

Low institutional capacity at all levels: the institutions responsible for conservation and sustainable utilization of the resources including IBC do not have the necessary capacity to ensure the sustainable utilization and protection of the resources. Mandates of all responsible organizations for the management and utilization of forests genetic resources are not clear. Furthermore, low institutional capacity is manifested by the low level of budget allocated to the forestry sector as well as low level of skill available in various levels.

Agricultural land expansion: Agricultural expansion is posing great threats to the conservation and sustainable utilization of the forest genetic resources. Shifting cultivation and expansion of commercial tea, coffee plantations and rice at the cost of natural forest (deforestation and degradation), in Shaka, Kafa, Bench-Maji, and Gambella; seasonal migration of highlanders and the associated land clearance for crop cultivation in Benishangul

Gumuz and North Gondar are some of the examples constraining sustainable utilization and conservation of forest genetic resources.

Fire hazard: Both wild fire and intentional fire are frequent in some parts of the country (e.g. Bale, Benishangul Gumuz Regional State, North Gondar), and are causing serious damages on forest genetic resources. FRA (2010) indicated that over 16,000 ha of forest area was affected by fire in Oromia Regional State alone.

Climate change, the related drought and desertification: erratic rainfall and associated draught and desertification are affecting the survival of forest genetic resources.

Unsustainable utilization: in many parts of the country, over harvesting utilization has resulted in the depletion of the forest genetic resources.

Invasive species and bush encroachment*:* some of the forests such as the Borana woodland, which is known for gum and resin products, are deteriorating due to bush encroachment (e.g. *Acacia drepanolobium, A. oerfota, A. mellifera*). On the other hand, *Prosopis juliflora*, which was introduced to the country for its multiple benefits such as land reclamation, has turned to be invasive in Afar and Somali Regional States and is reducing the overall biodiversity of the areas it invades by forming a thick monospecific scrub.

Poor forest information system: The conserved forest genetic resource of the country in general lacks sufficient and accurate information. There is poor information exchange among the actors and the stakeholders of the sector.

Encroachment: illegal logging and fire wood collection, livestock grazing affecting regeneration and healthy population structure.

Increased demand for wood and increased accessibility: increase for demand and market value for indigenous tree species and booming of handicrafts coupled with increased accessibility due to infrastructure development is aggravating both deforestation and degradation. The pressure on indigenous trees is even higher since their timbers are much preferred than the exotic tree species in sawmills and the market.

Pest and disease: termite problem is prevalent in some zones of Oromia and Benishangul Gumuz.

4.3 The state of use and management of forest reproductive materials, availability, demand and supply

The major forest reproductive material in afforestation and refforestation efforts in Ethiopia is seed, and is supplied by the Forestry Research Center and private seed vendors. Local collections are also made bu regional bureaus of agriculture for their own consumption. Efforts are underway to establish additional state owned tree seed centers in SNNP, Oromia, Tigray and Amhara Regional States. To date, the national demand for tree seeds is not known precisely, and it definitely varies from year to year. Data on tree seed request and supply at FRC from 2007-

2010 indicated that the center on average was supplying 7,278 kg of pure seeds annually in the stated period satisfying 78% of the request. However, the recent reports of four Regional States of SNNP, Oromia, Amhara and Tigray claim the annual planting of a total of over 3 billion tree seedlings, which might have required about 35 tones of seeds, in 2009 and 2010.

Tree seed and vegetative propagules import

There were efforts to import high value tree species from abroad. In addition, some individuals have brought some seed lots from abroad for research purposes. EIAR has recently imported fruit tree species through High Value Tree Crops project from Africa, Latin America and Asia (Table 12).

4.4 The state of forest genetic improvement and breeding programs

Genetic tests conducted in Ethiopia include the provenance researches on *Eucalyptus saligna*, *E. grandis*, *Juniperus procera*, provenance/progeny trials on *E. globulus* and a progeny trial on *E. camaldulensis* (Tables 13, 14 and 15). Table 16 shows the type of tree seeds available for sale at FRC.

Table 12. Seed and vegetative propagules transferred internationally per annum

No.	Scientific name	Native (N) or exotic (E)	Quantity of seed (kg)	No of vegetative propagules	No of seedlings	Purpose	Number of varieties imported
1	*Annona muricata*	E					
2	*Annona reticulata*	E					1
3	*Bambusa balcooa*	E					
4	*Bambusa distegia*	E					
5	*Bambusa tulda*	E					
6	*Bambusa vulgaris sub green*	E					
7	*Bambusa vulgaris sub.vitatta*	E					
8	*Carica papaya*	E					2
9	*Citrus aurantifolia*	E					2
10	*Citrus paradisi*	E					2
11	*Citrus reticulata*	E					8
12	*Citrus reticulate x Citrus paradisi*	E					9
13	*D. brandisii*	E					
14	*Dendrocalamus asper*	E					
15	*Emblica officinalis*	E					1
16	*Ficus carica*	E					6
17	*Mangifera indica*	E					28
18	*Morus alba*	E					1
19	*Phoenix dactlifera*	E					2
20	*Punica granatum*	E					9
21	*Sclerocarya birrea ssp. caffra*	E					3
22	*Tamarindus indica*	E					1
23	*Ziziphus mauritiana*	E					8

Table 13. Tree improvement programs

No.	Scientific name	Native (N) or Exotic (E)	Improvement objectives	
			Timber	NWFP
1	*Acacia senegal*	N		✓
2	*Cordia africana*	N	✓	
3	*Eucalyptus camaldulensis*	E	✓	
4	*Eucalyptus globulus*	E	✓	
5	*Eucalyptus grandis*	E	✓	
6	*Eucalyptus saligna*	E	✓	
7	*Hagenia abyssinica*	N	✓	
8	*Jatropha curcas*	E		✓
9	*Juniperus procera*	N	✓	

Table 14. Tree Improvement Trials

No.	Species		Plus Trees	Provenance Trials		Progeny Trials		Clonal Testing and Development			
1	Scientific name	Native (N) or Exotic (E)	No	No of Trials	No of Provenance	No of Trials	No of Families	No of tests	No of clones tested	No of clones selected	No of clones used
2	*Acacia senegal*	N		1	6						
3	*Cordia africana+*	N	222								
4	*Eucalyptus camaldulensis*	E				1	405				
5	*Eucalyptus globulus**	E		1	52	1	300	1	2		
6	*Eucalyptus grandis*	E		1	12						
7	*Eucalyptus saligna*	E		1	10						
8	*Hagenia abyssinica+*	N	225								
9	*Jatropha curcas**	E		4	13						
10	*Juniperus procera*	N		2	9						

* Provenance/progeny trial; + Seeds collected, genetic tests (provenance/progeny) not yet established, * 13 different seed sources and not strictly provenances

Table 15. Seed Production Areas

No.	Species	Seed Production Area		
		Number	Area	Location(s)
1	*Grevillea robusta*	5	40	Chora, Cherse, Hageremariam, Yirgalem, Wondogenet
2	*Cupressus lusitanica*	1	16	Menagesha-Kolobo
3	*Eucalyptus viminalis*	1	13	Elena
4	*Pinus patula*	2	34	Duna, Gemeda and Turfe
5	*Juniperus procera*	2	15	Agaro and Arjo
6	*Hagenia abyssinica*	1	5	Kore
7	*Cordia africana*	1	5	Dembi

Table 16. Type of Reproductive Material Available

No	Species	Type of Material	Available for national requests only	
			Commercial	Research
1	*Acacia abyssinica*	Seed	√	√
2	*Acacia decurrens*	Seed	√	√
3	*Acacia melanoxylon*	Seed	√	√
4	*Acacia nilotica*	Seed	√	√
5	*Acacia saligna*	Seed	√	√
6	*Acacia Senegal*	Seed	√	√
7	*Acacia tortilis*	Seed	√	√
8	*Albizia grandibracteata*	Seed	√	√
9	*Albizia gummifera*	Seed	√	√
10	*Albizia lebbeck*	Seed	√	√
11	*Albizia schimperiana*	Seed	√	√
12	*Azadirachta indica*	Seed	√	√
13	*Balanites aegyptiaca*	Seed	√	√
14	*Cajanus cajan*	Seed	√	√
15	*Callistemon citrinus*	Seed	√	√
16	*Casuarina cunninghamiana*	Seed	√	√
17	*Casuarina equisetifolia*	Seed	√	√
18	*Chamaecytisus palmensis*	Seed	√	√
19	*Cordia africana*	Seed	√	√
20	*Croton macrostachyus*	Seed	√	√
21	*Cupressus lusitanica*	Seed	√	√
22	*Cupressus torulosa*	Seed	√	√
23	*Delonix regia*	Seed	√	√
24	*Dodonaea angustifolia*	Seed	√	√
25	*Dovyalis abyssinica*	Seed	√	√
26	*Dovyalis caffra*	Seed	√	√
27	*Ekebergia capensis*	Seed	√	√
28	*Entada abyssinca*	Seed	√	√
29	*Erythrina brucei*	Seed	√	√
30	*Eucalyptus camaldulensis*	Seed	√	√
31	*Eucalyptus citriodora*	Seed	√	√
32	*Eucalyptus globulus*	Seed	√	√
33	*Eucalyptus grandis*	Seed	√	√
34	*Eucalyptus saligna*	Seed	√	√
35	*Eucalyptus viminalis*	Seed	√	√
36	*Acacia albida*	Seed	√	√

37	*Grevillea robusta*	Seed	√	√
38	*Hagenia abyssinica*	Seed	√	√
39	*Jacaranda mimosifolia*	Seed	√	√
40	*Juniperus procera*	Seed	√	√
41	*Leucaena leucocephala*	Seed	√	√
42	*Melia azadarach*	Seed	√	√
43	*Millettia ferruginea*	Seed	√	√
44	*Moringa stenopetala*	Seed	√	√
45	*Olea europaea var. africana*	Seed	√	√
46	*Parkinsonia aculeate*	Seed	√	√
47	*Phoenix reclinata*	Seed	√	√
48	*Pinus patula*	Seed	√	√
49	*Pinus radiate*	Seed	√	√
50	*Podocarpus falcatus*	Seed	√	√
51	*Prunus Africana*	Seed	√	√
52	*Schinus molle*	Seed	√	√
53	*Sesbania aculeate*	Seed	√	√
54	*Spathodea nilotica*	Seed	√	√
55	*Tamarindus indica*	Seed	√	√
56	*Ziziphus Mauritania*	Seed	√	√

4.5 The state of current and emerging technologies

Ethiopia has now sufficient GIS facilities and experties in various institutions for resource assessment, though systematic and periodic resource assessnment is lacking. There are also some biotechnology laboratories in the research systems and in higher learning institutions, such as in Mekele Institute of Technology and Holetta Agricultural Research Center of EIAR. However, the biotechnology labs are mainly engaged in crop multiplication. Mekele plant tissue culture micro-propagation research and development under Mekele Institute of Technology has multiplied so far few trees or shrub species of commercial importance. These include Rose, Citrus, Apple, *Eucalyptus species* and Fig tree. In the long run, both institutes have a plan to multiply species of *bamboo* (i.e *Arundinaria. alpina* and *Oxytenanthera abyssinica*). Micropropagation and genetic modification studies were conducted on *H. abyssinica* elsewhere.

4.6 Assessment of needs to improve the forest genetic resources management and use

IBC, Ministry of Agriculture and other relevant ministries, Regional Bureaus of Agriculture and other relevant bureaus, EIAR and Regional Research Institutes, WGCFNR and other higher learning institutes should have proper strategic planning to contribute to the conservation and sustainable utilization of forest genetic resources. The government on the other hand should strengthen and capacitate these institutions with human and financial resources. Hence, the following should be fulfilled:

Fine tuning higher learning programs: As the country is mainstreaming PFM in almost all forest management practices, there is a need to have graduates/foresters with strong social science knowledge. The graduates from Natural Resources Management Programs of various Universities happen to be not competent enough for forestry works. Currently, except Wondo Genet College Forestry and Natural Resources, none is graduating students in the field of forestry. There is also lack of skilled manpower on integrated natural resource management. Currently, graduates of Natural Resources Management are working as foresters, but foresters need to be trained in sufficient number. There is also a need for a training program on monitoring, reviewing and verification of the carbon stock contained in forests.

Building institutional capacity: Since there are limitations of capacity at all levels, there is a need to capacitate the human, the material and the financial resources of the responsible institutions for forest genetic resources conservation and management. The government needs to capacitate the human, the financial and the material resources of the sector. The institution responsible for conservation, IBC, should be organized up to grassroots level. There is more need for forest restoration, conservation and management courses. On job training and skill development should be offered to experts at various levels on forest genetic resources conservation and management. Institutions should have a better information management system than their current practices.

Promotion of new techniques and technologies: Conservation of forest genetic resources entails characterization of the genetic structure of populations; hence there is a need to invest in modern molecular techniques. Not much has been done in this regard. All the molecular studies reported in this document were conducted in laboratories abroad.

Knowing the resource base and monitoring: There are several studies on forests and forest genetic resources in recent years. However, there is a great need for reliable and credible information on extent of natural and planted forest resources, trends in land use and land cover changes and tree cover and forest genetic resources in agroforestry landscapes.

Improve the national capacity on tree seed service: Quality tree seeds should be made available at the right time and at the right place for successful afforestation/reforestation and agroforestry promotion activities. Huge amount of seed is produced every year but remains unutilized because of lack of capacity. Capacitating the various actors in the seed system and operating in a decentralized fashion could guarantee supply of tree seeds to end users. However, there should be quality assurance and certification system in place to guarantee quality. There is also a great need to establish and manage stands for seed production and establishing genetic testing plantation for getting best adapted and improved seed sources.

Improve the national capacity on forest protection: problems related to forest fires (which happens also to be a transboundary issue), disease and termite problem need to be addressed very well. Adequate information is not available on the damage pathogens cause to trees both in natural and plantation forests of Ethiopia. Hence, there is a need to build the national capacity in forest protection.

Environmental impact assessment: Agricultural investment including gum and resin collection, infrastructure development and resettlement are important for the national economy of the country and the welfare of the poor. However, the consequences of such national programs should seriously undertake environmental impact assessments. It is felt that the environmental impact assessment proclamation is not well implemented, and hence active clearing of forest resources is going on, which in the view of several experts, is damaging the ecosystem and livelihood of the forest dependent communities.

CHAPTER 5: THE STATE OF NATIONAL PROGRAMS, RESEARCH, EDUCATION, TRAINING AND LEGISLATION

5.1 Introduction

Ethiopia has been making concerted efforts to addressing poverty reduction in a comprehensive way through the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) from 2005/06-2009/10. Programs to implement this strategy included water harvesting, reforestation, composting, improved use of fertilizers, and diversification of fuels away from reliance on firewood and charcoal. Currently, the country has prepared and is implementing the five-year GTP for the period 2010/11 to 2014/15. In addition, the country has developed CRGE. Ethiopia is also a signatory to several multilateral environmental conventions including the Biodiversity Convention, the Convention to Combat Desertification, the Libreville Declaration on Health and Environment, the Stockholm Convention, etc.

National efforts in this regard include the development and issuance of the Conservation Strategy of Ethiopia in 1997, the Environmental Policy of Ethiopia in 1997, the Environmental Impact Assessment Proclamation in 2002, NBSAP in 2005, the Forest Development, Conservation and Utilization Proclamation (Proclamation No. 542/2007) and Policy, the Proclamation on Access to Genetic Resources and Community Knowledge, and Community Rights (Proclamation No. 482/2006), and the preparation of a climate change national adaptation program of action (NAPA), the Ethiopia's Program of Adaptation to Climate Change (EPACC), the Nationally Appropriate Mitigation Action (NAMA) prepared by Environmental Protection Authority in 2010, and the national situation analysis and needs assessment (SANA) exercise on health and environment inter-linkages and the Forest Carbon Partnership Facility (FCPF): readiness preparation proposal.

Currently there are 31 public universities and 8 federal and regional agricultural research institutes (with their several research centers) distributed all over Ethiopia. Some of the universities and all agricultural institutes are engaged in some degree of forest genetic resources utilization, management and conservation related programs and activities (Table 17). However, WGCFNR, IBC, Addis Ababa University and the FRC are by far the most important public institutions involved in forest research. Furthermore, WGCFNR, Mekele University, Haramaya University, and Mada Walabu University are involved in education and training on forest genetic resources.

Table 17. Institutions involved with conservation and use of forest genetic resources

Name of Institution	Type of Institution	Activities or Programs	Contact Information
Government institutions			
Institute of Biodiversity Conservation	Conservation	Forest Genetic Resources Conservation Program	www.ibc.gov.et
Addis Ababa Bureau of Agriculture	Development	Afforestation/reforestation and forest management	
Afar Pastoral and Agropastoral Bureau	Development	Rangeland management	
Alaje Forest Enterprise	Development	Afforestation/reforestation and forest management	
Amhara Bureau of Agriculture	Development	Afforestation/reforestation and forest management	http://www.amhboard.gov.et/
Amhara Forest Enterprise	Development	Afforestation/reforestation and forest management	
Benishangul Gumuz Bureau of Agriculture	Development	Afforestation/reforestation and forest management	
Dire Dawa Agriculture, Water and Miniral resources Bureau	Development	Afforestation/reforestation and forest management	http://www.dire-dawa.gov.et
Harari Bureau of Agriculture	Development	Afforestation/reforestation and forest management	
Ministry of Agriculture	Development	Afforestation/reforestation and forest management	www.moa.gov.et
Oromia Bureau of Agriculture	Development	Afforestation/reforestation and forest management	+251- 113-717440
Oromia Forest and Wildlife Enterprise	Development	Afforestation/reforestation and forest management	
SNNP Bureau of Agriculture	Development	Afforestation/reforestation and forest management	+251-462-206125
Somali Pastoral and Agropastoral Bureau	Development	Rangeland management	
Tigray Bureau of Agriculture	Development	Afforestation/reforestation and forest management	
Addis Ababa University	Higher learning	Plant Biology and Biodiversity Management, Environmental Science, and General Biology Programs	http://aau.edu.et
Ambo University	Higher learning	Plant Science, and Natural Resource Management Programs	http://www.ambou.edu.et/
Arbaminch University	Higher learning	Plant Science, and Horticulture Science Programs	http://amu.edu.et
Debre Berhan University	Higher learning	Plant Science Program	http://www.dbu.edu.et/
Debre Markos University	Higher learning	Natural Resource Management	http://www.dmu.edu.et
Dilla University	Higher learning	Plant Science, Rangeland management, and Land Resource Management Programs	http://www.dillauniversity.edu.et/
Haramaya University	Higher learning	Rangeland ecology and ecotourism, natural resource	http://www.haramaya.edu.et/

		management	
Hawassa University	Higher learning	Range Science, Plant Science, and Horticultural Science Programs	http://www.hu.edu.et/
Jigjiga University	Higher learning	Dry land agriculture	http://www.jju.edu.et/
Jimma University	Higher learning	Horticulture and Plant Science, and Natural Resource Management	http://www.ju.edu.et/
Mada Walabu University	Higher learning	Biodiversity and Natural Resources Program	http://www.mwu.edu.et
Mekelle University	Higher learning	Rangeland, Land Resource and Natural Resource Management Programs	http://www.mu.edu.et/
Samara University	Higher learning	Natural Resource Management	http://www.su.edu.et/
University of Gondar	Higher learning	Natural Resource Management, and Plant Sciences Programs	http://www.uog.edu.et/
Wolaita Sodo University	Higher learning	Natural Resource Management, and Plant Sciences Programs	http://www.wsu.edu.et/
Wollega University	Higher learning	Plant Sciences, and Watershed Management Programs	http://www.wuni.edu.et/
Wondo Genet College of Forestry and Natural Resources	Higher learning	Forestry, Natural Resource Management, and Wildlife and Ecotourism Management Programs	http://www.hu.edu.et
Amhara Environmental Protection and Land Use Authority	Regulatory		
Benishangul Gumuz Environmental Protection and Land Use Authority	Regulatory		
Environmental Protection Authority	Regulatory	Environmental policies, strategies, laws and standards, formulation	www.epa.gov.et
Ethiopian Wildlife Conservation Authority	Regulatory	Protected area establishment and management	http://www.ewca.gov.et/
Oromia Land Administration and Environmental Protection Bureau	Regulatory		
Afar Pastoral and Agropastoral Research Institute (ARPARI)	Research		
Amhara Regional Agricultural Research Institute (ARARI)	Research	Forestry and agroforestry research/forest management, NTFP	http://www.arari.gov.et/
Ethiopian Institute of Agricultural Research (EIAR)	Research	Plantation and Agroforestry, Natural Forests, Non-Timber Forest Products, and Forest Products Utilization Research Programs	www.eiar.gove.et
Gambella Agricultural Research	Research		

Institute (GARI)			
Oromia Agricultural Research Institute (OARI)	Research	Plantation, Agroforestry, Natural Forests and Non-Timber Forest Products	
Somali Pastoral and Agropastoral Research Institute (SORPARI)	Research	Forestry and Range Ecology Research	http://www.sorpari.org.et/
Southern Agricultural Research Institute (SARI)	Research	Natural forest management research	http://www.sari.gov.et
Tigray Agricultural Research Institute (TARI)	Research		
Non Governmental Institutions			
Organization for Rehabilitation and Development in Amhara (ORDA)	Development	Participatory forest management and reforestation	http://www.ordainternational.org/
Relief Society of Tigray		Forestry	http://www.rest-tigray.org/
Menchen fur Menschen		Integrated rural development (includes seedling production and distribution and reafforestation)	http://en.menschenfuermenschen.com/
Forum for Environment	Communication and advocacy	Forests; Protected Areas; Urban Environment; Energy; and Climate Change	http://www.ffe-ethiopia.org/
FARM Africa		Community forest management and Pastoral development	http://www.farmafrica.org.uk
SOS Sahel		Forest management and Pastoral development	http://www.sahel.org.uk
Environment and Coffee Forest Forum (ECFF)		Conservation planning/ Conservation and use of wild populations of *Coffea arabica*	http://www.ecff.org.et/
CIFOR Ethiopia		Dry forests management	http://www.cifor.org/
MELCA Mahiber		Environmental education and Environmental advocacy	http://www.melca-ethiopia.org/
Orthodox Church Development Commission		Integrated rural development	http://www.ethotc.org
INBAR		Bamboo management	http://www.inbar.int/
World Vision Ethiopia		Improving food security	http://www.worldvision.org
Lem Ethiopia		Community tree nursery establishment and environmental education	http://www.lemethiopia.org.et
Food for the Hunger Ethiopia		Agriculture and Environment/ natural resource management	http://www.fh.org
German International Cooperation (GIZ)		Sustainable land management	http://www.giz.de

5.2 National programs and strategies

Climate Resilient Green Economy (CRGE)

Ethiopia aims to achieve middle-income status by 2025 in a climate-resilient green economy. One of the pillars of the green economy strategy is protecting and reestablishing forests for their economic and ecosystem services, including as carbon stocks. According to the document, the

major (87%) green house gas emissions in Ethiopia come from agriculture (50%) and forestry (37%). In forestry the emission comes from deforestation for agricultural land (50%), fuel wood consumption (46%) and logging (4%). Reduction of demand for fuel wood through the use of fuel wood efficient stoves and additional baking technologies is envisaged, and this would mean reduce 50 Mt CO2e reductions in GHG emission. In addition, carrying out afforestation and reforestation on 3 million ha of land and implementation of sustainable forest management on 2 million ha of high forests and woodlands is envisioned, which will help to increase carbon sequestration by more than 40 Mt CO2e. The Government of Ethiopia intends to attract development partners to help implement this green economy strategy.

Growth and Transformation Plan (GTP)

This plan is a medium term strategic framework for the period from 2010/11 to 2014/15. The major targets for natural resource conservation program are:

a. Increasing area of land rehabilitated from 3.2 million hectare in 2009/10 to 10.2 million hectare by 2014/15
b. Increasing land developed under community based watershed development program from 3.8 million hectare in 2009/10 to 7.8 million hectare by 2014/15
c. Increasing total area of land covered with forest and forest master plan from 0.7 million hectare in 2009/10 to 2.2 million hectare by 2014/15
d. Increasing total area of land covered with multipurpose trees 6.1 million hectare in 2009/10 to 16.2 million hectare by 2014/15
e. Increasing forest coverage from 13 million hectare in 2009/10 to 18 million hectare by 2014/15
f. Increasing multipurpose trees from 5062 hectare in 2009/10 to 10154 hectare by 2014/15
g. Increasing natural resource conservation activities from in pastoral areas from 200,000 hectare in 2009/10 to 350,000 hectare by 2014/15

Climate Change National Adaptation Program of Action

The Conference of the Parties to the UNFCCC at its Seventh Session (COP 7 of the UNFCCC) decided that the least developed countries including Ethiopia be provided with support to address urgent and immediate needs related to adaptation to Climate Change. Identifying high priority adaptation projects was the ultimate goal of the whole NAPA preparation process. The selected high ranking projects in the process included:

1. Improving/enhancing rangeland resource management practices in the pastoral areas of Ethiopia
2. Community based carbon sequestration project in the Rift Valley System of Ethiopia
3. Promotion of on farm and homestead forestry and agroforestry practices in arid, semi-arid and dry-sub humid parts of Ethiopia

Nationally Appropriate Mitigation Action (NAMA)

Ethiopia prepared NAMA in 2010. The Ethiopian NAMA is comprised of various sectors including forestry projects.

Ethiopia's Program of Adaptation to Climate Change (EPACC)
This Program for action on adaptation to climate change has been developed in 2010. The main objective of EPACC is to create the foundation for a carbon-neutral and climate-resilient path towards sustainable development in the country.

Productive Safety Net Program (PSNP)
The Productive Safety Net Program (PSNP) was launched in 2005 by the Ethiopian government and a consortium of donors with an annual budget of nearly US$500 million, reaching more than 7 million Ethiopians in food insecure areas. The PSNP has been mainly used to mitigate the impacts of climatic and food insecurity risks on chronically food-insecure farmers by providing employment, and involves massive watershed rehabilitation works. A study indicated that the mean change in tree holdings for the PSNP participating farmers was more than double from that of the non-participants.

Managing Environmental Resources to Enable Transition (MERET)
A World Food Program assisted development program called Managing Environmental Resources to Enable Transition – MERET in to addressing what were felt to be the root causes of food insecurity in Ethiopia at that time. It is hoped that lessons from MERET can inform disaster risk reduction programming in contexts of recurrent weather-related hazards. The MERET project has contributed to the rehabilitation of several thousand ha of land through constructing soil and water conservation measures and planting of livelihood improving biological measures such as fruit trees, fodder shrubs and grasses.

Sustainable Land Management Program (SLMP)
SLMP is a World Bank supported initiative under the Ministry of Agriculture. The project aims at arresting and reversing the long-term deterioration in soil fertility and soil erosion. Under the SLMP only 55 watersheds out of the 177 that have been prioritized in food secure areas are financed.

Forest Genetic Resources Conservation Program
Forest Genetic Resources Conservation program was started in 1997 and ended in 2006. The program was financially supported by GTZ and executed by IBC. It has conducted forest genetic resource assessment and socioeconomic surveys on 33 natural forests. To date, IBC has identified six *in situ* sites for forest coffee conservation and other six conservation stands targeting *Oxynthethera abyssinica*, *Hagenia abyssinica*, *Podocarpus falcatus*, *Ficus ovata*, *Arundinaria alpina* and *Pouteria adolfi-freidericii* and has conserved 343 accessions of 59 woody species in the Gene Bank.

National Biodiversity Strategy and Action Plan (NBSAP)

Ethiopia developed NBSAP in 2005. The objectives of this strategy included conserving representative ecosystems through a network of protected areas, ensuring sustainable use and management of all remaining natural ecosystems outside of the protected areas by 2020, sharing equitably the costs of conserving and benefits from the sustainable use of biodiversity, and conserving the agrobiodiversity through complementing in situ and ex situ conservation programs. However, the implementation of the strategy and action plan is not satisfactory, and

hence IBC needs to make a concerted effort to coordinating and monitoring the implementation of NBSAP.

Area Exclosure and Farmer Managed Natural Regeneration

Successful rehabilitation and restoration activities have been conducted in Tigray, Amhara, SNNP and Oromia. For example, a report from Tigray Bureau of Agriculture indicated that close to 1000,000 ha of land was rehabilitated through area exexclosure until 2010. A separate community managed natural regeneration project based on partnership among World Vision, the World Bank, the community and the Ethiopian Government has been running since 2007 at Humbo in SNNP Regional State with a goal of regenerating 2,728 ha of degraded land. The Humbo Community Managed Natural Regeneration project is the first successful Clean Development Mechanism project in Africa.

Large Scale Plantation Development

Planted forests in Ethiopia are estimated to cover around 230,000 ha, excluding small scale tree plantations by local people. These plantations are mainly composed of *Eucalyptus* species (59.3% of industrially planted area) and *Cupressus lusitanica* (20.6%), followed by the indigenous *Juniperus procera* (5.7%) (Lemenih and Bongers, 2011).

Participatory Forest Management (PFM)

PFM was started in Ethiopia in 1997 in Bonga and Chilimo forests by Farm Africa. The actors and the forests under PFM include FARM-Africa and SOS Sahel in the forests of Bonga (8950 ha), Borana (80,066 ha) and Chilimo (5,000 ha), GTZ in the forests of Adaba-dodola (36,000 ha) and Mojo (2,000 ha), JICA in the Belete Gera Forest (1,252 ha) and FARM-Africa/SOS Sahel Bale Eco-Region Sustainable Management Program in the Bale Massif (411,136 ha).

The NTFP-PFM Research and Development Project in South-west Ethiopia that aimed to contribute to maintaining a forested landscape to support improved livelihoods for the local forest dependent communities and thereby ensure the delivery of environmental services in a wider context have been under implementation in Bench Maj and Masha since 2003. The project is excuted by Huddersfield University and the Ethiowetlands & Natural Resources Association. It is funded primarily (80%) by the European Commission, with matching funds provided by the Embassies of the Netherlands and Norway in Ethiopia. Another PFM project entitled: "A new Approach to the Conservation of Wild *Coffea arabica* in Southwest Ethiopia: Developing the Potential of Participatory Forest Management" is under implementation since 2010 with the financial support from European Union's Environment Budget line and with additional funding from the Darwin Initiative. The project partners are Huddersfield University, UK the Ethiowetlands & Natural Resources Association, Sustainable Livelihood Action (eeig) the Netherlands. Associate Partners include the Institute for Biodiversity Conservation, RDCOs in Sheko Woreda and the Horn of Africa Regional Environment Centre. The project aims to: 'contribute to the conservation of coffee biodiversity through the application of simplified PFM procedures to achieve sustainable ways of conserving this biodiversity *in situ* with joint (community and government) management and benefit sharing mechanisms.

An international conference on participatory forest management, biodiversity and livelihoods in Africa conducted in 2007 deliberated on several issues and concluded that PFM was growing in scope and area coverage in Africa and underscored the need for mainstreaming PFM in government structures. Recently, European Union supported Scaling-up PFM Project (SUPFM) has been launched and runs from 2009 to 2014. The SUPFM project is aiming at improving forest condition and forest-based livelihoods through building the capacity of the Ministry of Agriculture and the community to scale-up and mainstream PFM and NTFP development in 92 forest sites found in four regional states (Benishangul Gumuz, Amhara, SNNP and Oromia).

Bamboo Management and Processing

A bamboo sector strategy framework has been developed by an international consultant in 2009 with an overall objective of promoting a holistic development of the bamboo sector in Ethiopia (Brias, 2009). A project by the name Eastern Africa Bamboo Project (EABP) was executed by the United Nations industrial Development Organization (UNIDO), supervised by the International Network for Bamboo and Rattan (INBAR) and funded by the Common Fund for Commodities (CFC) from 2006-2009. The project improved household incomes by 100% (Brias, 2009). A separate project, "Bamboo as sustainable biomass energy: A suitable alternative for firewood and charcoal production in Africa" has been under execution since 2009 and will be ending in 2013. This project is being run by INBAR and the European Union, along with the Rural Energy Development and Promotion Centre (REDPC) and the Federal Micro and Small Enterprises Agency. The project is the first to develop bamboo firewood and charcoal as an alternative to timber charcoal in the region.

Natural Gum Processing and Marketing

Ethiopia is endowed with rich diversity of woody species that produce different commercial gums and resins including frankincense, myrrh and gum. The ten years data (2002 to 2011) obtained from the Ethiopian Revenues and Customs Authority shows that on average the country exports 3579 (±739) metric ton of gums and resins annually; the total amount of export and income from in the period were 35,787 metric ton, and 73,249,395 USD, respectively. The gum and resin bearing forest resources are getting depleted from time to time due to expansion of crop and livestock production, human settlement, overgrazing, fuel wood and charcoal production, fire and poor tapping practices. Efforts are underway to demarcate and protect these forest genetic resources at the grassroots level; for example some districts in Amhara region have already inventoried and demarcated gum and resin bearing forests. However, immediate action has to be taken to save these forest resources from destruction and viable populations need to be identified across the geographic range of the species for *in situ* conservation.

Biofuel Development Program

The Biofuels Development and Utilization Strategy envisage facilitating adequate production of biofuels from indigenous resources so as to substitute imported petroleum and export excess products. A total of 327,094 ha of land are allocated to 14 companies in four regional states

(SNNP, Benishangul Gumuz, Amhara and Oromia) for development of plantations of *Jatropha*, castor bean, palm and sugarcane for biofuel.

Forest Inventory

The Ministry of Agriculture used to have a project named Woody Biomass Inventory and Strategic Planning (WBISPP), which produced important documents. Accordingly, it was found out that the extent of the woody vegetation in Ethiopia is to be 59.7 million hectares (WBISPP, 2004). The inventory work included woody plants in all types of land cover such as forests, woodlands, scrublands, grassland and cultivated areas. Data analysis was done at the level of the Land Use System within each Woreda. After the termination of WBISP in 2004, IBC has made inventory on woody species diversity in most of the Afrmontane forest resources of Ethiopia. A periodic inventory and assessment of forests and trees is highly required for proper resource management planning, utilization, management and development. Hence, the Ministry of Agriculture needs to take up this important issue as one of the major national programs in the country.

5.3 Research and dissemination

Researches on natural resources management in general and FGRs in particular have been conducted in both federal and regional agricultural research institutes and higher learning institutions.

Ethiopian Institute of Agricultural Research (EIAR)

EIAR runs four national research programs: 1) Plantation and agroforestry research program, 2) Natural forests research program, 3) Non-timber forest products research program and 4) Forest products research program. Under EIAR, FRC and the other 14 agricultural research centers are responsible for carrying out forestry research (Appendix 8). Whereas the FRC coordinates and runs only the four forestry research programs, the other research centers are also involved in crop, livestock and soil and water conservation researches. Hence, the forest research process is undertaken in a decentralized but coordinated way in EIAR centers.

Regional Agricultural Research Institutes (RARIs) and Pastoral and Agropastoral Research Institutes

There are currently seven regional research institutes, and they have got several research centers under them (Appendix 8). All of these institutes undertake forestry researches in various agroecologies within their own regional states.

Wondo Genet College of Forestry and Natural Resources (WGCFNR)

This college conducts applied and development oriented researches on non timber forest products, biodiversity conservation, natural resource economics, fuel wood, silviculture, agroforestry, wildlife, participatory forest management, land use land cover changes, climate change and soils.

Addis Ababa University

Addis Ababa University has undertaken various botanical explorations on Ethiopian vegetation and has published series of books on the Ethiopian flora. The university owns and runs the National Plant Herbarium, which has got tremendous collections of Ethiopian plant specimens. The university is also engaged in various social, botanical, ecological, physiological, genetics and propagation researches on forest genetic resources of the country.

Institute of Biodiversity Conservation (IBC)

In addition to conservation, the Institute of Biodiversity Conservation is undertaking conservation based research on FGRs. A number of Afromontane forests were studied for their species diversity, socio-economic, and ecological importance.

Other Universities

In the last decade, the number of public and private universities has increased dramatically and is still continuing to increase in the coming decade. Most of the public universities (both new and old) are engaging themselves in various researches that are related to forest genetic resources management and utilization in one way or another.

5.4 Education and training

Wondo Genet College of Forestry and Natural Resources (WGCFNR)

This college is running BSc, MSc and PhD training programs in various fields. The college is part of Hawassa University, and has got three schools: School of Forestry, School of Natural Resources and Environmental Studies, and School of Wildlife and Ecotourism. The programs in the college include Agroforestry and Soil Management, Ecotourism and Cultural Heritage Management, Forest Products Processing and Utilization, General Forestry, Geographic Information Science, Natural Resources Economics and Policy, Soil Resources and Watershed Management and Wildlife, Wetland and Fisheries Management. The college has produced over 4000 graduates until 2011 since its establishment, and currently college has increased its enrollment capacity to 2000 students.

Other Universities

A number of higher learning institutes have programs on agriculture and natural resources management (Appendix 9), in which they deal also with some aspect of forest genetic resources utilization and management. The programs include natural resources management, watershed, management, and rangeland science and biodiversity management.

5.5 Coordination mechanisms and networking

The Ministry of Agriculture at the federal level and the Bureaus of Agriculture at regional level are responsible for leading and coordinating all forest development and management activities in Ethiopia. The conservation of forest genetic resources on the other hand is the responsibility of the Institute of Biodiversity Conservation. Research on forest and forest genetic resources is

being conducted in the Ethiopian Agricultural Research System (EARS) with the involvement of the Ethiopian Institute of Agricultural Research, Regional Agricultural Research Institutes, Institute of Biodiversity Conservation and higher learning institutions. The actors on forest genetic resource conservation and management further more involves different NGO, farmers, pastoralists and agropastoralists and the government of Ethiopia itself. However, there is lack of coordination and regular forums to deliberate on forestry research and development strategic issues, needs and development options. This has resulted in failure to bringing perspectives, interest and priorities of the stakeholders in forestry research process and has hampered the extension and use of available forestry technologies in development activities. Therefore, there is a need to establish forestry research and extension advisory council, which can serve as a mechanism to prioritize forestry research and development intervention, check and regulate implementations.

5.6 Assessment of major needs in capacity building

The major needs for developing forest genetic resources are listed and prioritized in Table 18. Needs for awareness creation are presented in Table 17.

Table 18. Needs for developing forest genetic resources legislation

Needs	Priority level			
	Not applicable	Low	Moderate	High
Improve forest genetic resources legislation			√	
Improve reporting system				√
Consider sanction for non-compliance		√		
Create forest genetic resources targeted regulations			√	
Improve effectiveness of forest genetic resources regulations				√
Enhance cooperation between forest genetic resources national authorities				√
Create a permanent national commission for conservation and management of forest genetic resources				√
Create policy alignment among various sectors				√

Table 19. Awareness raising needs

Needs	Priority Level			
	Not applicable	Low	Moderate	High
Prepare targeted forest genetic resources information				√
Prepare targeted forest genetic resources communication strategy			√	
Improve access to forest genetic resources information		√		
Enhance forest genetic resources training and education				√
Improve understanding of benefits and values of forest genetic resources			√	

CHAPTER 6: THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

6.1 Regional, Sub-regional and International Networks

A very large number of networks currently address one or more aspects of plant genetic resources particularly forest genetic resources. While all aim to promote and support collaboration among partners for a common purpose, there is a huge diversity in their objectives, size, focus, geographic coverage, membership, structure, organization, governance, funding, etc. The objectives and working areas of the most active and prominent regional and sub-regional networks are addressed here.

Eastern Africa Plant Genetic Resources Network (EAPGREN)

EAPGREN is a regional Network of National Agricultural Research Systems (NARS) of the ASARECA member countries (http://www.asareca.org/eapgren/about/about_us.htm). The Network was established to promote the sub-regional collaboration and networking through exchange of information and material, research and development, capacity building, adoption of common approaches and methods, and regional integration in plant genetic resources activities. EAPGREN has three main activity areas namely capacity building, research activities and Plant Genetic Resources (PGR) support services. Thus, Ethiopia has actively participated and benefited from this network.

African Forest Research Network (AFORNET)

AFORNET is a network of African forest research scientists that promotes quality research on the use, management and conservation of African forest and tree resources (http://www.afornet.org/). It also aims to strengthen multidisciplinary and multi-country research. AFORNET operates a research grants scheme with the aim of promoting and strengthening individual scientists' research capacity in order to retain outstanding scholars for generating and disseminating knowledge that is relevant to development.

African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE)

ANAFE is a network of African colleges and universities teaching agriculture and natural resource sciences. The network was launched by 17 universities and 12 technical colleges in 1993, and now has 131 member educational institutes in 35 African countries. ANAFE is involved in curriculum development, teaching and training materials development and provision as well as in sharing information among the network members. Wondo Genet College of forestry and Natural Resources from Ethiopia is a member of ANAFE.

Sub-Saharan African Forest Genetic Resources Network (SAFORGEN)

The Sub-Saharan African Forest Genetic Resources Network (SAFORGEN) was established in 1999 with the aim of combining and sharing expertise among African national forest genetic resource programs. The network has identified 59 high priority tree species that need immediate conservation measures in Africa. Ethiopia is a member of the network.

International Network for Bamboo and Rattan (INBAR)

INBAR is an intergovernmental organization working to improve the social, economic, and environmental benefits of bamboo and rattan. INBAR connects a global network of partners from the government, private, and not-for-profit sectors in over 50 countries, including Ethiopia, to define and implement a global agenda for sustainable development through bamboo and rattan.

6.2 International Agreements

In the past ten or so years, few agreements have been ratified in the international fora. Two of them, the Nagoya Protocol on Access and Benefit Sharing and the International Treaty on Plant Genetic Resources for Food and Agriculture are very relevant and they are addressed here. The Nagoya protocol is one of those agreements worth-mentioning here.

The Nagoya Protocol on Access to Genetic Resources and Benefit Sharing

Ethiopia is currently in the process of ratifying the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits, which was adopted at the tenth meeting of the Conference of the Parties on 29 October 2010, in Nagoya, Japan. Specific obligations to support compliance with domestic legislations or regulatory requirements of the Party providing genetic resources and contractual obligations reflected in mutually agreed terms are a significant innovation of the Protocol. By promoting the use of genetic resources and associated traditional knowledge, and by strengthening the opportunities for fair and equitable sharing of benefits from their use, the Protocol will create incentives to conserve biological diversity, sustainably use its components, and further enhance the contribution of biological diversity to sustainable development and human well-being.

International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA)

The Treaty addresses conservation, exploration, collection, characterization, evaluation and documentation as well as sustainable use of plant genetic resources. Ethiopia ratified the Treaty in 2003 and the Institute of Biodiversity Conservation has been focal point for the Treaty since ratification. Two country reports on the state of PGRFA have been submitted to FAO so far.

Future needs and priorities for international collaboration and networking

So far international collaboration and networking in FGRs conservation is minimal. Thus, future needs and priorities are shown in Table 20.

Table 20. Needs for international collaboration and networking

Needs	Level of priority			
	Not applicable	Low	Medium	High
Understanding the state of diversity				√
Enhancing *in situ* management and conservation			√	
Enhancing *ex situ* management and conservation				√
Enhancing use of forest genetic resources			√	
Enhancing research			√	
Enhancing education and training		√		
Enhancing legislation		√		
Enhancing information management and early warning systems for forest genetic resources.			√	
Enhancing public awareness		√		

CHAPTER 7: ACCESS TO FOREST GENETIC RESOURCES AND SHARING OF BENEFITS ARISING FROM THEIR USE

7.1 Policies, regulations and legislations

Being a party to Convention on Biological Diversity, Ethiopia has formulated the relevant policies such as Environmental Protection Policy, Biodiversity Conservation Research Policy, and also issued legislation on ABS from the use of genetic resource. Ethiopia has also ratified The Nagoya Protocol on ABS.

Federal Forest Policy

The government of Ethiopia has formulated forest development, conservation and utilization policy and passed legislation in 2007. The objective of the policy is to meet public demand in forest products and foster the contribution of forests in enhancing the economy of the country through appropriately conserving and developing forest resources. The policy provisions are designed, among others, to encourage the development of forests by individuals, organizations and government and the designation of protected forests and productive forests to be administered in accordance with laws to be enacted for each. The policy further establishes that forestry research is to be expanded focusing on growing native tree species and their utilization as well as identifying useful exotic species and growing seedlings of such trees for wide dissemination.

Forest legislations

The Federal Proclamation (542/2007) recognizes two types of forest ownership: state and private. According to this law, state forests are any protected or productive forests owned by the federal or a regional state. Private forests are forests other than state forests that are developed by any private person and include forests developed by members of a peasant association or by any association organized by private individuals, investors, and governmental and NGOs.

Further, Regional States have issued their own provisions to fill existing gaps in forestry sector. In Oromia proclamation that establishes Forest and Wildlife Enterprise was issued in 2009. This proclamation is aimed at conservation, production and sustainable use of forest and wildlife of the region. In the South Region, draft forest development, conservation and utilization proclamation is finalized and submitted to regional council for approval. Similarly, in

Benushangul Gumuz Regional State, a draft proclamation on forest development, conservation proclamation and a forest fire management guideline have been prepared. In Amhara region, establishment of forestry agency, which is responsible for managing forest resource, is in place recently. Furthermore, most of the regions have issued their own land administration and environmental protection proclamations. All these regional legal documents in one way or the other support the conservation, development and sustainable use of forest resources.

Land administration and registration

In the year 2007, the federal government has issued a land administration and registration proclamation. It seems to increase land tenure security, improve productivity, and avoid expectations of land redistribution. Thus, the tenure security, may have expected to encourage investment in forest development and increase production forest, which takes longer duration for its return. The provisions forest proclamation allows the participation of local communities in the development and conservation and also in the sharing of benefits from the development of state forests. Further, the proclamation establishes that development of management plan for forests that have not been designated as protected or productive state forests, and such forests shall be given to the community, associations or investors so that they conserve and utilize them in accordance with directives to be issued by the appropriate body.

Access and Benefit sharing legislations

Ethiopia has put in place Proclamation 482/2006 to provide legal frameworks for how the genetic resources are accessed and how benefits are obtained from their use. The basic objective of this Proclamation is to ensure fair and equitable benefit share arising out of the use of genetic resources and to promote the conservation and sustainable utilization of the country's biodiversity resources. Statements of the Proclamation includes a range of issues such as ownership, user rights, and conditions for access, benefit sharing, types of benefits, powers and responsibilities among the others. The law bears the necessity of Prior Informed Consent (PIC) to access genetic resources or community knowledge. Following PIC, the Institute including relevant stakeholders negotiates on Mutual Agreed Terms (MAT establishment) with the user of the genetic resource.

7.2 Access and Movement of Forest Germplasms

Germplasms movement into and out of the country has a long history in Ethiopia. As there were no regulations in place until recent past, genetic resources have been freely accessed. The understanding was that genetic resources are considered as "a common heritage of human kind". Students, researchers, tourists, and other travelers have been involved in the transfer of germplasms into and out of Ethiopia. Ethiopia is implementing access to genetic resource regulations, which does not allow free access to genetic resources. Over the past ten years, most of the forest genetic resource access requests have come from Ethiopian students and researchers pursuing their MSc. and PhD studies outside Ethiopia. These access requests have been facilitated through Material Transfer Agreement (MTA). The 31 accessed species that fulfilled the MTA requirements and transferred out of the country were presented in Appendix 10. On the other hand, the status of FGRs found outside the country is not known. Even the research status of germplasms accessed and transferred through MTA is unknown because of lack of

information exchange between the users and provider. There has been no follow up mechanisms in place to monitor the development of the GRs.

7.3 Access and Benefit sharing

In July 2006, a British Biotechnology firm (Vernique Biotech Ltd - UK "Company") signed access and benefit sharing agreement with the Institute of Biodiversity Conservation to commercialize the oilseed plant *Vernonia galamensis*. The agreement was signed based on Mutually Agreed Terms (MAT) set by the two parties. *Vernonia galamensis* is considered as a potential replacement for petroleum in a variety of industrial uses. According to the agreement, the Company has exclusive access to *Vernonia* seed to export and use for the purpose of developing and commercializing the 27 V*ernonia* seed oil products for ten years. In exchange, the Ethiopian government agreed to receive royalty payments and profit shares, while hundreds of local farmers believed to have an opportunity to boost their earnings by growing the oilseed on their farm lands. The agreement excludes intellectual property rights over *Vernonia galamensis* or any genetic components thereof.

With regards to benefit sharing, the agreement includes both monetary and non-monetary benefits. Vernique agreed to pay an upfront payment of € 35,000 up on signing the agreement. Also, Veronique has agreed to source at least 75% of its annual requirements for Vernonia seed by producing it and/or by buying it from contract growers or local communities in Ethiopia. This was aimed to benefits local communities from the agreement of Vernonia. As part of the non-monetary benefits, Vernique has agreed to train local communities. The agreement had also included sharing of research results and technologies with the provider. On the other hand, liscence/ or upfront payment was obtained after the agreement.

The implementation of the ABS including vernonia agreement is challenged by various factors. The most important are: limited negotiation capacity and lack of effective enforcement, lack of follow up mechanisms for the ABS agreement, lack of clear market information regarding the value of genetic resources. As a consequence, value is often determined by the user, who frequently determines the value of the genetic resource by comparison to a non-genetic substance that is currently in use. Lack of information about the commercial status of the accessed genetic resource products is another challenge affecting benefit sharing agreements.

Recently, DOCOMO Plc. has applied for access to three forest species namely, *Osyris quadripartita*, *Dichrostachys cinerea* and *Warburgia ugandensis* to process various herbal, cosmetics and medicinal products. The competent authority, IBC has received the application and examined the access request in accordance with article 14 of the access Proclamation and procedure for commercial access outlined under article 3 of the regulation. Following public comments and concerned local community's consent, IBC has given PIC to the Company. In return, the Company has accepted the PIC grant of IBC. Therefore, negotiation processes on the requested access will begin soon.

7.4 Stakeholders Involved in Genetic Resource Transfer/Movement and Their Roles

Genetic resource transfer regulation involves a broad range of stakeholders. The following institutions are mandated to regulate access and movement or transfer of genetic materials.

(i) **Local Communities**: Being the custodian of Ethiopian biodiversity, access and benefit sharing legislation gives local communities are responsible to give PIC to access community knowledge related to genetic resources. Moreover, they are empowered to regulate genetic resources in their localities. They can prohibit any person, who does not belong to their communities, from collecting or taking genetic resources without having the necessary permit.
(ii) **Responsibilities of Regional Bodies:** Local administrations and regional bodies at all levels who are responsible for the conservation of genetic resources are empowered to:

- regulate that genetic resources is not accessed from their respective jurisdiction without permit by any person who does not belong to the communities thereof; and
- require access permit from any person, who does not belong to the communities thereof and who is collecting or taking genetic resources from their respective jurisdiction, and if he is without permit, seize the genetic resource and present him to the law and notify the IBC the detailed particulars of the genetic resource and the person found in possession.

(iii) **Ethiopian Revenue and Customs Authority**: The Proclamation on ABS empowered custom offices to regulate transfer of any genetic resources being taken out of the country. It is responsible to seize genetic resources being transported out of the country and the person transporting them without permit.
(iv). Institutions involved in Mail Service : Postal and other courier service institutions are also responsible to require their clients to show permit before receiving and transporting genetic resources out of the country as mail.
(v) **Ministry of Agriculture**: The Plant and Animal Health and Regulatory Directorate under the Ministry is responsible to regulate plant and animal health of imported and exported genetic resources to protect the country's biodiversity from invasive pests and diseases. Based on a pre-import evaluation, the Directorate issue import permit. The Ministry is empowered to ensure that the quarantine certificate they issue to export genetic resource products, contain a statement indicating that the certificate does not constitute a permit to use the product as genetic resource and that doing so is prohibited and would constitute an offence. It also prohibits or restricts the importation of living plants, plant parts, and seeds for planting. It ensures that they are aware of the quarantine status of the organisms they accept into and store in their collections. The organization provides lists of controlled organisms' exotic species.

Although the stakeholders are involved genetic resource regulation, there is weak or no collaboration or coordination among them. As a result, genetic resources are not adequately regulated. Effective genetic resource regulation very much depends, among other things, on the meaningful and effective collaboration, integration and implementation of the regulations.

CHAPTER 8: THE CONTRIBUTION OF FOREST GENETIC RESOURCES TO FOOD SECURITY, POVERTY ALLEVIATION AND SUSTAINABLE DEVELOPMENT

8.1 Introduction

The forest sector is playing key roles in the state's economy in many ways. Forests, woodlands and trees outside forests are the major suppliers of energy (through fuel wood) and wood based products of national consumption with huge substitution role from importation of commercial oil. Ethiopia is also renowned for a number of NWFPs of international importance such as forest coffee, products of apiculture, gums and incense, spices and civet musk. These products are exported in order to earn foreign currency. The sector also provides quite a large employment opportunity, formal and informal, as well as environmental protection services that support other

economic sectors, such as the agriculture, construction, tourism and energy sectors, to operate in a sustainable manner. The mean contribution of the forest sector to the GDP of Ethiopia over the last ten years (2002 to 2011) is 4.5% (CSA, 2012). However, a separate estimate of the contribution of the forestry sector to the national GDP puts it at 9% (Nune et al, 2009).

8.2 Role in Agricultural sustainability

Forests support sustainable agriculture through provision of fertile croplands, and support through services such as pollinators, biological controllers, gene pool for crop improvement, watershed protection, organic fertilizer, farm implements, fodder and bee forage. For example, fodder supply from forests and woodlands amount up to 65% in the drylands. Moreover, biomass transfer, organic inputs and nutrient cycling services from on-farm trees in the traditional agroforestry systems is playing significant role in sustaining the agricultural production system in Ethiopia. Parkland agroforestry systems were proved to improve soil fertility and crop yield in different parts of Ethiopia. Multistory home garden agroforestry systems were found to provide ecologically and socioeconomically sustainable agricultural production systems by improving species diversity, the diversity of crops produced and other ecosystem services in Sidama zone of southern Ethiopia. These enset-coffee based home gardens have high species diversity. Most of them are evolved from forests, where farmers maintain the upper storey trees and clear the understory vegetation to open up space for planting enset, coffee, and other food and cash crops. The high diversity of species in these systems contributes to conservation of species, nutrient recycling, improves soil fertility, biological pest control, soil and water conservation; year round production of different crops; and reducing risks. The preservation of woody species in such cultivated landscape could contribute to productive farming, biodiversity conservation and supply of farmers' requirements for various wood products, thereby reducing the pressure on remnant forest in the area.

8.3 Food security and poverty alleviation

Forests have always been important resources in the day to day lives of the people of Ethiopia, hence contribute to the wellbeing and rural development in many ways. Their role in food security and poverty reduction is increasingly recognized. In parts of Tigray, forest income contributes to 27% of total household annual income, while incomes from crop and livestock production were 43% and 16%, respectively (Babulo et al., 2009). In central Shewa forest income provides 39% of the average annual household income compared to crop & livestock combined income of 40%, hence forest income roughly equal to that of agriculture (Mamo et al., 2007). According to the study of Mamo et al. (2007) forest income was more important than all other income sources combined for the poorest 40% of households, and contributed more income than agriculture for 65% of the surveyed households. This forest income also reduced income inequality by 21%, thus, has an important income equalizing effect among rural households. In Bale area, forest income contributes to 34% of total per capita income higher than that of livestock (30%), crop (26%) and other income sources (6%) (Tesfaye, 2011). According to the study of Tesfaye et al (2011), forest income is particularly important when cash income alone is considered where it contributes to 53% of the total annual household cash income, and helps 20% of the population to remain above the poverty line. Similar roles of forests in poverty reduction have been reported from wider geographical regions across the country such as southwest, eastern parts and central Ethiopia.

Biomass energy at the national level provides more than 96.9 percent of the total domestic energy consumption: 78 percent from woody biomass, 8 percent from crop residues, and 11 percent from animal dung (WBISPP, 2004). At the national level fuel wood entrepreneurs receive about US$420 million per year, and honey and beeswax are worth US$86 million per year (Lemenih, 2008). A number of commercially important NWFPs are collected from the vegetation resources of Ethiopia that are exported to provide foreign currency and support the national economic development. The most renowned are wild coffee, gum & resins, honey and beeswax. About 30–35% of annual coffee production in the country originates from either wild or semi-managed coffee forests (Workaffess and Kassu, 2000), which in 2005, for instance, provided a total of 69,681 tons of coffee (Nune et al, 2009). Gum and incense are other important forest products of national significance. Over the last decade, average annual gum-resin production has increased in Ethiopia and so is the earnings from the sub-sector. The ten years data (2002 to 2011) obtained from the Ethiopian Revenues and Customs Authority shows that on average the country exports 3579 (±739) metric ton of gum & resin annually; the total amount of export and income from in the period were 35,787 metric ton, and 73,249,395 USD, respectively. Forests provide edible food products from semi-domesticated as well as wild plants and animals. More than 300 species of wild trees and shrubs have been recorded as important traditional food sources in Ethiopia, including forest plants. The majority of these species (ca. 72 %) have edible fruits and/or seeds, while in the remaining their vegetative parts – leaves, stems and tubers/roots – are eaten. Some of these (for example, *Moringa stenopetala* and *M. oleifera)* provide edible as well as nutrient- and vitamin-rich leaves and shoots, which also have medicinal values. *Moringa* is widely used as a source of food to households in the semi-arid regions of southern Ethiopia, particularly in Konso. *Cordia africana*, *Balanites aegyptiaca*, *Dovyalis abyssinica*, *Ficus* spp., *Carissa edulis* and *Rosa abyssinica* produce fruits that are commonly consumed in rural Ethiopia. Fruits of *Opuntia ficus-indica* and *Borassus aethiopum* are consumed and traded in the market for cash income in Tigray and Afar national regional states. A variety of wild animals such as fish, mammals and birds are utilized for food, providing direct income.

Significant people in the country are dependent on traditional medicines. In 2005 alone, about 56,000 tons of medicinal plants are used in Ethiopia, most of which are harvested largely from wild plant stocks. The total value to the economy in same year was estimated at ETB 2 billion. The indirect value of this through import substitution is therefore huge. The forestry sector also provides quite a large employment opportunity at the national level, formally and informally. Official estimates put forest employment to be 0.29 %of total workforce but this ignores a huge number of self-employed citizens in the sector. For instance, over 35,000 women have been recorded in Addis Ababa alone to engage in fuel wood collection business, with 82 %of them fully dependent on the business (WBISSP, 2004). A recent survey of six major towns, excluding Addis Ababa, also recorded 7415 small and medium forest enterprises, 30% of which are operating informally hence not captured by official statistics (Haile et al, 2009). In Addis Ababa alone there are more than 737 carpenters producing furniture and construction timber (Nigatu, 2004).

8.4 Cultural services

Forests and trees provide diverse cultural services that are related to spiritual and religious services, knowledge systems, maintenance of social relations and cultural heritages. Both products and services obtained from forest ecosystems are embedded in the cultural practices of numerous ethnic and social groups in Ethiopia hence play considerable role in ensuring societal wellbeing. Unfortunately, these aspects of forest uses are overlooked in the country; hence very little information is available. Some typical cultural services of forests, specifically those related to religious and ritual use values are observed among diverse ethnic and social groups in Ethiopia. For e.g. forests that are often recognized around curches, monasteries, mosques and burial grounds are recognized by the followers as 'sacred sites'. Among the Ethiopian Orthodox Christian believers, there has been a long standing association of maintaining forests around religious sites such as churches and monasteries. For followers of the religion a church among a forested landscape symbolizes 'the garden of Eden'. The traditional Gamo people own a practice of worshipping nature through the adoration of sacred sites. These sites include sacred natural forests, burial grounds, ponds, streams and other landscape features.

Among the Borana Oromo, there has been a long standing association between culture and forest that developed into a sophisticated natural resources management institution called the Geda system. For the Borana cutting of trees around water sources is forbidden, as they are assumed essential for guarantying sustainable water flow. Cutting such trees is considered as blocking or destroying the water body itself, hence the very existence of the society. *Tamarindus indica* and *Ficus sycomorus* are some of the prominent tree species identified in this category. These species are also used as indicators of water sources. Furthermore, the Borana people believes that cutting big trees such as *Ficus sycomorus*, *Tamarindus indica* and *Acacia tortilis* could result in death of the person who cuts them. Several trees are also recognized to have special values in traditional ritual, blessing and ceremonial uses and are not supposed to be cut down for ordinary uses. Such trees are considered as society's identity. Among these tree species are *Tamarindus indica*, *Ficus sycomorus*, and *Berchemia discolor*. They have also protected patches of Juniperus procera forests in hilly areas as appreciated *baddaa sadeen* meaning 'forest with tall trees' and 'a dark green forest'

The study conducted among the Berta and Gumuz ethnic groups reveled that some plant species both cultivated and wild offer diverse cultural services. The uses include cultural hair ointment, traditional musical instrument, and brewing of traditional drinks. For example, the musical instrument called 'Waza' in Berta language is made of dry fruits of *Lagenaria abyssinica* in combination with the sticky bark of *Albizia malacophylla* and stem of *Oxytenanthera abyssinica*. Similarly among the Gumuz, fruit of *Oncoba spinosa* assembled with the fiber of *Gossypium arboretum* into a beads tied to legs to create a special sound during dancing. Some plants materials are also used as necklace used by both women and men.

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Appendices

Appendix 1. Priority woody species in southwest forests for conservation, in decreasing order of priority

No.	Species	Family
1	*Hagenia abyssinica*	Rosaceae
2	*Afrocarpus falcatus*	Podocarpaceae
3	*Morus mesozygia*	Moraceae
4	*Cordia africana*	Boraginaceae
5	*Bridelia micrantha*	Euphorbiaceae
6	*Gardenia ternifolia*	Rubiaceae
7	*Malacantha alnifolia*	Sapotaceae
8	*Schrebera alata*	Oleaceae
9	*Fagaropsis angolensis*	Rutaceae
10	*Baphia abyssinica*	Fabaceae
11	*Celtis zenkeri*	Ulmaceae
12	*Ficus sp.*	Moraceae
13	*Stereospermum kunthianum*	Bignoniaceae
14	*Olea capensis*	Oleaceae
15	*Rhamnus prinoides*	Rhamnaceae
16	*Ficus ovata*	Moraceae
17	*Ficus exasperata*	Moraceae
18	*Ficus lutea*	Moraceae
19	*Ficus mucuso*	Moraceae
20	*Flacourtia indica*	Flacourtiaceae

No.	Species	Family
21	*Strychnos mitis*	Loganiaceae
22	*Trichilia prieuriana*	Meliaceae
23	*Apodytes dimidiata*	Icacinaceae
24	*Blighia unijugata*	Sapindaceae
25	*Rhus natalensis*	Anacardiaceae
26	*Solanecio mannii*	Asteraceae
27	*Allophylus abyssinicus*	Sapindaceae
28	*Arundinaria alpina*	Poaceae
29	*Phoenix reclinata*	Araceae
30	*Albizia gummifera*	Fabaceae
31	*Croton macrostachyus*	Euphorbiaceae
32	*Syzygium guineense*	Myrtaceae
33	*Ilex mitis*	Aquifoliaceae
34	*Ritchiea albersii*	Capparidaceae
35	*Lecaniodiscus fraxinifolius*	Sapindaceae
36	*Myrsine africana*	Mrsinaceae
37	*Calpurnia aurea*	Fabaceae
38	*Diospyros abyssinica*	Ebenaceae
39	*Hallea rubrospiculata*	Rubiaceae
40	*Turraea holstii*	Meliaceae

41	*Sapium ellipticum*	Euphorbiaceae
42	*Trema orientalis*	Ulmaceae
43	*Trichilia dregeana*	Meliaceae
44	*Premna schimperi*	Verbenaceae
45	*Buddleja polystachya*	Loganiaceae
46	*Ficus vallis-choudae*	Moraceae
47	*Antiaris toxicaria*	Moraceae
48	*Ficus vasta*	Moraceae
49	*Embelia schimperi*	Myrsinaceae
50	*Euphorbia abyssinica*	Euphorbiaceae
51	*Garcinia buchananii*	Clusiaceae
52	*Vernonia hymenolopis*	Asteraceae
53	*Albizia grandibracteata*	Fabaceae
54	*Ekebergia capensis*	Meliaceae
55	*Prunus africana*	Rosaceae
56	*Acacia abyssinica*	Fabaceae
57	*Vangueria apiculata*	Rubiaceae
58	*Trilepisium madagascariense*	Moraceae
59	*Erythrina abyssinica*	Fabaceae
60	*Carissa edulis*	Apocynaceae
61	*Entada abyssinica*	Fabaceae
62	*Oncoba spinosa*	Flacourtiaceae
63	*Ricinus communis*	Euphorbiaceae
64	*Pouteria adolfi-friederici*	Sapotaceae
65	*Celtis africana*	Ulmaceae
66	*Dombeya schimperiana*	Sterculiaceae
67	*Brucea antidyscenterica*	Simarubiaceae
68	*Hypericum revolutum*	Hypericaceae
69	*Teclea nobilis*	Rutaceae
70	*Ficus sur*	Moraceae
71	*Coffea arabica*	Rubiaceae
72	*Lepidotrichilia volkensii*	Meliaceae
73	*Acanthus sennii*	Acanthaceae
74	*Rinorea friisii*	Violaceae
75	*Canthium oligocarpum*	Rubiaceae
76	*Millettia ferruginea*	Fabaceae
77	*Albizia schimperiana*	Fabaceae
78	*Ficus salicifolia*	Moraceae
79	*Vernonia filigera*	Asteraceae
80	*Maesa lanceolata*	Myrsinaceae
81	*Dracaena fragrans*	Dracaenaceae
82	*Cyathea manniana*	Cyatheaceae
83	*Bytteneria catalpifolia*	Asteraceae
84	*Hypericum* sp.	Hypericaceae
85	*Ocotea* kenyensis	Olacaceae
86	*Schefflera myriantha*	Aralaceae
87	*Solanum gigantum*	Solanaceae
88	*Tamarix aphylla*	Tamaricaceae

89	*Vernonia dalettiensis*	Asteraceae
90	*Ficus thonningii*	Moraceae
91	*Manilkara butugi*	Sapotaceae
92	*Erythrina brucei*	Fabaceae
93	*Celtis philippensis*	Ulmaceae
94	*Cassipourea malosana*	Rhizophoraceae
95	*Macaranga capensis*	Euphorbiaceae
96	*Vernonia amygdalina*	Astreaceae
97	*Pouteria altissima*	Sapotaceae
98	*Alchornea laxiflora*	Euphorbiaceae
99	*Pavetta abyssinica*	Rubiaceae
100	*Dombeya torrida*	Sterculiaceae
101	*Polyscias fulva*	Araliaceae
102	*Schefflera abyssinica*	Araliaceae
103	*Mimusops kummel*	Sapotaceae
104	*Oxyanthus speciosus*	Rubiaceae
105	*Ehretia abyssinica*	Boraginaceae
106	*Maytenus addat*	Celastraceae
107	*Nuxia congesta*	Loganiaceae
108	*Vernonia* sp.	Asteraceae
109	*Pittosporum virdiflorum*	Pittosporaceae

110	*Acanthopale pubescens*	Acanthaceae
111	*Discopodium penninervium*	Solanaceae
112	*Erythrococca sp.*	Euphorbiaceae
113	*Acalypha acrogyna*	Euphorbiaceae
114	*Allophylus macrobotrys*	Sapindaceae
115	*Capparis erythrocarpos*	Capparidaceae
116	*Clerodendron myricoides*	Verbenaceae
117	*Dalbergia lactea*	Fabaceae
118	*Erythrococca trichogyne*	Euphorbiaceae
119	*Euphorbia ampliphylla*	Euphorbiaceae
120	*Ficus sycomorus*	Moraceae
121	*Phyllanthus reticulatus*	Euphorbiaceae
122	*Sesbania sesban*	Fabaceae
123	*Bersama abyssinica*	Melianthaceae
124	*Grewia ferruginea*	Tiliaceae
125	*Vangueria sp.*	Asteraceae
126	*Celtis gomphophylla*	Ulmaceae
127	*Elaeodendron buchananii*	Celastraceae
128	*Senna petersiana*	Fabaceae
129	*Lobelia giberroa*	Lobeliaceae
130	*Maytenus arbutifolia*	Celastraceae

Appendix 2. The red list of endemic trees and shrubs of Ethiopia

***Distribution in Ethiopian Floeristic Region (s):** BA (Bale), GD (Gonder), GG (Gamo Gofa), GJ (Gojam), HA (Hararge), IL (Iluababor), KF (Kafa), SD (Sidamo), SU (Shewa), TU (Tigray), WG (Welega) and WU (Welo).

No.	Name of the Species	Status	Distribution in Ethiopian Floeristic Region (s)*
1	*Acacia bricchettiana*	CR	HA
2	*Acacia negrii*	VU	GD, WU, GJ, HA, SD
3	*Acacia prasinata*	CR	AF, SU
4	*Acalypha marissima*	CR	WG
5	*Acanthus sennii*	NT	GD, GJ, WG, SU, HA, AR, BA, KF, GG, SD
6	*Argyrolobium schimperianum*	EN	TU, GD, GJ, SU
7	*Barleria longissima*	CR	SD
8	*Becium formosum*	VU	BA
9	*Blepharis cuspidate*	CR	SD
10	*Blepharispermum obovatum*	CR	BA
11	*Boswellia ogadensis*	CR	HA
12	*Boswellia pirottae*	VU	GD, GJ, WU, SU, KF
13	*Cadaba divericata*	VU	SD, HA
14	*Cladostigma nigistiae*	EN	SD
15	*Commiphora monoica*	CR	BA
16	*Crotalaria agatiflora*	NT	SU, HA, IL, AR, GG
17	*Crotalaria exaltata*	EN	SU, BA, KF, SD
18	*Crotalaria intonsa*	VU	GD, SU, KF, SD
19	*Crotalaria rosenii*	NT	SU, AR, BA, KF, SD
20	*Crotalaria sacculata*	CR	SD
21	*Cussonia ostinii*	NT	WU, GD, GJ, WG, IL, AR, KF, GG
22	*Delosperma abyssinica*	CR	TU
23	*Delosperma schimperi*	EN	TU, WU
24	*Dombeya kefaensis*	EN	KF
25	*Dombeya longebracteolata*	VU	KF, GG, SD
26	*Echinops ellenbeckii*	EN	SU, AR, HA
27	*Erythrina burana*	VU	HA, BA?
28	*Erythrococca uniflora*	EN	SD
29	*Euphorbia burger*	CR	HA
30	*Euphorbia dalettiensis*	EN	SD, HA
31	*Euphorbia doloensis*	CR	SD
32	*Euphorbia ellenbeckii*	EN	SD
33	*Erythrophysa septentrionalis*	EN	HA
34	*Euphorbia baleensis*	CR	BA
35	*Euphorbia betulicortex*	CR	SD
36	*Euphorbia fissispina*	EN	SD
37	*Euphorbia makallensis*	CR	TU
38	*Euphorbia nigrispinioides*	VU	SU, HA?
39	*Euphorbia ogadenensis*	CR	BA, HA
40	*Euphorbia somalensis*	CR	HA
41	*Euphorbia tetracantha*	CR	BA

42	*Euphorbia uniglans*	EN	SD
43	*Euryops pinifolius*	VU	WU, GJ, SU
44	*Hildebrandtia aloysii*	VU	HA, BA
45	*Hildebrandtia diredawaensis*	EN	HA
46	*Hybanthus puberulus*	CR	SD
47	*Ficus ruspolii*	VU	SD, KF
48	*Helichrysum elephantium*	VU	BA, GG, SD
49	*Helichrysum horridum*	EN	GD, SD
50	*Hybanthus puberulus*	CR	SD
51	*Hypericum gnidiifolium*	VU	TU, SU
52	*Indigofera curvirostrata*	CR	SD
53	*Indigofera ellebenbeckii*	CR	HA
54	*Hibiscus boranensis*	VU	SD
55	*Indigofera kelleri*	CR	HA
56	*Indigofera rothii*	EN	SU, HA
57	*Inula arbuscula*	CR	GD
58	*Inula confertiflora*	NT	WU, SU, HA, BA, AR
59	*Kanahia carlsbergiana*	EN	AR, BA
60	*Lantana kisi*	EN	TU
61	*Lindenbergia awashensis*	EN	AF, SU
62	*Maerua boranensis*	CR	SD
63	*Maytenus addat*	NT	SU, AR, SD, GG
64	*Kirkia burger*	VU	SD, BA, HA
65	*Kleinia gypsophila*	CR	HA
66	*Kleinia negrii*	EN	WU, HA, SD
67	*Kotschya recurvifolia*	VU	BA, HA, KF, SD
68	*Maytenus cortii*	CR	GD
69	*Maytenus harenensis*	CR	BA
70	*Monadenium shebeliensis*	CR	HA
71	*Moringa rivae* subsp. *longisiliqua*	VU	SD, BA, HA
72	*Phyllanthus dewildiorum*	EN	WG, KF
73	*Phyllanthus limmuensis*	VU	GD, GJ, WG, IL, KF
74	*Polyscias farinose*	VU	TU, GD, GJ, SU, KF
75	*Polysphaeria aethiopica*	EN	SD, BA
76	*Otostegia tomentosa* subsp. *steudneri*	VU	GD, WU
77	*Phyllanthus borenensis*	CR	SD
78	*Pseudoblepharispermum bremeri*	CR	HA
79	*Rhynchosia erlangeri*	EN	HA
80	*Rhynchosia splendens*	CR	GD
81	*Rinorea friisii*	EN	IL, KF
82	*Rubus aethiopicus*	EN	SU, GD
83	*Rubus erlangeri*	EN	BA, SD
84	*Sparmannia macrocarpa*	NT	GD, GJ, WU, SU, AR, WG, KF, GG, HA
85	*Stomatanthes meyeri*	CR	KF
86	*Tacazzea venosa*	EN	TU, GD, GJ
87	*Taverniera abyssinica*	CR	TU, SU
88	*Ruellia boranica*	EN	SD
89	*Satureja unguentaria*	EN	GD
90	*Sesbania melanocaulis*	EN	KF, WG
91	*Tephrosia dichroocarpa*	EN	TU, GD, GJ
92	*Terminalia hararensis*	DD	BA, HA

93	*Terminalia hecistocarpa*	DD	BA
94	*Tragia abortive*	VU	GG
95	*Tragia negeliensis*	VU	SD, BA
96	*Verbascum arbusculum*	CR	SU
97	*Wellstedia filtuensis*	CR	SD
98	*Wendlandia arabica* subsp. *aethipica*	EN	SU
99	*Verbascum arbusculum*	CR	SU
100	*Vernonia cylindrical*	VU	TU, GD, GJ, WG
101	*Vernonia dalettiensis*	CR	HA
102	*Vernonia tewoldei*	EN	KF, BA
103	*Vernonia thulinii*	CR	WG

Appendix 3. Forests inventoried and surveyed

	Forests inventoried and surveyed					
No.	**Forest name**	**Region**	**No.**	**Forest name**	**Region**	**Remark**
1.	Abobo	Gambela	27.	Tara Gedam	Amhara	
2.	Ades	Oromia	28.	Tiro Bother Becho	Oromia	
3.	Asebot	Oromia	29.	Wefwasha	Amhara	
4.	Belete Gera	Oromia	30.	Yabelo	Oromia	
5.	Boginda	Oromia	31.	Yayu	Oromia	
6.	Bonga	SNNP	32.	Ziquala	Oromia	
7.	Donqoro	Amhara	33.	Arbaminch	SNNP	
8.	Dindin	Oromia	34.	Bishan Gary	Oromia	
9.	Goderre	Gambela	35.	Metema	Amhara	
10.	JelloMuktar	Oromia	36.	Sheraro	Tigray	
11.	Jemjem	SNNP	37.	Gambela	Gambela	
12.	Jibat	Oromia	38.	Bulen(Debate)	Benshangul Gumuz	
13.	Kedo	Oromia	39.	Yabello		
14.	Kolbu	Oromia	40.	Getaluf		
15.	Kabayo	Oromia	41.	Guza		
16.	Zege – Tana Monastry	Amhara	42.	Barziba Michael		
17.	Limalimo	Amhara	43.	Goha Mariam		
18.	Masha	SNNP	44.	Checheho-Medhanialem		
19.	Maze	SNNP	45.	Argadidim,		
20.	Megada	SNNP	46.	Kefoye-T/Haymanot,		
21.	Mena Angetu	Oromia	47.	Qolaidengors		
22.	Munessa	Oromia	48.	Ata and didim		
23.	Riqie		49.	Soras,		
24.	Setema	Oromia	50.	Maynet		
25.	Sheko	SNNP	51.	Mokish		
26.	Sigmo	Oromia	52.	Huletusiman		

Appendix 4. National parks and wildlife sanctuaries

No.	Wildlife protected areas	Year of establishment	Management category	Area in Sq. Km
1	Abijatta-Shalla Lakes	1970	National park	887
2	Alatish	2005	National park	2665
3	Arsi Mountain	2009	National park	1200
4	Awash	1965	National park	756
5	Babile	1973	Sanctuary	6982
6	Bale Mountains	1969	National park	2471
7	Borena Saint	2006	National park	4375
8	Chebera-Churchura	2005	National park	866
9	Dati Welel	1998	National park	441
10	Gambella	1969	National park	5061
11	Geraille	2005	National park	3858
12	Gibe Sheleko	2008	National park	248
13	Kafta-Sheraro	2007	National park	5000
14	Kuni-Muktar	1985	Sanctuary	27
15	Lake Abaya	2008	National park	500
16	Mago	1978	National park	2157
17	Maze	2005	National park	202
18	Nechisar	1973	National park	514
19	Omo	1966	National park	4068
20	Senkelle	1976	Sanctuary	54
21	Simien Mountains	1966	National park	412
22	Tis-Abay	2009	National park	210
23	Yabello	1976	Sanctuary	2496
24	Yangudi-Rassa	1973	National park	4731
	TOTAL			50181

Appendix 5. List of native forest tree species and respective number identified natural stands

No.	Species name	No of identified seed stands	No.	Species name	No of identified seed stands
1	*Acacia abyssinica*	3	19	*Ekebergia capensis*	2
2	*Acacia albida*	6	20	*Entada abyssinica*	3
3	*Acacia nilotica*	2	21	*Erythrina abyssinica*	1
4	*Acacia polyacantha*	1	22	*Erythrina brucei*	3
5	*Acacia senegal*	3	23	*Hagenia abyssinica*	7
6	*Acacia seyal*	3	24	*Juniperus procera*	8
7	*Acacia tortilis*	3	25	*Milletia ferruginea*	5
8	*Pouteria adolfi-friedericii*	2	26	*Maerua aethiopica*	3
9	*Albizia grandibracteata*	3	27	*Moringa stenopetala*	3
10	*Albizia gummifera*	9	28	*Olea europaea (africana)*	5
11	*Albizia schimperana*	4	29	*Parkinsonia aculeate*	4
12	*Balanites aegyptiaca*	3	30	*Pterolobium stellatum*	5
13	*Cordia africana*	8	31	*Phoenix recilnata*	4
14	*Croton macrostachyus*	4	32	*Podocarpus falcatus*	14
15	*Diaspyros abyssinica*	1	33	*Prunus Africana*	6
16	*Dodonaea angustifolia*	2	34	*Syzygium guineense*	2
17	*Dombya torrida*	1	35	*Tamarindus indica*	2
18	*Dovyalis abyssinica*	3			

Appendix 6. List of tree and shrub species conserved in field gene banks

No	Ex situ Site	No of Conserved Species	Scientific Name of the Species	Area (ha)	Region
1	Adeda, Mandura	5	*Dxytenanthera abyssinica, Vitex doniana, Ziziphus spina-christi, Pliostigma thoningi and Acacia senegal*	4.2	Benshangul Gumz
2	Adulala, Ziquala	11	*Acacia albida, Acacia etbaica, Acacia Senegal, Acacia seyal, Acacia tortilis, Cordia africana, Ficus sur, Hagenia abyssinica, Podocarpus falcatus, Calpurnea aurea* and *Milletia ferruginea*	15	Oromia
3	Ahonsho, Asosa	5	*Cordia africana, Oxytenethera abyssinica, Ziziphus spina-christi, Pliostigma thoningi, and Securidaca longipedunculata*	17	Benshangul Gumz
4	Gareno Gorotta, Goba	4	*Hagenia abyssinica, Podocarpus falcatus, Juniperus procera* and *Olea europaea subsp. cuspidata*	6.5	Oromia
5	Goba (Medicinal Plants)	6	*Cordia africana, Millettia ferruginea, Olea europaea, Maesa lanceolata, Solanu incanum,Withania somenifera*	3.7	Oromia
6	Kona Giorgis, Debre-Tabor	10	*Acacia abyssinica, Cordia africana, Ficus sp, Hagenia abyssinica, Podocarphus falcatus, Milletia ferruginea Juniperus procera, Olea europaea subsp. Cuspidate, Chroton machrostachyus and Dodonea angustifolia*	8.4	Amhara
7	Lephis, Arsi Nagalle	9	*Prunus africana, Cordia africana, Hagenia abyssinica, Podocarphus falcatus, Milletia ferruginea, Juniperus procera, Olea europaea subsp. cuspidata, Calpurnea aurea and Croton machrostachyus*	14.3	Oromia
8	Shashamanne Botanical Garden	19	*Acacia albida, Acacia etbaica, Acacia Senegal, Acacia seyal, Acacia tortilis, Cordia africana, Ficus sur, Ficus sycomorus, Ficus ovate, Ficus vasta, Hagenia abyssinica, Juniperus procera, Podocarphus falcatus, Olea europaea subsp. cuspidate, Prunus Africana, Calpurnea aurea, Croton machrostachyus, Milletia ferruginea and Dodonea angustifolia*	16.2	Oromia
9	Wendo Genet (Medicinal Plants)	7	*Grewia ferruginea, Embelia schimperi,Brucea antidysentrica, Coffea arabica, Dodonea angustifolia, Mayatenus gracilipes, Vernonia amygdalina,*	2.7	SNNP
10	Gulele Botanic Garden	3	*Junuperus procera, Hagenia abyssinica, Olea europaea*	-	Addis Ababa
11	Wendo Genet Arboretum		-	-	SNNP

Appendix 7. Prioritized Main Thematic Areas for Research on Forest Genetic Resources

S/N	Major Research Thematic Areas	Priority Rank	Remarks
1	Reproductive and Conservation Biology	I	
2	Botany and Forest Ecology	II	
3	Indigenous Knowledge	III	
4	Conservation Genetics and Tree Breeding	IV	
5	Silviculture and Forest management	V	
6	Forest Protection	VI	
7	Gender Issues	VII	
8	Forest Economics and Policy	VIII	
9	Forest Product Utilization	IX	

Source: National Strategy for Research on Forest Genetic Resources of Ethiopia (2001)

Appendix 8. List of research institutes involved in FGRs research

Ethiopian Institute of Agricultural Research (EIAR)	Jarati Research Center (Somali
Ambo Plant Protection Research Center	Gode Research Center
Assosa Agricultural Research Center	Dollo Research Center
Bako National Maize Research Project	Kelafo Research Center
Debrezeit Agricultural Research Center	**Amhara Regional Agricultural Research Institute (ARARI)**
Fogera Agricultural Research Center	Adet Agricultural Research Center
Forestry Research Center	Andassa Livestock Research Center
Holetta Agricultural Research Center	Bahir Dar Agricultural Mechanization Research Center
Jimma Agricultural Research Center	Bahidar Fishery and Aquatic Life Research Center
Kulumssa Agricultural Research Center	Debrebrehan Agricultural Research Center
Mehoni Agricultural Research Center	Gondar Agricultural Research Center
Melkassa Agricultural Research Center	Kombolocha Agricultural Research Center
National Fish and Other Aquatic Lives Research Center	Sekota Dryland Agricultural Research Center
Pawe Agricultural Research Center	Sirinka Agricultural Research Center
Tepi Agricultural Research Center	**Southern Agricultural Research Institute (SARI)**
Werer Agricultural Research Center	Areka Agricultural Research Center
Wondogenet Agricultural Research Center	Bonga Agricultural Research Center
Oromia Agricultural Research Institute (OARI)	Jinka Agricultural Research Center
Bako Agricultural Mechanization Research Center	**Afar Pastoral and Agropastoral Research Institute (ARPARI)**
Sinana Agricultural Research Center	Dubti Pastoral and Agropastoral Research Center
Bako Agricultural Research Center	**Tigray Agricultural Research Institute (TARI)**
Yabello Pastoral & Dry land Agricultural Research Center	Alamata Agricultural Research Center
Adami Tulu Agricultural Research Center	Abergele Agricultural research Center
Holetta Bee Research Center	Axum Agricultural research Center
Mechara Agricultural Research Center	Humera Agricultural research Center
Fedis Agricultural Research Center	Maitsebri Agricultural research Center
Bore Agricultural Research Center	Mekelle Agricultural Research Center
Somali Pastoral and Agropastoral Research Institute	**Gambella Agricultural Research Institute (GARI)**
Fafan Research Center	Abobo Agricultural Research Center

Appendix 9. List of universities and their programs related to agriculture and natural resources

Name of University	**Establishment Year**	**College/faculty**	**Programs/departments**
Wollega University	2007	College of Agriculture and Natural Resource	1. Animal Science
			2. Natural Resource Management
			3. Plant Science
			4. Soil and Watershed Management
			5. Water Resource Irrigation Management
Mekelle University	2000	College of Dryland Agriculture and Natural Resources	1. Animal, Rangeland and Wildlife Science
			2. Dryland Crop and Horticulture Science
			3. Land Resource Management and Environmental Protection
			4. Natural Resource Economics and Management
University of Gondar	1954	Faculty of Agriculture	1. Natural Resource Management
			2. Plant Sciences
			3. Rural Development and Agricultural Extension
Jimma University	1999	College of Agriculture and Veterinary Medicine	1. Horticulture and Plant Science
			2. Post-Harvest Management
			3. Natural Resource Management
			4. Animal Science
			5. Agricultural Economics and Extension
			6. Veterinary Medicine
Dilla University	2004	School of Agriculture	1. Plant Science and Protection
			2. Horticulture and Spices
			3. Applied Animal Science and Rangeland Management
			4. Land Resource Management
Addis Ababa University	1950	College of Natural Sciences	1. Plant Biology and Biodiversity Management Program Unit
			2. Environmental Science Program Unit
			3. General Biology Program Unit
Ambo University	1939	College of Agriculture and Veterinary Medicine	1. Plant Science
			2. Natural Resource Management
			3. Animal Science
			4. Veterinary Lab Technology

Arbaminch University		College of Agriculture	1. Plant Science
			2. Animal Science
			3. Horticulture Science
			4. Rural Development and Agricultural Extension
Madawalabu University		Agriculture and Natural Resource	1. School of biodiversity and natural resources
			2. Agriculture
Jigjiga University		Dryland Agriculture	
Debrebrehan University	2006	Agriculture and Natural Resource Sciences	1. Animal Science
			2. Plant Science
			3. Water resource and irrigation management
Aksum University	2005	College of Agriculture	
Wolaita Sodo University	2007	Faculty of Agriculture	1. Animal Science
			2. Plant Science
			3. Natural Resources management
Haramaya University	1952	College of Agriculture and Environmental Sciences	

Appendix 10. List of forest germplasms taken out of the country with MTA

No.	Species name	Purpose of transfer	Research hosting country	Frequency of Transfer
1	*Acacia saligna*	Research	Australia	1
2	*Acacia senegal*	Research	Netherlands	1
3	*Adansonia digitata*	Research	South Korea	1
4	*Albizia gummifera*	Research	Sweden	2
5	*Albizia shimperina*	Research	Germany	1
6	*Boswellia neglecta*	Research	Netherlands	1
7	*Boswellia papyrifera*	Research	Netherland	6
8	*Coffea arabica*	Research	Sweden	8
9	*Commiphora africana*	Research	Netherlands	1
10	*Cordia africana*	Research	Sweden	6
11	*Croton macrostachys*	Research	Sweden	2
12	*Cupressus lustanica*	Research	Germany	2
13	*Ekebergia capensis*	Research	Kenya	1
14	*Erica arborea*	Research	Sweden	1
15	*Erythrina bruccei*	Research	Germany	2
16	*Eucalyptus*	Research	Germany	1
17	*Ficus carica*	Research	Sweden	1
18	*Ficus Spp.*	Research	South Korea	1
19	*Ficus thonningii*	Research	Austria	1
20	*Hagenia abyssinica*	Research	Sweden	4
21	*Hypericum revolutum*	Research	Sweden	1
22	*Jatropha spp.*	Research	England	1
23	*Juniperus procera*	Research	Sweden	2
24	*Milletia ferruginea,*	Research	Germany	2
25	*Mimusops kummel*	Research	South Korea	1
26	*Opuntia ficus-indica*	Research	Germany	1
27	*Pinus pastula*	Research	Germany	1
28	*Podocarpus falcatus*	Research	Germany	4
29	*Prosopis juliflora*	Research	UK	2
30	*Pruns africana*	Research	Germany	4
31	*Tamarindus indica,*	Research	South Korea	1