Forest Genetic Resources Working Papers

State of Forest Genetic Resources in Eritrea

Prepared for

The sub- regional workshop FAO/IPGRI/ICRAF on the conservation, management, sustainable utilization and enhancement of forest genetic resources in Sahelian and North-Sudanian Africa (Ouagadougou, Burkina Faso, 22-24 September 1998)

By

Elias Araya Eman

A co-publication of FAO, IPGRI/SAFORGEN, DFSC and ICRAF

December 2001

Forest Resources Division
FAO, Rome, Italy

Working Paper FGR/23E

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A co-publication of
Food and Agriculture Organization of the United Nations (FAO)
Sub-Saharan Africa Forest Genetic Resources Programme of the International Plant Genetic Resources Institute (IPGRI/SAFORGEN)
Danida Forest Seed Centre (DFSC) and
International Centre for Research in Agroforestry (ICRAF)

December 2001

Working papers FGR/23E

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The current publication « *State of the Forest Genetic Resources in Eritrea* » is issue of country national report presented at *The Sub- Regional Workshop FAO/IPGRI/ICRAF on the conservation, management, sustainable utilization and enhancement of forest genetic resources in Sahelian and North-Sudanian Africa* (Ouagadougou, Burkina Faso, 22-24 September 1998). It is published with the collaboration of FAO, IPGRI/SAFORGEN, DFSC and ICRAF, as one of the country and regional series which deals with the assessment of genetic resources of tree species in the Sahelian and North-Sudanian Africa and identification of priority actions for their Conservation and Sustainable Utilisation.

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Citation

Araya Eman E. 2001 *State of Forest genetic Resources in Eritrea.* Sub-Regional Workshop FAO/IPGRI/ICRAF on the conservation, management, sustainable utilization and enhancement of forest genetic resources in Sahelian and North-Sudanian Africa (Ouagadougou, Burkina Faso, 22-24 September 1998). Forest Genetic Resources Working Papers, Working Paper FGR/23E. Forestry Department, FAO, Rome, Italy.

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1. SOCIO-ECONOMIC AND ECOLOGICAL CHARACTERISTICS

1.1. Geographic position of the country

Eritrea is located in the northeastern part of Africa and covers an area of 124,320 km^2. It is bounded by the Sudan in the west and northwest, Ethiopia in the south, Djibouti in the southeast, and the Red Sea in the east (FAO, 1994). Administratively, Eritrea is divided into six zones (*zoba*) namely: Makel, Debub, Gash-Barka, Anseba, Semenawi Keih Bahri, and Debubawi Keih Bahri.

1.2. Socio-economic information

The population of Eritrea is about 3.5 million out of whom 80% live in rural areas and derive their livelihood from agriculture. There are nine linguistic groups namely: Afar, Bilen, Tigre, Saho, Tigrigna, Kunama, Nara, Hidareb, and Rashaida (MOA, 1993).

The economy of the country declined progressively declined the prolonged liberation war years. Between 1985 and 1990, real Gross Domestic Production (GDP) declined by 0.7% per annum, but has been increasing rapidly since independence. For example, an increase of 8% was reported in 1997. Agriculture is the main economic activity, both as a source of food and raw material for industry. In 1994, crop production, livestock, forestry, and fishery contributed approximately one-third of the Gross Domestic Production (FAO, 1996).

1.2. Ecological information

Due to its geographical setting, Eritrea has diverse climates ranging from hot arid, adjacent to the Red Sea to temperate sub-humid in isolated micro-catchments within the eastern escarpment of the Highlands. About 72% of Eritrea is classified as very hot, with mean annual temperature exceeding 24 ^oC, while not more than 14% is classified as mild or cool with mean annual temperature below 21.5 ^oC (FAO, 1996).

Most parts of the country receive rainfall from the southwest Monsoon, between April and September. Some rains fall in April/May while the main rain starts in June, with the heaviest precipitation in July and August. Only the coastal plains and the central part of the eastern escarpment of the central highland experience winter rainfall, November through March. This is borne by the north and southeast continental air streams with little moisture until affected by the Red Sea. The total annual rainfall tends to increase from north to south, from less than 200 mm at the northern border with the Sudan to more than 700 mm in the south western part of the country. The Green Belt Zone, receives the highest annual rainfall averaging about 900 mm (FAO, 1994).

The soils of Eritrea are highly variable. In the northern and southern sections of the coastal plains of the Red Sea, they are predominantly sandy desert soils. In other part of the plains, ortho-solonchaks, regosols, and andosols are found. In the Highlands, the predominant soils are chromic, eutric, and calsic cambisols of strong red colour. Other soils found in the Highlands are lithosols, xerosols and fluvisols, while soils in the western plains are mainly *vertisols* and fluvisols (FAO, 1996).
Three major forest/woodland types are distinguished in Eritrea: highland forests, acacia woodlands and riverine forests. Originally the highland forests of *Juniperus procera* and *Olea africana* would have extended over much of the plateaux, but have been largely destroyed or

degraded; only remnants now survive. On the lowlands and lower escarpments, *Acacia* woodlands occupy about one-quarter of the land area of the country. Riverine forests fringe river systems of the Gash/Mereb, Setit and Barka in the Lowlands, where Doum palm is an important constituent species. These forests are under the greatest threat as they occupy fertile, well watered and level sites – suited to development for commercial agriculture. But, they are also vital to the lives of the local population. On the coastal plains tree cover becomes increasingly sparse towards the sea. In places along the coast with mangrove forests, the predominant species is *Avicennia marina*.

Natural forest cover has been classified according to six major vegetation types using internationally acceptable methodology.

- Highland forest, composed of a mixture of coniferous species (Juniper) and broad-leaved species (African olive and associated species)
- Mixed woodlands of Acacia and associated species, occurring mainly in the southern part of the western lowlands, but also in restricted areas elsewhere in the country;
- Bush or shrub vegetation, which is the dominant cover in Eritrea;
- Grasslands and wooded grasslands, which occur in many parts of the country;
- Riverine forest, composed essentially of Doum palm, which is common in the Western Lowlands and is frequent in the Eastern Lowlands; and
- Mangrove occurring in many places along the coast but in large concentrations at Assab and between Tio and Massawa.

The natural vegetation of the country constitutes 0.8% highland forest. Forest and woodlands, including riverine forest and mangroves cover 13.5% of the total area. The category "bush" is the dominant vegetation in Eritrea covering 63% of the total area. The riverine forests and mangroves play important ecological and economic roles for rural communities, and occupy 1.5% and less than 0.1%, respectively. The most recent national vegetation cover data are presented in Table 1.

Table 1: Forest/ Woodland Type and Distribution

Forest Type	Km^2	Share of Total Area
Forest		0.8%
- Closed to medium forest	591	
- Open forest	410	
Woodland		11.3%
- Closed to medium closed woodland	4533	
- Open woodland	9541	
Bushland		63.8%
- Grassland/Wooded Grassland	25,577	
- Bushland	53,824	
Riparian forest		1.6%
- Riverine forest	1,865	
- Mangroves	64	

Source: Interpretation of Landsat TM by FAO project TCP/ERI/12 July 1997

2. STATE OF FOREST GENETIC RESOURCES

2.1. Phytogeography of the country

The vegetation of Eritrea has been described in a number of different publications, including some historical Italian-accounts, which still contain useful information, especially with regard to rates of change of natural vegetation. Perhaps the most significant of these is Pichi-Sermolli (1957 cited in Eritrean Biodiversity Stocking Assessment, 1998), which recognized 24 vegetation types and provided detailed descriptions of the typical species composition and distribution of the vegetation types in Eritrea.

More recently, the forest vegetation of NE Africa, including Eritrea has been described by Friis (1992 cited in Eritrean Biodiversity Stocking Assessment, 1998). These vegetation descriptions agree generally with those presented in White's Vegetation Map of Africa.

Descriptions of the regional vegetation of Eritrea were produced by Bristow and, for the coast, by Hemming (1961 cited in Eritrean Biodiversity Stocking Assessment, 1998). "The useful trees and shrubs in Eritrea" by Bein *et al*. (1996) was published more recently. The descriptions below are derived largely from these accounts, supplemented by additional material drawn from other sources.

The country is classified into six agro- ecological zones based on altitude, vegetation, and other ecological and geographic factors. The classification is very appropriate, although open for modification, as additional information are made available. The zones are:

Central Highlands Zone

The Central and Northern Highlands cover an area of 2,672,000 ha. This area includes the plateaux of the highlands and the higher parts of the eastern and western escarpments. It receives an uneven rainfall throughout the year. In the highlands around Asmara, the wet season may extend from March to December, but July and August are the only months with relatively reliable rainfall.

About 30 km North-East of Asmara, on the escarpments facing to the east, the area is more or less evenly rain fed all the year round. It is clear that on the highlands, depending on the latitude and slope directions, fluctuations of the precipitation levels is sometimes considerable. Temperature varies from one site to another, depending on latitude, altitude and slope directions.

As result of the relatively high moisture and lower temperature in this area, a specific floristic composition has been evolved. The relatively high rainfall and moderate climate have attracted more people to establish their farming systems, in the Highlands, mostly at the expense of the natural vegetation. Widespread clearing has converted forests into cultivation fields; and timber and non-woody collections have significantly disturbed the remaining forests. Some remnants of mountain mixed evergreen forests still exist in small locations throughout the highlands.

The mixed natural forest of the highlands is composed mainly of *Juniperus procera* and *Olea africana,* which may also be found in pure stands. *Juniperus procera* tends to occupy the higher elevations.

At lower altitude, it is either mixed or totally replaced by *Olea africana* and a number of other species. This formation also includes *Celtis africana, Carissa edulis, Teclea nobilis, Anogeissus leiocarpus, Dodonaea angustifolia, Combretum molle, Acacia etbaica,* and *Terminalia brownii*. The height of the principal tree species encountered (*Olea africana, Juniperus procera*) ranges from bush-like vegetation to over 15 m. The forest stands are composed of more than layers with varying crown closures.

Western Escarpment Zone

The western aspect of the mountains is relatively dry and hot. Rainfall regime and mean daily temperature change drastically from the top of the mountains to the Western Lowlands and from the relatively wet south to the drier north. The western part of the country receives rainfall from the southwest monsoon from April to November, with the heaviest rains in July and August. With the decrease of moisture and increase of temperature as one goes towards the west, the natural vegetation changes in composition, structure and physiognomy. In general, except in restricted sites, vegetation is very poor, low and scattered, and is composed largely of scattered shrub-like acacia species. Closed canopy woodlands are very rare, but do occur occasionally in the southern part of the area and in depressions and flat terrain between the mountains.

Human pressure on natural vegetation is higher in the southern portion of the watershed, owing to the higher rainfall, and diminishes in the dry northern part. The floristic composition of the natural woody vegetation includes a number of tree species namely: *Terminalia brownii, Albizia amara, Boswellia papyrifera, Euphorbia abyssinica, Faidherbia albida, Balanities aegyptiaca, Syzygium guineense, Tamarix aphylla*, etc. The average height of trees in this vegetation ranges from 2 to 5 m, sometimes higher in very limited areas. Density varies from thicket-like in depression to scattered trees or shrubs.
The physiognomy of the woody vegetation suggests three main classes in the western escarpment namely: closed to medium closed canopy woodlands, open woodlands and shrublands/bushlands.

The Green Belt Zone

This zone, on the Eastern Escarpment, is one of the few remaining areas of relatively undisturbed natural woody vegetation in upland Eritrea. The area is unique as it is fortunate to have two rainy seasons providing more than 1,000 mm annually. This accounts for its relative luxuriance and high rates of growth and regeneration. The major rainy season is from June to August, with light rains November to December.

The Eastern Escarpment forests are located to the north east of Asmara and cover an extensive area from the top plateau, running down to the east through several ranges of hills to the beginning of the Eastern Lowlands. The entire area has been, in theory, 'enclosed,' although several hundred families have maintained cultivation rights in the area. There is a significant amount of grazing, particularly around the forest margins. Even so, virtually all the steeper hillsides are covered with woody vegetation. Canopy cover ranges from 20 percent on hillsides to 80 percent in gullies and valley bottoms. At the highest point of the forested area (2300 m) vegetation is dominated by scrubby *Juniperus procera*, seldom exceeding 8m in height (despite its potential for reaching 40 m). The species is slowly regenerating and young trees are relatively plentiful. Other species found in these forests include *Acacia etbaica, A.abyssinica, Euclea schimperi* and *Carissa edulis*. African olive is uncommon although it

was once a dominant part of the flora. There is sparse under-storey of Aloe abyssinica and various grasses. Sisal (*Agave sisalana*) is found along roadsides, but is not under cultivation for fibre production.

A large range of species is found at lower elevations. These include *Terminalia spp., Barbeya oleaides, Celtis africana,* large numbers of *Dodonaea viscosa (angustifolia), Rhus abyssinica, Croton macrostachys,* and *Diospyros mespiliformis (African Ebony)* in well watered areas. The understory includes *Jasmium sp., Rosa abyssinica, Asparagus africana* and a range of shrubs and climbers. At the lowest elevations, the species range diminishes and is dominated by *Acacia etbaica, Balanities aegyptiaca* and *Cadaba rotundifolia.*

The Southwestern Lowland Zone

The South western Lowland Zone covers 20,000 km^2 in the Gash Barka Zone with rolling hills to the east that level out into flat fertile plains in the west. These plains are comprised of mostly fertile vertisols and are as yet under-utilised for agriculture. They are however difficult to cultivate. The area comprises important surface water resources consisting of the perennial Tekeze/ Setit river system, and the seasonal Mereb/Gash and Barka systems, which flow for 3 to 4 months annually.

Tree cover is characterised in the east by extensive savannah woodland covering rolling hills, and very large areas of annual grassland, with scattered *Acacia/Capparis* shrub and woodland. The vegetation shows very little signs of grazing or browsing. It is likely that species composition and density has not changed much in recent history, although larger trees have probably been taken for fuel wood and construction. Regeneration is patchy but evident for most species, with the exception of *Adansonia digitata.* The characteristic shapes of heavily browsed trees and shrubs, including those in populated settlements, are not apparent.

Extensive forests of Doum palm (*Hyphaene thebaica*) are found near major river systems, particularly the Barka and Gash. The trees are healthy and, although stems had been considerably exploited in the past for timber, they have been used minimally recently. The preference for mid-sized palm timbers for building purposes may explain the present two-storied forest structure, with tall old trees providing a scattered canopy over early vegetative phases of the palm comprising leaves without any significant stem. There are no intermediate size trees. These palms regenerate from the base when cut, so stem cutting is not as serious a threat as it can be to other species. Uncontrolled leaf cutting, however, is a major threat. Other parts of the riverine forest support *Faidherbia albida, Ficus sp*., and *Ziziphus spina-christi. Prosopis chilensis* and/or *P.juliflora* are making an appearance in the Tessenei area of the riverine forest, and this exotic is likely to spread, causing considerable difficulties to cultivators and herders.

The Northwestern Lowland Zone

The North Western Lowland covers 3,040,000 ha. There is little information about the vegetation of this zone. For the most part it consists of extensive sandy plains with *Acacia scrub, Capparis decidua, Balanites aegyptiaca, Calotropis procera* (where the water table is near the surface), *Boscia senegalensis* and a range of other semi-arid species. Extensive and fringing riverine forests can be found along seasonal watercourses, similar to those described in the previous section. Pastoralists following traditional migration routes frequently use this

zone. There is very little rain-fed agricultural cultivation as rainfall is inadequate. Fuel wood reserves are extensive.

The Coastal Plains Zone

The total area of the Eastern Coastal Plain is 4,670,000 ha. The coastal plains average around 24-32 km in width and consist almost entirely of mixed sand and stony alluvium (river flow deposits) derived from the highlands to the west. Along much of the coast, a broken line of limestone hills running approximately parallel to the coast about 15 km inland interrupts the plains. Near Massawa, there is another range of hills about 35 km inland which result in the formation of a sub-coastal plain at around 1000 m. South of Massawa the coastal plain is interrupted by the hills forming Jebel Ghedem which rises to 1018 m.. South of Jebel Ghedem, the coastal plain is formed from lava baserock overlain in most places with silt and gravel alluvial deposit.

The vegetation of the coastal plains is, in general, sparse and forms only a thin, partial cover to the land. Much of the vegetation of the region is similar in species composition and is dominated by species assemblage tolerant of a combination of drought, grazing pressure and salinity. There are however significant differences in plant community composition in response to local variations in conditions. No recent, complete floristic inventory has been undertaken in this zone and the species identified for this zone are undoubtedly incomplete. However, Hemming (1961) provides the best available description of the plant ecology of the coastal area of northern Eritrea.

Around Zula, much of the natural vegetation has been cleared for agriculture. Uncultivated areas are mostly degraded and heavily grazed, consisting mostly of weedy species, such as *Echinochloa colona, Datura metel, Solanum sp., Aerva javonica* and *Heliotropium petrocarpum*. Nearer to the shoreline, saline areas not used for cultivation, are covered by patchy *Suaeda monoica*, with a ground layer of *Cenchrus ciliaris* grass and occasional *Trianthema crystallina*.

On the richer loamy sands near Hirgigo and Wangobo, the grass cover is more extensive, comprising mostly *Cenchrus ciliaris* and *Cenchrus setigerus, Dactyloctenium scindicum* and very occasional stunted *Acacia tortilis* trees. This area is under considerable grazing pressure.

The plains lying between Wadis Wakiro and Desset support scattered low *Acacia tortilis* bushland, mixed with *Salsola spineseens* bushes after good rains. The groundcover may contain *Heliotropium pterocarpum, Euphorbia aegyptiaca, Dauerygium glaucum, Tribulus longipetalus,* and small amounts of *Aerva javonica and Aristida* spp. *Panicum turgidum*, a grass, is predominant at areas with deep soil, while in more saline soils, this species is replaced by *Eleusine coca* and *Dactyloctenium scindicum.* However, *Sueada monoica* bushes with *Dipterygium glaucum* and *Cenchrus ciliaris* grass cover are found in areas with most saline soils.

2.2. Utilization patterns of forest species

The vegetation cover is heavily denuded. Fuel wood consumption is one of the serious detrimental demands on ecology. Wood fuel is the major source of household energy in the country. The national fuel wood consumption is estimated at 1.29 million metric tonnes annually. Rural communities and most urban households, including some commercial

enterprises, depend on biomass fuel for energy, but the supply has dwindled. Hence, the rural people who used to enrich farmlands with animal manure and agricultural residues have minimised their traditional practice, not out of choice, but need. Instead, they are using such by-products for fuel due to the scarcity of fuel wood. This is causing environmental deterioration and reduction of soil fertility.

Significant non-wood products include gum arabic, gum olibanum and dried doum palm leaves. Both gum arabic and gum olibanum are traditional non-wood products of Eritrea. Although world prices exhibit fluctuations, there exists a preference in final markets for the natural products rather than synthetic substitutes. In 1996, 463 tonnes of gum olibanum and 117 tonnes of gum arabic and in 1997, 542.6 tonnes of gum olibanum and 49 tonnes of gum arabic were produced under MOA licence.

The country has no domestic supply of timber, importing 60,000 cubic metres annually. The landed value of timber is currently around US$ 332 per cubic metre (FAO, 1997). Transmission poles and scaffolding are also imported. Matches are produced in Asmara from imported splints. Undoubtedly Eritrea has an expanding need for construction grade softwood timber, spurred by an expanding population and expected rapid development.

2.3. Threats

Eritrea was once host to a wide variety of fauna and flora. However, due to mismanagement and natural calamities, these resources have dwindled greatly. As a matter of fact, many of them are either extinct or endangered. The main causes of forest destruction in Eritrea are: expansion of agriculture and unwise land use, overgrazing, traditional house construction, fuel wood and charcoal, and past excessive logging for timber production.

Endangered or rare species are those which have low numerical abundance compared with others (Schulze *et al*, 1994). Several tree and shrub species are endangered in Eritrea. *Boswellia papyrifera*, which is found in the western lowland is endangered owing to excessive and unwise exploitation for the production of gum olibanum. *Adansonia digitata*, the baobab tree, is also regarded as endangered owing to insufficient regeneration. Local people use the fruit for medicinal purposes and its bark, leaves and fruits as emergency food. In areas, where sesame oil crop is grown, people use the stem of *Tamarindus indica* for turning the mortar for the production of sesame oil. In addition to this, the fruit are used for food and medicine. As a result, the population has decreased significantly. *Balanites aegyptiaca* and *Ximenia americana* are also regarded as endangered species.

Effective study as to the number, type and distribution of flora has not yet been conducted in Eritrea. Due to this fact, the data and information, especially of herbs and succulent plants, which do have great importance in terms of bio-diversity, are very limited. Some of these may well be extinct.

The University of Asmara, the Ministry of Agriculture, and the Ministry of Marine Resources of the State of Eritrea are working co-operatively to identify the existing species, their distribution, their local uses, and propagation techniques. So far, some species have already been recognised as endangered. List of these species as per 1997 is tabulated in Table 2.

Table 2. Endangered trees and shrubs species

No	Scientific Name	Common Uses
1	*Albizzia anthelmintica*	Firewood, timber, fodder,tannin
2	*Adenosine digital*	Food source,medicinal
3	*Balanites aegyptiaca*	Food, fodder, building, medicinal, firewood
4	*Boscia angustifolia*	Food, building,artifact,medicinal
5	*Boscia salicifolia*	Food, fuel, fodder,tool,furniture
6	*Boswellia papyrifera*	Incense,fodder,medicine,building
7	*Buddleja polystachya*	Fodder,construction, medicine
8	*Commiphora africana*	Food,fodder,incense,medicinal
9	*Cordia africana*	Food,building,shade,bee forage,
10	*Croton macrostachys*	Firewood,building,tools,drum
11	*Diospyros mespiliformis*	Fodder,firewood,building
12	*Diospyros abyssinica*	Firewood, charcoal, timber
13	*Dobera glabra*	Firewood, timber, food ,fodder
14	*Entada abyssinica*	Firewood, timber, fodder, medicine
15	*Erythrina abyssinica*	Firewood, soil conservation, nitrogen fixation
16	*Ficus sycomorus*	Food, bee hive, shade
17	*Ficus vasta*	Food, bee hive, shade
18	*Juniperus procera*	Pole, timber, firewood, medicinal
15	*Kigelia africana*	Firewood, timber, fodder, bee forage, dye
19	*Maesa lanceolata*	Firewood, medicine, live fence
20	*Maerus crassifolia*	Firewood,
21	*Mimusops kummel*	firewood, fodder, for tool handle
22	*Nuxia congesta*	food, firewood, furniture
23	*Oncoba spinosa*	Firewood, timber, medicine, fodder
24	*Ozoroa insignis*	Firewood, timber, medicine, fodder
25	*Pappea capensis*	Timber, medicine, gum
26	*Piliostigma thonningii*	Firewood, timber, fodder
27	*Prunus africana*	Firewood, timber, medicine, fodder
28	*Rhus abyssinica*	food, firewood, construction
29	*Rhus natalensis*	food, firewood, construction
30	*Syzygium guineense*	firewood, construction wood
31	*Securidaca longipedunculata*	Poles, medicine, bee forage
32	*Tamarindus indica*	firewood, food, furniture, mortar
33	*Ximenia americana*	food, fodder, firewood, oil

Source: Report of the Ministry of Agriculture (1997).

** Due to limited information, the extinct and endangered herbs as well as the extinct tree species are not included in the above table.*

3. MANAGEMENT OF FGR

3.1. In situ conservation activities

The current MOA enclosure policy was initiated in the Highlands and, to some extent, has been based on a traditional system of land management used by agriculturists in the Highlands for many years. The immediate objectives of the enclosure policy are to:

- create favourable conditions for vegetation recovery through natural regeneration;
- develop pastoral reserves for the growing livestock numbers and woody biomass for local people;
- protect endangered tree and wildlife species from extinction;
- control runoff and loss of arable land by erosion;
- increase infiltration for water conservation and for more soil moisture.

The term "forest (or woodland) enclosure" applies to any area put under full or partial protection by implementing a number of measures intended to halt or at least limit human pressures placed on existing resources.

A survey of existing and potential closures was completed by the recent FAO Pre-Investment Study mission to MOA and provides the first comprehensive assessment of the extent of the closure system in Eritrea (FAO, 1997). The results of this survey are summarized in Tables 3 and 4. These data reveal that the overall area enclosed is 8.3% of total forest and woodland habitat type.

Table 3: Summary of Forest/ Woodland Enclosures Established in Eritrea

Zobas (Zones)	**Permanent Enclosures**		**Temporary Enclosures**		**Potential Enclosures**	
	Number	Area (ha)	Number	Area (ha)	Perm.	Temp.
Maekel	7	4,990	5	4,500	10	1
Debub	24	13,843	16	1,290	2	17
Anseba	17	8,138	2	64	0	1
Gash-Barka	10	23,435	10	8,650	0	0
S.K.Bahri	20	59,932	0	0	15	0
D.K.Bahri	0	0	0	0	5	0
Total	78	110,338	33	14,504	32	19

.

Table 4: Forest/ Woodland Enclosures Established In Eritrea By Zoba

Zobas	**Forest and Woodland area (ha)**	**Area Enclosed (ha)**	**% Area Enclosed**
Maekel	10,300	9,490	92
Debub	197,100	15,133	8
Anseba	157,100	8,202	5
Gash-Barka	708,200	32,085	5
S.K.Bahri	311,200	59,932	19
D.K.Bahri	123,500	0	0
Total	1,507,400	124,842	8.3

3.2. *Ex situ* conservation activities

Seed demand and supply

In 1996, government nurseries collected 3103 kg of seed and produced approximately 9 million seedlings, while the amount of seedlings produced in 1977 was 8.1 millions.

As the level of seedling production seems relatively constant at the moment, the actual seed demand has been calculated on basis of 1996 and 1997 annual reports from the nurseries on seedling production. The Forestry and Wildlife Divisions has compiled these reports.
These calculations are based on the total number of seedlings of the most commonly planted species in the country. With 1100 plants (spacing 3 x 3 m) per ha, 50% loss in the nurseries and 20% replacement in the field, the total annual seed demand for the country is estimated around 1600 kg.

As NTSP is being fully integrated into the FRD under DARHRD, it is not likely that NTSP will develop into an independent seed supplying organization. Instead NTSP will become the national focal point for tree seed quality control and advisory services on procurement of quality seed, supporting the activities of the zones on seed procurement through training, information service, research and minor physical inputs, and by support to identification and establishment of seed sources.

The zonal offices of the Forestry and Wildlife Division are responsible for the planning of seedling production, and NTSP should therefore ensure that they have information on available seed sources in their zones. Furthermore, NTSP should introduce a simple seed documentation system and assist in its implementation at the zonal levels.

The present structure with a large number of nurseries collecting seeds locally should be supported. Centralization of the collection of abundant and "easy-to-handle species" would not be as efficient nor sustainable as decentralized collection. Difficult species could however be collected, stored and distributed by NTSP. Furthermore, imports of seeds should be managed by NTSP.

The nurseries are in great need of training for staff, especially in seed collection procedures. Improvement of the understanding of physiological and genetical aspects of seed quality is also needed. NTSP must analyse the training needs, and implement training courses for nursery staff in the zones.

Plantation

Prior to liberation (before 1991), though few accurate records were maintained, tree planting was concentrated within 6 major catchments (namely, Anseba, Nefhi, Damas, Mereb, Ferendyt and Leghede) as part of a soil and water conservation strategy, based on Food-for-Work. In this way over 10,000 ha of plantation were planted, mainly consisting of *Eucalyptus cladocalyx,* but also *Eucalyptus globulus, Eucalyptus camaldulensis, Acacia saligna, Acacia decurrens* and *Acacia mearnsii.* Such work was nearly always combined with physical terracing operations. Due to the lack of subsequent maintenance, few of these plantations remain.

In the years leading up to liberation, tree planting by farmers appears rarely to have taken place. Tree planting for amenity by municipalities has obviously taken place in the past, to good effect, but due to the uncertainties prevailing over latter years, existing trees have been damaged, or have died. This tree planting exercise was based on approximately 31 nurseries, located principally within territories held by Ethiopia.

Following liberation (1991-1997) about 65.24 million seedlings have been planted and 124,480 ha of an area closed for natural regeneration. The survival rate of the planted

seedlings, is between 30 and 40% in the Lowlands and 60 to 70% in the Highlands. Details of major activities are given in Table 5.

Table 5. Achievements of afforestation Programme (1991 – 1997)

No	Activity	Unit	Achievements
1	Hillside terrace con.	ha	17,200
2	Check dam con.	km	2,000
3	Micro basin con.	No	1,084,200
4	Seed collection	kg	21,700
5	Seedling- production	No	75,904,800
6	Planting & Replanting	No	65,248,100
7	Road-construction	km	240
8	Spot weeding & cultivation	ha	1,300
9	Nursery establishment	No	47
10	Closure area	ha	124,480
11	Peasant training	No	4,440

Since Liberation, there has been an upsurge of interest on tree planting by individuals, communities and organizations with large numbers of seedlings collected from nurseries, free of charge. Since 1994 Eritrean students, have been participating in a national afforestation and soil conservation programme organized by the Ministry of Education and the Ministry of Agriculture during the summer vacation. Approximately 19,000 students have participated every year, resulting in the planting of nearly 5.8 million tree seedlings.

3.3. Selection and genetic improvement

Tree Improvement

NTSP's tree improvement activities relate to national needs and will benefit both the public and private sectors concerned with tree planting programmes. Tree improvement in the broad sense means the application to silvicultural practices of the principles, methods, and technologies of genetics of trees. Tree improvement encompasses the following main activities:

- matching seed source to planting site, using existing knowledge of environmental conditions of seed source and planting site, as well as specific knowledge of performance of species and provenances in particular environments,

- identification of provenances and individual trees of superior performance for the products required, as done in provenance, progeny, and clonal trials, and

- mass production of improved genetic material as done in seed stands, seedling or clonal seed orchards, clone gardens, possibly micro-propagation (meristems, cell-cultures).

At present, knowledge of genetic variation of species in Eritrea is very limited. In general, it is therefore recommended to use seed from local, well adapted seed sources for any planting area. Matching seed source to planting site therefore implies using seed sources located within the same area, and having similar environmental conditions as the prospective planting sites.

Enhanced performing material for production forestry would be used as more knowledge on performance of specific provenances or selections in various environments become available.

Selection of species and level of intensity for improvement are based on economic considerations, and the more intensive the improvement work, the higher the cost. Generally, the "investment" that may be made in improving the genetic qualities of tree species depends on the expected returns in terms of increased value production per unit area and year of the improved material, as well as the area where the material will be utilized.

Species/Provenance Trials

The medium and long-term afforestation efforts of Eritrea will be more successful if the most suitable species are used. The choice of species for a particular area must be considered, not only with regard to their suitability for survival and growth, but also whether they fit the purpose for which they are planted. The most suitable species can only be identified after comparing the performance of a large number of potentially suitable species in the environment where plantations are going to be established.

For species with wide natural distribution, it is important to examine if there are important differences in adaptability and productivity among different provenances. This is especially so for *Eucalyptus* species which have been introduced from the end of the last century. Four *Eucalyptus* species have been popular and are the most planted species in the Eritrean highlands and midlands. The original introduction and successive additional imports were poorly documented as to their identity and origin. Their genetic history is therefore obscure and problems are beginning possibly to arise with inbreeding depression. Possibly, early introductions might have been made from single-tree collections.

The medium and long term afforestation efforts with *Eucalyptus* in the Eritrean Highlands and Midlands using *Eucalyptus* seeds produced in the region itself should take into account potential growth restrictions due to inbreeding problems. Consequently, to enlarge the genetic base in the Highlands and Midlands of Eritrea, the National Forestry Research Programme recently introduced other species and provenances of this genus from Australia. The objective is to determine the extent and pattern of variation between provenances of promising species with wide natural variation, in order to select the most promising provenance for establishment of seed stands of the genus *Eucalyptus*.

Species/Provenance Trials of Eucalyptus

Five species provenance trials were established during 1995 in three groups as follows:

- Three seed lots of *Eucalyptus cladocalyx* and one of *Eucalyptus leucoxylon* from Australian natural provenances and a local (Adi-keih) *Eucalyptus* provenance (landrace) were included in one trial at Merhano and in one trial at Adi-keih.

- Seed lots from Australia of *Eucalyptus globulus* sub-species *globulus, Eucalyptus globulus* subspecies *maidenii, Eucalyptus globulus* subsp. *bicostata*, along with a local landrace of *Eucalyptus globulus* sub-species *globulus* were included in a second trial, also located at Merhano and Adi-keih.

- In a third trial at Merhano, four seedlots of *Eucalyptus rudis* and one of *Eucalyptus camaldulensis* from Australia, along with a local landrace from Maitekela were included.

- One trial was established with four *Eucalyptus* provenances in Shambuko. Termites have destroyed this trial.

Provenance Trial of Gliricidia Sepium at Halhale (1995)

Seed of three provenances of *Gliricidia sepium* (82/94 Retalhuleu, 12/91 Belen Rivas and 12/91 Monte Rico) of the five top performers was given to Eritrea for verification trials. The objective was to study differences between selected best provenances of *Gliricidia sepium* under non-optimal conditions for the species, i.e. higher than normal altitude, and lower than normal rainfall.

The survival of all provenances decreased to low levels and most plants had died back due to frost in early 1997. The provenances ought to be tested again at lower altitudes. The trial will be abandoned, but maintained for the production of vegetative material obtainable for some years.

Provenance Trial of Cordia africana (Halhale,1997)

Provenances included *Cordia africana, Hal-hal, Cordia africana, Mai-Aini, Cordia africana, Shambuko.*

3.4. National priority species

The first step in a tree improvement programme is to determine the species to be included and the level of improvement intensity for the selected species. The integrated approach can be utilized as a tool for making initial decisions.

Species may be ranked according to a number of criteria; the most important criteria are area planted with a species, and the value of production on that area. Table 6 shows the ranking of species in order of priority based on their estimated share of total annual planting area in 1996.

Table 6: Ranking of Species in Order of Priority

Species	Area (ha)	% of area
Eucalyptus cladocalyx	2677	39
Eucalyptus rudis	696	10
Eucalyptus globulus	585	9
Dodonaea angustifolia	454	7
Acacia etbaica	402	6
Acacia senegal	382	6
Acacia saligna	351	5
Schinus molle	268	4
Olea africana	246	4
Eucalyptus camaldulensis	184	3
Leucaena leucocephala	157	2
Melia azedarach	135	2

Cupressus lusitanica	89	1
Azadirachta indica	86	1
Cordia africana	55	1
Juniperus procera	39	1
Total	**6806**	**100**

4. POLICY, PLANNING AND INSTITUTIONAL MECHANISM

4.1. National forest policy and legislation

The pre-existing policy, and associated rules and legislation, is known as *Forest and Wildlife Conservation and Development No. 192/1980*. This was inherited from the Ethiopian administration. The intention of the current Government is that it is replaced by a revised proclamation, which had been in draft form since currently in draft since 1996.. This draft defines the following sub-sector objectives:

- produce fuel wood and construction poles;
- promote soil conservation through reforestation;
- restore the ecosystem through natural regeneration;
- promote the development of non - wood forest products; and
- protect the existing known populations of endangered wildlife while undertaking a national reconnaissance of remnant habitats and associated communities.

The last clause of government's draft policy for the forestry and wildlife sub-sector has also been shaped by its ratification of international agreements for trade in endangered species (CITES,1974), and the Convention on Biological Diversity (COB, 1992).

In pursuance of these objectives, the following elements of a draft strategy have been put forward:

- implement the international agreements relating to forestry and wildlife;
- establish national parks and other areas for the conservation and management of wildlife;
- conserve, protect and establish a system for sustainable use of the forests and wildlife of Eritrea;
- develop plans to protect current endangered wildlife and habitats in consultation with local land users;
- produce fuel wood and construction material in a sustainable fashion through private wood lots combined with increased royalties on existing forest lumber;
- protect catchments by permanent and temporary closure, augmented where necessary by reforestation;
- promote the use of multiple-use tree species and the development of agroforestry;
- encourage the introduction and adoption of alternative energy sources;
- promote participatory approaches for the protection and restoration of the environment;
- ensure the sustainable exploitation of wood and non-wood forest products;
- make tree seedling production financially self sustaining through charging for seedlings; and
- raise public awareness of and commitment to general conservation issues as they affect Eritrea.

One area of potential incompatibility between the productive and conservation roles of the Ministry of Agriculture is the impact of clearing of natural forest vegetation for agricultural development under concession agreements.

4.2. Institutions involved in FGR

Ministry

Within the Ministry of Agriculture (MOA) there are 3 Departments, each with several divisions as follows:

Land Resources & Crop Production	***Animal Resources***	***Research and Human Resources Development***
- Crop production and Protection	- Animal Health & Protection	- Agricultural Engineering
- Irrigation & Soil Conservation	- Animal Production	- Crop Development
- Forestry & Wildlife Develop.	- Range lands & Nutrition	- Forestry Development
- Survey & Design		- Livestock Development
		- Human Resources
		- Agricultural Engineering

There is also an Administrative Division and supporting units directly under the Minister. Other institutions such as the Department of Environment from the Ministry of Land, Water and Environment and University of Asmara have direct relationship with the forestry sector of the Ministry of Agriculture.

Regional Administration

There are 6 Regions (Zoba) and 51 sub-regions (Sub-zoba). Although 8 of the sub-regions are cities, they are likely to have tree planting activities. The Ministry of Agriculture in the Regions still reports to the MOA Headquarters at Asmara, although under the existing arrangements more autonomy exists in the Regions than formerly. The administrative structure in the Regions is similar to that at HQ, although somewhat simplified. There are two Sub-Divisions; beneath each are listed their respective Units.

Land Resources & Crop Production	***Animal Resources***
- Crop production and Protection	- Animal Health & Protection
- Irrigation & Soil Conservation	- Animal Production
- Forestry & Wildlife	- Rangelands & Nutrition
- Survey & Design	

Planning and programming are to be conducted independently in the Regions, which will submit their own draft programmes and budgets annually to HQ. Licensing and control (including granting of agricultural concessions) is also entrusted to various degrees to the Regional level, where it comes directly under Senior Agricultural Officers.

Sub-Regional Administration

This is similar to the Regional set-up. Under the Head of the Agricultural Sub-Division are two units: Animal Resources and Land Resources & Crop Production. These operate mainly at the technical level, and report to the appropriate Regional Divisions.

Forestry and Wildlife reports are produced monthly, quarterly and annually at Sub-regional level, and are incorporated in the appropriate periodic report of the Agricultural Sub-Division before being sent to regional level. Here, they are amalgamated into the Regional periodic report for the various units that compose the Ministry of Agriculture. This is sent to the central MOA in Asmara, where the Annual Report for the Ministry is prepared by amalgamating the reports for the various Regions. The reports are produced to standard formats, and are accompanied by standard forms containing the requisite data on different aspects of forestry.

5. TRAINING AND RESEARCH CAPACITY BUILDING AND REINFORCEMENT

Forestry research, at the Department of Agricultural Research and Human Resources Development (DARHRD), started in 1994 with the first field experiments established in 1995. More recently DARHRD had established Forestry Research Division with the following main components: National Tree Seed Project (NTSP), Silviculture and tree improvement research and Agroforestry research and demonstration.

The following are highlights of previous and on-going forestry research activities :

- Species elimination trials with some 20 potentially useful indigenous and exotic species have been established at five locations (Merhano, Halhale, Adikeih, Shambuko, and Ghinda) since 1995.
- Experiments focusing on evaluation of several *Eucalyptus sp.* and provenances have been established at three locations (Merhano, Adi keih and Halhale) since 1996.
- A trial of *Gliricidia sepium* provenances supplied by the Oxford Forestry Institute was established at Halhale location in 1995. Trials of *Cordia africana* (3 local provenances) at Halhale and *Acacia senegal* (17 provenances) at Shambuko have been established since 1997.
- A fodder species trial with *Gliricidia sepium, Leucaena leucocephala,* and *Sesbania sesban* was established at Halhale location in 1996.
- Spacing and crop performance trial with *Cordia africana* and *Jacaranda mimosifolia* was established at Halhale in 1995.
- The first agroforestry research/demonstration trial was established at Halhale in 1996 with *Cajanus cajan* and the commonly planted crops in that area(wheat/barley and pulses). Alley cropping trial with *Leucaena leucocephala* at Halhale and adaptation potential of tree planting on field boundaries and terrace hedges at Halibmentel were also established in 1998.
- Nursery studies on seed pretreatment, germination, seedling pot sizes for six commercially important indigenous species have been conducted at Bietghiorgis nursery (near Asmara) since 1995.
- Broadening the range of potentially useful indigenous and exotic species like *Leucaena leucocephala, Sesbania sesban, Acacia saliga, Acacia etbaica, Acacia polyacantha Chamaecytisus palmensis, Grevillea robusta, Albizzia lophanta, Casuarina cristata, Casuarina glauca, Desmanthus vulgatus, Moringa oleifera* etc. were included in the trials established during 1996 and 1997.

Development of National Medium-Term Operational Plan for Agricultural Research (Owino,1998)

Eritrea has developed its "Medium-Term Operational Plan for Agricultural Research" (MTOP) for both short-term (1997-2000) and medium-term (2001-2003) period. This document identifies priority research activities and elaborates their implementation plans. According to this document, the priority areas identified for forestry research are ranked as follows:

Table 7. Ranking of Forestry and Agro forestry Research Areas in the Medium Term Operational Plans for Forestry Research Division

Rank	Research area
1	Biodiversity and germplasm maintenance of endangered tree species
2	Participatory Agroforestry Survey and Trials
3	Alley cropping trials for *Pigeon pea, Gliricidia sepium and Sesbania sesban*
4	Establishment and management of plantations
5	Forestry Species Elimination/Provenance Trials (and identification of alternative species for fuelwood)
6	Effects of insecticide applications on the survival rate of *Eucalyptus spp*. in semi-arid and arid lowland areas.
7	Trials of seedling, nursery management and transplanting methods
8	Germination of indigenous species
9	Silvicultural performance trials for Central Highland Zone
10	Survey of fuel wood supply and consumption

In addition to the above, other important areas for forestry/agroforestry research identified in MTOP as important but which were not ranked include:-

- On-farm research on *Acacia senegal* production
- The role of trees and shrub species in stabilizing spate irrigation systems
- Participatory management of natural forests and bushland
- Regeneration and management of Doum Palm
- Evaluation of *Faidherbia albida* at Sub-Zoba level
- Effects of Eucalyptus plantations on soils
- Yield and stand table development for selected species

Research Needs for Effective Reforestation of Degraded Lands

The country is already experiencing setbacks in its mass tree planting campaigns. Some of this is due to mismatching of species to sites but some of the setbacks are due to imperfections in the methods of tree establishment and management in the juvenile periods. For example, research that could make improvement to the physiological vigour of seedlings, including the most appropriate root symbionts, prior to field planting could make huge differences in tree survival rates and growth. Research on tree tending techniques such as drip irrigation, micro-catchment, fertilization, etc. could greatly improved tree survival and growth performance, particularly in the drier parts of the country. Yet these aspects do not feature prominently in the priorities defined in Medium-Term Operational Plan for Agricultural Research (MTOP).

Research on the Conservation of Biodiversity and Endangered Species

This area is accorded the highest priority in the MTOP. It is, no doubt a very important area of national development concern. However, it appears unlikely that DARHRD will develop national comparative research advantage in this field. Thus, its high priority status for DARHRD is misplaced. An important research aspect in which DARHRD could make quick progress concerns the regeneration of natural forests and woodlands. Even for this narrow topic, DARHRD needs to develop research activities in collaboration with institutions like the University of Asmara for additional expertise, which is not likely to be realised at DARHRD within the period of the plan.

At present, emphasis should be on communicating already available information on seed collection, pre-treatment and storage procedures to the nurseries. The first priority must be to ensure high seed quality through proper seed collection and handling. Secondly, germination and quality problems of important species, which may prevent optimum seed utilization should be investigated. But as the need for training and extension services is very large, it is not realistic for NTSP with the present staff level to be engaged in more than very limited research activities. However, through the interaction with nursery staff, problems that cannot be solved by standard seed procedures may be identified and then investigated later when resources are available (Moestrup and Thomsen, 1998).

6. REGIONAL AND INTERNATIONAL COOPERATION

Given the magnitude of the problem associated with forestry and soil and water conservation and environmental issues which are directly related to the development and management of forest resources, it is recognized by the Government, that one of the possible ways to tackle the problems of soil degradation, fuel wood/construction wood crisis and natural heritage and terrestrial biological diversity at an acceptable cost is to work in collaboration with regional and international organizations.

Apart from the MOA planting programme, most formal afforestation and conservation was carried out in collaboration with different international governmental and non-governmental organizations. In addition, among the sectoral programs and projects undertaken by the Ministry of Agriculture with regard to the overall conservation and afforestation activities in co-operation with international governmental and non-governmental organisations include projects on indigenous trees and shrubs; on-farm agro-forestry trials in highland Eritrea; community-based road-side tree planting; afforestation and soil conservation; assessment and management of riverine forest; and integrated watershed development. The international governmental and non-governmental organisations have included: EU, DANIDA, SOS Sahel, World Vision International, Grass Root International.

FAO has worked in partnership with MOA of Eritrea in identifying an investment project for forestry and wildlife sector by improving information and in strengthening institutions responsible for the implementation of programme by providing technical assistance, training their staff and providing equipment.

The Forestry Research Division works in collaborating with international organisations such as CSIRO, ICRAF, and DFSC.

The National Tree Seed Centre of Eritrea is supported by DANIDA and FAO. It could also benefit from collaborating in the network of National Tree Seed Centres operating in our region like Ethiopia, The Sudan, Tanzania, and Uganda, which, is supported by UNESCO and DANIDA and receive technical backstopping by DANIDA Forest Seed Centre. Technical collaboration between the centres are co-ordinated through annual meetings.

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ANNEXES

Annex 1: Value and Use of Target, important Species

Species Name	Value code	Present,future or potential use											
		ti	po	wo	nw	pu	fo	fd	sh	ag	co	am	xx
Acacia abyssinica	1		/	/	/			/	/	/	/		d
Acacia etbaica	1	/	/	/	/		/	/					
Acacia mearnsii	1		/	/	/			/		/	/	/	a
Acacia mellifera	1		/	/	/			/		/	/		d
Acacia nilotica	1		/	/	/			/		/	/		d,h
Acacia polyacantha	1	/	/	/	/			/		/	/	/	d
Acacia saligna	2		/	/	/			/	/	/	/	/	d
Acacia senegal	1		/	/	/		/	/			/		
Acacia seyal	1		/	/	/			/	/	/	/		a,d
Acacia tortilis	1	/	/	/				/	/	/	/		a,d
Adansonia digitata	1		/	/	/		/	/	/	/		/	a
Albizia amara	1	/	/	/	/			/		/	/	/	
Albizia anthelmintica	1	/	/		/			/		/			
Avicennia marina	1	/	/	/	/			/		/	/		d
Azadirachta indica	2	/	/	/	/			/	/	/	/	/	c
Balanites aegyptiaca	1	/	/	/	/		/	/	/	/			c,d,e
Boscia angustifolia	1	/	/					/					
Boscia salicifolia	1		/	/	/			/	/			/	
Boswellia papyrifera	1				/			/					d
Casuarina cunninghamiana	2	/	/	/				/	/	/	/	/	
Commiphora africana	1	/	/	/	/		/	/					d
Commiphora erythraea	1				/								c
Conocarpus lancifolius	1	/	/	/				/	/	/	/	/	
Cordia africana	1	/	/	/	/		/	/	/	/	/	/	
Croton macrostachyus	1	/	/	/	/			/		/	/		
Cupressus lusitanica	2	/	/	/					/	/		/	d,e
Dalbergia melanoxylon	1	/	/	/	/			/		/			
Diospyros abyssinica	1	/	/	/					/				
Diospyros mespiliformis	1	/	/	/	/		/	/	/				
Dobera glabra	1	/					/	/	/				h
Dodonaea angustifolia	1		/	/	/			/		/	/		b,d,f, g,h
Erythrina abyssinica	1		/	/	/			/		/	/		d,e
Eucalyptus camaldulensis	1	/	/	/				/		/		/	
Eucalyptus cladocalyx	1	/	/	/				/		/			
Eucalyptus globulus	2	/	/	/	/			/		/			
Eucalyptus rudis	2	/	/	/						/		/	
Faidherbida albida	1	/	/	/	/		/	/	/	/	/		d
Ficus sycomorus	1		/	/	/		/		/	/	/	/	
Ficus vasta	1	/	/	/			/				/		
Grevillea robusta	2	/	/	/				/	/	/	/	/	
Hyphaene thebaica	1	/					/	/			/		a,b,g
Jacaranda mimosifolia	2	/	/	/				/	/	/		/	
Juniperus procera	1	/	/	/	/				/	/		/	
Kingelia africana	1	/	/	/	/			/			/		
Leucaena leucocephala	2	/	/	/				/		/	/	/	

Species Name	Value code	Present,future or potential use											
		ti	**po**	**wo**	**nw**	**pu**	**fo**	**fd**	**sh**	**ag**	**co**	**am**	**xx**
Maesa lanceolata	1			/	/		/						d
Mangifera indica	2			/	/		/	/	/	/	/	/	
Melia azadarach	1	/	/	/	/			/	/	/		/	
Mimusops kummel	1	/	/	/			/						f
Mimusops schimperi	1	/		/			/				/	/	
Moringa Oleifera	2				/		/	/	/	/	/		d,e
Olea africana	1	/	/	/	/		/	/					h
Oncoba spinosa	1	/		/	/		/					/	
Ozoroa insignis	1	/			/								
Pappea capensis	1			/	/			/					
Phoenix dactylifera	1				/						/	/	b
Piliostigma thonningii	1	/	/	/	/		/	/		/	/	/	a
Prunus persica	1			/			/	/					
Psidium guajava	1		/	/			/						
Rhus glutinosa subsp. abyssinica	1	/	/	/			/	/					h
Rhus natalensis	1		/	/	/		/	/					h
Schinus molle	2			/			/	/	/	/	/	/	c
Securidaca longepedunculata	1		/		/			/					a
Syzygium guineense	1	/	/	/	/		/	/					
Tamarindus indica	1	/	/	/	/		/	/	/	/	/	/	
Terminalia brownii	1	/	/	/	/			/	/	/	/		f,h
Ximenia americana	1	/	/	/	/		/	/					d
Ziziphus spina-christi	1	/	/	/			/	/	/		/		d

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

UTILIZATION :

ti timber production;
po posts,poles,roundwood;
pu pulp and paper;
wo fuelwood,charcoal;
nw non-wood products (gums,resins,oils,tannins, medicines,dyes...);
fo food;
fd fodder;
sh shade,shelter;
ag agroforestry systems;
co soil and water conservation;
am amenity,esthetic;
xx other:

(a-Fibre/weaving/rope b-Thatch/Roofing/Mats c-Toxin/Indecticide
d-Live fence/Dry fencing e-Ceremonial/Boundary marking f-Smoke bath
g-Brooms h-Toothbrushes/Stuffing)

NB: Most of the indigenous and landraces target/important species in Eritrea have a current socio-economic importance.

Annex 2: Management and location of genetic resources, by natural site and species

Species /area type	Reserve natural park	Stands in-situ ,ex-situ	Protected natural stands	Protected planted stands	Villages fields, Home steads	Experimental fields, trials**
Acacia abyssinica, GBZ			> 500			
Acacia asak, CPZ			> 10000			
Acacia etbaica, CHZ			> 10000	> 10000		
Acacia mearnsii CHZ				< 1000	> 1000	
Acacia mellifera CPZ SWLZ			> 10000 > 10000			
Acacia nilotica SWLZ			> 500			
Acacia polyacantha SWLZ			< 500			
Acacia saligna CHZ				> 10000	> 1000	
Acacia senegal CHZ WSZ SWLZ			< 500 > 500 > 1000	> 10000 > 1000		17-Provenances
Acacia seyal CPZ CHZ WSZ SWLZ			> 500 < 500 > 1000 > 1000			
Acacia tortilis CPZ SWLZ			> 500 > 500			
Acokanthera schimperi GB CHZ			> 10000 < 500			
Adansonia digitata SWLZ			< 100	< 100		
Albizzia amara CHZ WSZ SWLZ			> 500 > 1000 > 500			
Anogeissus leiocarpus GBZ WSZ SWLZ			> 1000 < 1000 < 100			
Azadirachta indica CPZ SWLZ					> 1000 > 1000	

Balanites aegyptiaca CPZ CHZ SWLZ			< 100 > 500 > 500	< 500		
Boscia angustifolia CHZ SWLZ			< 100 < 100			
Boswellia papyrifera WSZ SWLZ			< 1000 > 1000			
Carissa edulis GBZ CHZ			> 1000 < 500			
Cassia siamea CPZ SWLZ					> 500 > 500	
Combretum fragrans, SWLZ			> 500			
Combretum molle, GBZ CHZ SWLZ			> 1000 < 100 < 100			
Conocarpus ancifolius CPZ SWLZ					> 1000 < 100	
Cordia africana, CHZ			< 100			3-Provenances
Dalbergia melanoxylon SWLZ			< 500			
Delonix regia CPZ SWLZ					< 100 < 100	
Dichrostachys cinerea, GBZ CHZ SWLZ			> 1000 < 500 < 500			
Diospyros abyssinica, CHZ			< 100			
Diospyros mespiliformis GBZ SWLZ			< 100 > 100			
Dodonaea angustifolia, GBZ CHZ WSZ			> 10000 > 1000	>10000		
Eucalyptus camaldulensis CHZ		EX=571		< 10000	> 500	5Provenances
Eucalyptus cladocalyx GBZ CHZ		EX=1005		> 1000 > 10000	> 10000	4Provenances
Eucalyptus globulus CHZ		EX=749		> 1000	> 1000	7-Provenances

Species /area type	Reserve, natural park	Stands in-situ ex-situ	Protected natural stands	Protected planted stands	Villages fields, homesteads	Experimental fields, trials**
Eucalyptus rudis, CHZ				< 1000		5- Provenances
Euclea schimperi GBZ, CHZ, WSZ			> 10000 > 1000 < 1000			
Gliricidia sepium CHZ						3- Provenances
Grevillea robusta CHZ					> 1000	
Hyphaene thebaica SWLZ			> 1000			
Jacaranda mimosifolia CHZ					> 1000	
Juniperus procera CHZ GBZ			> 10000 < 1000	> 1000	< 500	
Maytenus senegalensis GBZ CHZ			> 500 > 500			
Melia azedarach CHZ					> 1000	
Mimusops kummel GBZ			< 100			
Olea africana GBZ CHZ WSZ			> 10000 > 1000 < 1000	> 1000	< 500	
Schinus molle CHZ					< 500	
Sclerocarya birrea SWLZ			< 100			
Stereospermum kunthianum GBZ			< 100			
Tamarindus indica SWLZ			< 100			
Teclea nobili GBZ			> 10000			
Terminalia brownii GBZ CHZ, WSZ			> 10000 > 1000 < 1000			
Ziziphus spina- christi SWLZ			> 1000			

Number of individual trees (or surface area) in each category, per major ecological zone, as follows:

< 100 individuals > 100 individuals
> 500 individuals > 1,000 individuals
> 10,000 individuals

**:indicate the amount of provenances, families, clones. NB.*: indicates the seed stand that serves also as ex-situ conservation stands.

Ecological zones

CHZ: Central Highland Zone
WEZ: Western Escarpment Zone
SWLZ: South Western Lowland Zone
GBZ: Green Belt Zone
CPZ: Coastal Plains Zone

Annex 3: Species and Populations Degree of Management and Security

Species By ecological zone	protected in parks	Managed			Unmanaged		Threatened by				
		soil-water protect	wood, non wood production	animal grazing	used and harvested	used and grazed	environmen	clearing	Over grazing	Infrastructur	other factors
Acacia seyal CPZ CHZ WSZ SWLZ		>500 <500 >1000 >1000									
Acacia etbaica, CHZ		>10000						>10000			
Acacia mearnsii CHZ		>1000									
Acacia saligna CHZ		>10000									
Adansonia digitata SWLZ		<100						<100			
Albizzia anthelmintica CHZ								<1,000			
Azadirachta indica CPZ SWLZ			>1000 >1000								
Balanites aegyptiaca CPZ CHZ SWLZ		<500						<100 >500 >500			
Boscia angustifolia CHZ SWLZ								<100 <100			
Boscia salicifolia CHZ SWLZ								<100 <100			
Boswellia papyrifera WSZ SWLZ								<1000 >1000			
Cassia siamea CPZ			>500								

SWLZ			>500								
Commiphora africana CPZ								<500			
Conocarpus lancifolius CPZ SWLZ			>1000 <100								
Cordia africana, CHZ								<100			
Croton macrostachyus CHZ											
Dalbergia melanoxylon SWLZ								<500			
Delonix regia CPZ SWLZ			<100 <100								
Diospyros abyssinica CHZ								< 100			
Diospyros mespiliformis GBZ SWLZ								< 100 > 100			
Dobera glabra								> 1,000			
Dodonaea angustifolia, CHZ WSZ		>10000						> 10,000 > 1,000			
Erythrina abyssinica											
Eucalyptus camaldulensis CHZ		<10000									
Eucalyptus cladocalyx GBZ CHZ		>1000 >10000									
Eucalyptus globulus CHZ		>1000									
Eucalyptus rudis CHZ		<1000									
Ficus vasta								< 500		< 500	
Grevillea robusta CHZ			>1000								

Jacaranda mimosifolia, CHZ			>1000								
Juniperus procera GBZ CHZ		>1000						> 10,000 < 1,000			
Kigelia africana CHZ								< 500			
Maerus crassifolia, CHZ								< 500			
Maesa lanceolata, CHZ								< 500			
Melia azedarach, CHZ			>1000								
Mimusops kummel, GBZ								< 100			
Mimusops schimperi CHZ								< 500			
Nuxia congesta CHZ								< 500			
Olea africana GBZ CHZ WSZ		>1000						>10,000 >1,000 <1,000			
Oncoba spinosa GBZ								< 500			
Ozoroa insignis WSZ								< 1,000			
Pappea capensis CHZ								< 100			
Piliostigma thonningnii, WSZ								< 500			
Prunus africana, CHZ								<500			
Rhus abyssinica GBZ								<500			
Rhus natalensis, GBZ								<500			
Schinus molle CHZ			<500								
Securidaca longipedunculata,											

GBZ								<100			
Syzygium guineense CHZ								<100			
Tamarindus indica SWLZ								<100			
Ximenia americana SWLZ								<100			

Ecological zones

CHZ: Central Highland Zone
WEZ: Western Escarpment Zone
SWLZ: South Western Lowland Zone
GBZ: Green Belt Zone
CPZ: Coastal Plains Zone
NWLZ: North- Western Lowland