

THE STATE
OF THE WORLD'S
FOREST GENETIC RESOURCES
COUNTRY REPORT
YEMEN

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.

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The State of Forest Genetic Resources in Yemen



Translated from Arabic into English by: Hassan O. AbdelNour

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Abbreviations & Acronyms

ACSAD	Arab Centre for the Study of Arid Zones and Dry
AREA	Agricultural Research & Extension Authority
FAO	Food & Agriculture Organization of the United Nations
FGR	Forest Genetic Resources
FRA	Forest Resources Assessment
FRGC	Forest Resources Genetic Conservation
FTGR	Forest Tree Genetic resources
GAFDC	General Administration for Forests & Desertification Control
GEF	Global Environment Facility
GR	Genetic Resources
GIS	Geographic Information System
ha	Hectare
ICARDA	International Centre for Research in Dry Areas
IUCN	International Union for the Conservation of Nature
Km	Kilometre
km ²	Square Kilometre
m	meter
NENA	Near East & North African (countries)
NWFPs	Non-wood Forest Products
PA	Protected Area
SFM	Sustainable Forest Management
SI	Satellite Imageries

Part I

Executive Summary

There is considerable biological & forest diversity in Near East & North African Countries, including Yemen. The forest estate in the Near East countries is equivalent to 5.8% of the total land area of these countries. Besides forests, Yemen is endowed with important other woodland area considered a valuable resource for wood and Non-wood Forest Products such as medicinal products, dye material, oils & scents. They also render valuable services in soil stabilization, watershed management and desertification control. Fire wood and charcoal constitute the most important forest product together with fodder for domestic livestock. No industrial wood or paper is produced. Demand for these is entirely met from imports.

The forest & woodland area has increased during the past decade particularly Acacia woodlands due to the rendered availability of alternate fuel substitutes in the countryside. However, the threat to clear the forest & woodlands has re-surfaced in view of the rising cost and rarity of alternate fuels under the current non-settled political situation.

Introduction

Forests are complex ecosystems that cover 30% of the global forest area, providing habitat for countless terrestrial species. Forests are vital for livelihoods as well as economic & social development, providing food, raw material for shelter, energy and manufacturing. They are also critical for environment protection and conservation of natural resources. Forests contain more carbon than the atmosphere. With climate change, forests, with their dual roles as both producers and absorbers of carbon, take to a new importance. FAO (2010).

Many countries in the world accord particular attention to protect their genetic resources (GR) in forests & woodlands. Even more attention is directed towards the conservation and sustainability of GR. Genetic diversity provides the fundamental basis for evolution of forest tree species. This forest & tree diversity enabled forests and trees to adapt to adverse and changing conditions over thousands of years and yielded a unique irreplaceable portfolio of forest tree genetic resources (FTGR). Yet the greater part of Forest Genetic Diversity (FGD) remains unknown, particularly as regards tropical forests. Tree species estimates range between 80 000 and 100 000 species, whereas the species subjected to in-depth studies on their current and future potential is less than 500 species. Up to a short time ago FTGR studies focussed on domestication of a few species that were considered most suitable for the production of wood, fibre & fuel from agro-forestry and forest plantations.

Forest & woodland genetic resources are considered some of the most important natural resources owned by Yemen but not equitably tapped to date. The importance of FGR has

been recognized by FAO for decades. In a conference held in 1967 FAO acknowledged that FGRs are in continuous and increasing attrition. This pressed the organization to pursue the establishment of a commission of specialized experts on FGR to assist it in its efforts in FGR management. Since then FAO activities in FGR form an important part of its overall activities. This activity is considered a basic component in other FAO activities such as National Forest Programmes, Sustainable Forest Management (SFM), Tree breeding & Improvement, Protected Area (PA) development and Forest Resources Assessments (FRA).

Forests of the world suffer continuous retreat in area due to the continuous forest removal (deforestation) and conversion of tropical forests to farmlands. Some 13 million hectares (ha) of forestlands have been converted to other uses between 2000 and 2010 (FRA 2010). However many countries in the world are experiencing a positive trend in Forest Genetic Resources Conservation (FGRC). Studies indicate that deforestation rates are on the decrease as a result of joint global and local efforts. Brazil for instance went through a deforestation rate of 2.6 million ha/annum during the last decade compared to 2.9 million ha/annum during the 1990s. The forest area in PAs, wildlife sanctuaries and other areas subject to legal conservation processes has increased by more than 94 million ha since 1990, i.e. 13% of the total global forest area.

Part II

A Brief on the Country & Forest Sector

Introduction

Topography of Yemen:

Yemen is located in the south western corner of the Arabian Peninsula between Lats.12-20°N and Long. 41-54°E with a total area of 550 000 square kilometres (km²) without the empty quarter, together with more than 120 islands in the Arabian & Red Seas and the Gulf of Aden, the most notable of which is Socotra.

Yemen can be divided into the following zones (Al Khulaidi, 2000):

1. Coastal Plains:

These extend along the Red & Arabia Seas and the Gulf of Aden, with more than 2000 kilometres (km) in length. They include:

1.a. The Western Coastal (Tihama) Plain: It stretches along the Red Sea. It's a flat and undulating plain intersected by numerous valleys, most notable of which are Mor, Rimah, Zabid, Siham, Risian and Sardod. The height ranges from zero- 300 meters (m) on the lower foothills. It is 420km long with widths varying from 20-50km and an area of 14 700km², i.e. 2.6% of the total area of the country,

1.b. The Southern & South Eastern Plain: It's a flat and undulating plain intersected by numerous valleys, most notable of which are Bana, Ahear, Hijr, Tibn and Mufaa. It stretches along the coast of the Arabian Sea and Gulf of Aden with an estimated length of 158km and a width varying between 8-35 km and an area of 44 240km², i.e. 7.9% of the total area of the country,

2. Lower Mountain Highlands:

2.a. Tihama Slopes & Western Highlands: These are the heights facing Tihama and open to the Red Sea with heights varying between 300-1000 m, gentle and steep slopes. They include areas facing the coastal strip of Hodeida, Mihweet, Hajja, Zamar & Rima Governorates,

2.b. Southern Highlands: These are the heights facing the Southern Plain open to the Gulf of Aden & Arabia Sea. Their heights range between 400-1000m and encompass the areas facing the coastal strip of Abien, Lahaj, Shabwa & Hadramoat Governorates, up to the coastal areas of Mahara Governorate. Most notable of its valleys is Hadramoat Valley.

3. Median Mountain Highlands:

3.a. Western Highlandss: They encompass the heights west of Hijja and Mihweet Governorates around Milhan & Bura Mountains, Taaiz heights, heights around Al Sharg Town, west of Huth and west of Makhadeer (Ibb). Heights range between 1000-1800m,

3.b. Southern & South Western Highlands: They include Dhalie areas, Mikras, Lower Yafie, Irif (Maghatra, Taaiz), Lower Awlig, Loder, Modeya, Aries Mount (Abien), Haraf area, Milhan Mount (Lahaj) and Hadramoat Plateau with height range of 1000-1800m,

4. High Mountain heights: These are heights above 1800m. They include Ibb Heights, Sabr & Turba (south of Taaiz), Rima, Zamar, Jebel Al Loz (east of Sanaa), Prophet Shoeb Mount, Mikras, Jebel Abran, Upper Yafie, Hajja & Sanaa.

5. Mountain Highland Plains:

These are divided into:

a. Higher than 1800m and include Saada, Sanaa, Zamar, Rdaa & Ghaa Bkail,

b. Lower than 1900m and include bas plains of (east Taaiz), Hagl bottom and Shahara bottom.

6. Eastern Mountains:

6. a. High Eastern Mountains: These are the areas which separate the valleys that drain to the west (Red Sea) and those which drain east (desert). They include the mountains east of the plains and heights of Zamar, Omram east and north of Radaa, between Radaa and Al Baidaa, between Abien and Al Baidaa. They are more than 1800m high,

b. Median Height Eastern Mountains: They slope gently towards the desert. They include the mountains east of Saada, around and west of Maareb, east of Al Baida, around Baihan , east of Atq (Shabwa) and east of Mahara, with heights ranging between 1200-1800m.

7. The Eastern Desert:

It extends along the entire Yemeni borders. It gradually descends from 1000m towards the east, east and north east till it gets to less than 500m. It is covered by desert sand sheets and sand dunes. It includes the areas east and north of Maareb and Ramlat Sabiaen.

Climate

Rains fall in Yemen in two seasons: The first season that extends between March & May. The second season extends between July & October. Average monthly rainfall varies between 2 and 10mm in desert areas, between 3 & 10mm in coastal areas, between 25 & 75mm in elevated areas and reaches 107 mm in Ibb area. The average annual rainfall varies between 32 & 114mm in coastal areas; between 16 & 199mm in desert areas; between 150 & 990mm in highlands and reaches 1270mm in Ibb area.- See table 1, Fig 1.

Table (10). Monthly average rainfall (mm) in major meteorological stations during 2006.

Town	Sanaa	Taiz	Makala	Sioun	Aden	Hodaida	Socatra	Ibb	Elsoda	Zamar	Haja
Jan.	0.0	0.0	0.0	92.0	3.0	0.0	0.0	0.0	0.0	0.0	0.8
Feb.	1.4	36.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	55.5	0.0
Mar.	8.1	40.3	0.0	0.0	0.0	0.0	0.0	11.1	0.0	82.3	0.4
Apr.	14.2	27.8	0.0	6.0	0.0	0.0	4.1	92.6	0.0	80.3	44.6
May	6.5	81.4	0.0	40.1	0.0	0.0	0.0	220.0	40.0	14.4	14.5
June	0.0	66.8	0.0	0.0	0.0	0.0	0.0	214.3	85.6	0.5	43.0
July	39.8	40.2	3.8	0.0	18.0	0.0	5.5	206.5	211.0	189.8	40.9
Aug.	80.1	115.0	11.1	0.0	0.0	16.7	44.2	260.3	415.0	208.5	69.1
Sept.	0.0	54.7	0.0	0.0	0.0	0.0	0.0	174.0	196.0	44.6	27.2
Oct.	0.0	15.5	2.0	0.0	0.0	0.0	0.0	24.8	0.0	0.0	2.2
Nov.	0.5	5.3	0.0	60.0	0.0	0.0	0.0	59.4	34.0	1.5	21.7
Dec.	0.0	10.7	99.0	0.0	11.0	97.1	0.1	13.2	0.0	1.7	33.5
Ave.	12.6	41.2	9.7	16.6	2.7	9.5	4.5	106.4	81.8	56.6	24.8
Total	150.6	493.9	115.9	198.6	32.0	113.8	53.9	1276.2	981.6	679.1	297.9

(Source: National Bureau for Civil Avian & Meteorology).

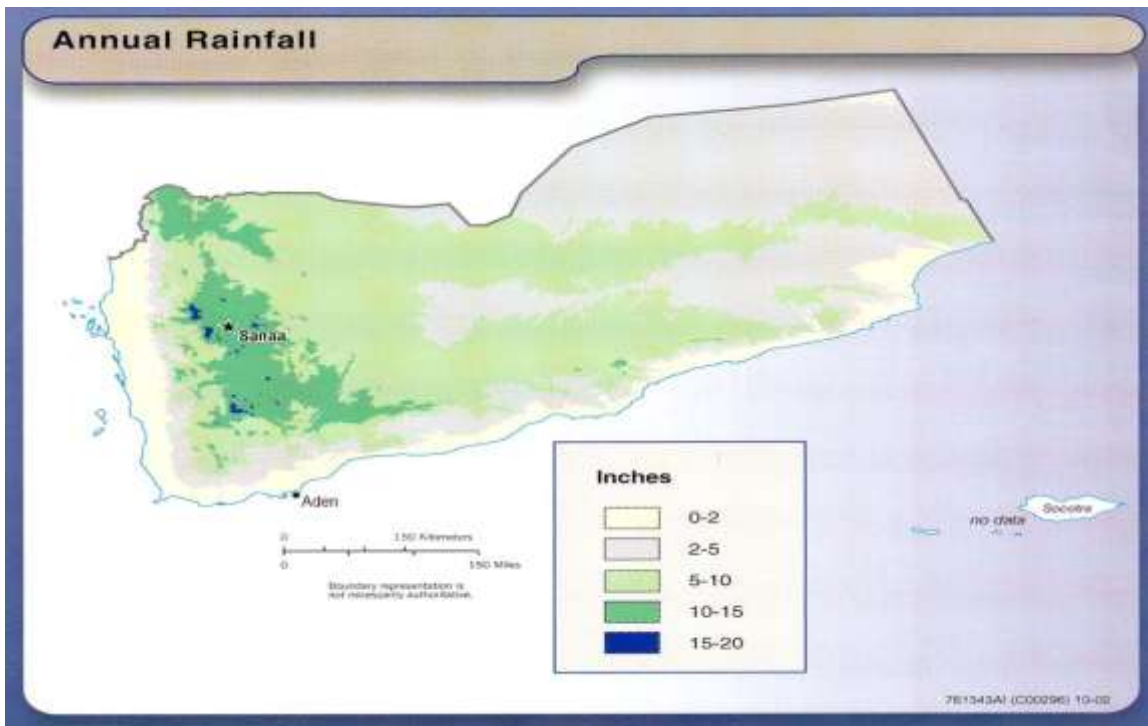


Fig.(1). Annual Rainfall



Fig.(2). Topography of Yemen



Fig (3). Governorates



Fig. (4). Main Towns & Cities

Temperature

Average annual temperature varies in Highlands such as Sanaa, Zamar and Ibb between 12-16°C in winter and 19-22°C in summer. As for coastal areas like Hudiedah, Aden and Makalla, it varies between 25-27°C in winter and 30-32°C in summer. In desert areas from Maaraeb and Siaoun it ranges between 21-21°C in minter and 31-33°C in summer-see table (2).

Table (2). Monthly average temperature (C°) for 2006.

Town	Sanaa	Aden	Taiz	Elmakla	Socatra	Ma'rab	Hodaida	Ibb	Zamar	Soda	
Jan.	U	29.0	29.3	27.4	29.5	29.6	35.2	31.9	28.4	26.0	26.8
	L	0.7	22.0	9.9	17.0	19.4	6.2	18.5	2.0	0.0	4.8
	A	14.9	25.7	18.7	23.3	24.5	20.7	25.2	15.2	13.0	15.8

Feb.	U	30.0	29.8	27.6	38.8	30.5	35.2	31.4	29.8	27.0	28.6
	L	2.0	20.0	7.8	17.2	18.6	6.1	20.2	4.6	1.2	6.2
	A	16.0	24.9	17.7	28.0	24.6	20.7	25.8	17.2	14.1	17.4
Mar.	U	29.8	31.7	29.8	33.5	32.5	37.4	32.5	29.5	26.8	27.4
	L	3.4	17.3	10.5	15.0	19.5	6.8	19.2	6.0	2.3	6.4
	A	16.6	24.5	20.2	24.3	26.0	22.1	25.9	17.8	14.6	16.9
Apr.	U	30.0	33.0	31.1	34.9	36.0	38.6	36.0	30.3	27.0	28.0
	L	8.4	21.0	14.3	18.2	21.4	15.6	21.0	9.3	7.0	9.0
	A	19.2	27.0	22.7	26.6	28.7	27.1	28.5	19.8	17.0	18.5
May	U	32.2	39.6	35.1	38.4	39.6	41.4	36.8	32.0	30.0	31.4
	L	11.4	24.0	16.0	21.8	22.0	19.0	27.0	11.3	8.7	11.6
	A	21.8	31.8	25.6	30.1	30.8	30.2	31.9	21.7	19.4	21.5
Jun.	U	33.5	41.8	33.8	38.2	36.0	42.4	37.3	31.1	31.0	30.5
	L	12.0	27.0	16.6	23.0	23.0	21.2	25.0	11.0	9.5	12.0
	A	22.8	34.4	25.2	30.6	29.5	31.8	31.2	21.1	20.3	21.3
Jul.	U	33.4	39.7	32.7	37.6	34.6	42.6	40.8	30.0	30.0	30.0
	L	13.4	26.0	17.1	22.8	25.0	22.0	28.6	11.0	11.0	12.0
	A	23.4	32.9	24.9	30.2	29.8	32.3	34.7	20.5	20.5	21.0

Aug.	U	31.8	37.8	31.6	35.8	35.0	41.8	38.6	29.2	28.0	28.5
	L	13.5	26.0	16.7	21.7	25.0	20.4	25.3	10.2	11.0	11.0
	A	22.7	31.9	24.2	28.8	30.0	31.1	32.0	19.7	19.5	19.8
Sep.	U	30.0	37.5	32.5	37.2	37.0	41.1	38.3	30.6	27.5	27.6
	L	10.4	25.8	14.8	23.8	25.0	18.6	25.0	7.5	7.6	9.5
	A	20.2	31.7	23.7	30.5	31.0	29.9	31.7	19.1	17.6	18.6
Oct.	U	28.6	35.5	31.4	35.4	35.0	36.6	35.8	29.6	26.3	25.8
	L	6.4	23.5	12.0	19.8	22.0	14.5	24.8	4.7	6.0	9.0
	A	17.5	29.5	21.7	27.6	28.5	25.6	30.3	17.2	16.2	17.4
Nov.	U	27.4	32.0	28.2	33.8	32.0	33.5	32.6	28.0	25.0	26.0
	L	4.4	20.0	10.9	18.0	21.0	12.8	22.1	4.0	2.0	6.4
	A	15.9	26.0	19.6	25.9	26.5	23.2	27.4	16.0	13.5	16.2
Dec.	U	27.8	31.0	26.8	32.5	31.0	33.2	31.1	27.0	24.5	24.0
	L	4.5	23.0	12.4	18.7	19.6	7.8	21.4	7.0	1.0	6.0
	A	16.2	27.0	19.6	25.6	25.3	20.5	26.3	17.0	12.8	15.0

U: Upper; L: Lower; A: Average. Source: National Bureau for Civil Avian & Meteorology)

Population

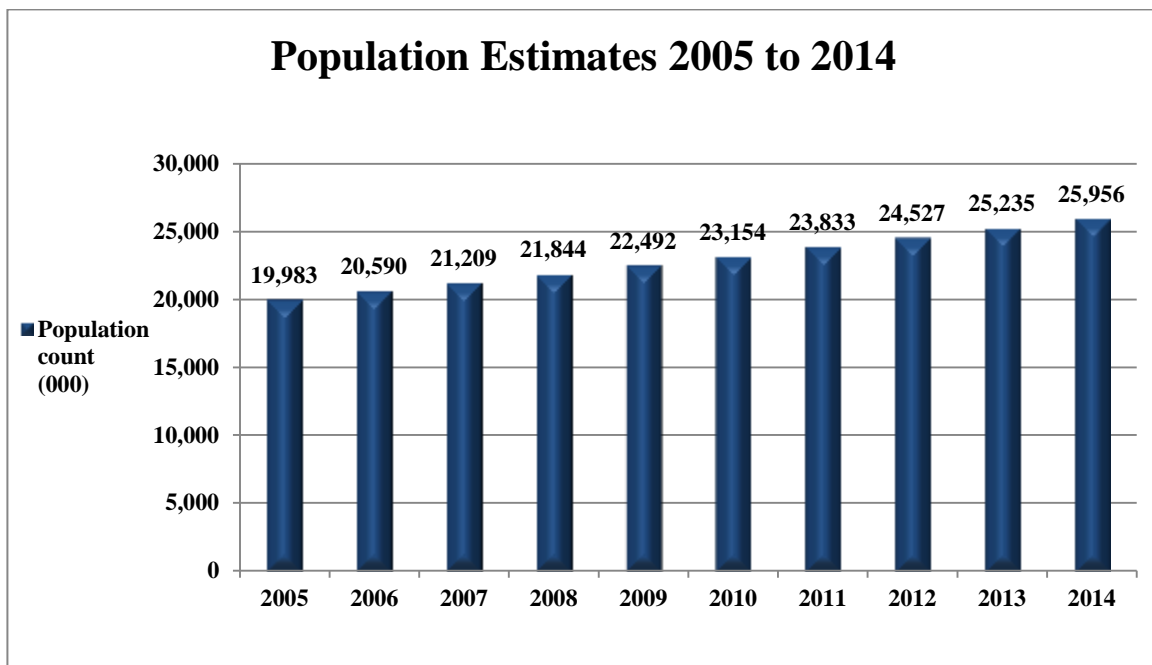
Total population resident in Yemen in 2010 is 32.2 million, table 3, Fig 5.

Table (3). Population Demographic Indicators (000).

Category	2004*	2005**	2006**	2007**	2008**	2009**	2010**
Total population <15 years	8867.0	8992.0	9148.0	9302,7	9461.9	9629.3	9807.4
Total population (15-65) years	10143.4	10251	10707.6	11175.8	11652.1	12132.5	12613.6
Total elderly population (>65) years	674.8	740	734.3	730.9	729.6	730.3	732.9
Total	19685.2	19983	20589.9	21209.4	21834.6	22492.0	23154

(*). According to 2004 census. (**).Future projections

Fig.(5). Population



Forestry Sector in Yemen

Dependency on Satellite Imageries (S. I.), Remote Sensing and deployment of software to analyse S.I. is a basic technique to assess forest & woodland areas, the state of forest resources and study of dynamics in land-use changes. There is no accurate assessment of forest & woodland areas in Yemen. None of the aforementioned techniques have been used till now. The current stated assessment is largely personal and institutional interpretations not supported with adequate field activities. This is due to the lack of capacity and expertise in the country.

Estimates indicate that forest lands have shrunk to fewer two thirds during the period 1973-93 (Adil Abdel Razag ,1999). According to FRA (2010) the forest area in Yemen is less than 10% of the total land area. According to (El Goure *et al*/1995), the estimated forestland is as in table (4).

Table (4). Estimated Forest Areas of Yemen

Year	Forestland Area (1000 ha)
1987	2000
1989	7000
1990	7000

According to The State of World’s Forests 2010, the Forest & Other Woodlands Area in Yemen is as in table (5).

Table (5). Area of Forests & Other Woodlands in Yemen

Forests		Other Woodland Area	
(000) ha	Ratio to total land area	(000) ha	Ratio to total land area
549	1%	1 406	3%

As for vegetation and forestland areas for the country, several maps were produced in 1992 by Hunting Co. based on remotely sensed data on scale 1: 1000 000. The data lacked accuracy and was not supported by ground truthing, hence the maps included areas of grasslands as forest & woodland areas.

There are no real forest areas in Yemen. However it is believed that vast areas of the country were covered with forests that were removed. Their presence is restricted to a narrow range in valley banks intersecting Tihama Hill slopes, Western & South Western Heights of medium altitude. There, tropical like forest formations are encountered that contain tall trees of some 30m high, particularly in Wadi Rajaf (Gebel Buraa), Hadiya (Gebel Rima), Wadi Yor (Gebel Milhan), Higriay Valleys (south Taaiz), Wadi Bani, Wadi el Durr (Al Adeen), Wadi Harr (Haraz) and Hoff (Al Mahara). Most of these valleys are

in lopes facing west. The most notable of natural vegetation associated with these tropical-like forests are (Hall et al 2008):

Combretum molle, *Mimusops laurifolia*, *Celtis toka*, *Berchemia discolor*, *Terminalia brownii*,
Stereospermum kunthianum, *Phoenix caespitosa*, *Acacia johnwoodii*, *Commiphora kataf*,
Ficus sycomorus, *Ficus vasta*, *Trichilia emetica*, *Tamarindus indica*, *Ziziphus mucronata*
and *Breonadia salicina*.

These forests tracts very much resemble the ones on Valley banks in East Africa.-see table (6).

Table (6). Geographic distribution of important vegetation of forest valleys (Hall et al 2008)

Species	Haraz					J.Melhan	J. Bura			J. Raymah				Elhajaria	Kholan Elsham	Arabian Peninsula	Saudi Arabia
	Rajma	WadiHar	Wadi Hajian	Oseel	Wadi Elsakhna	Wadiyvor	Walja	Elhalah	Wadi rajaf	WadiElb asal	Aloja	Hadia	ElOdein		Wadi Lia	Oman	
<i>Antiaris toxicaria</i>	X							X	X								
<i>Diospyros mespiliformis</i>						X	X				X				X		
<i>Triumfetta pentandra</i>							X	X									
<i>Mimusops laurifolia</i>	X	X					X	X	X	X	X		X				X
<i>Bauhinia tomentosa</i>			X			X	X			X	X		X				
<i>Piliostigma thonningii</i>								X					X				
<i>Bridelia scleroneura</i>								X					X				
<i>Meineckia phyllanthoides</i>	X					X	X	X		X							
<i>Croton macrostachyus</i>								X									
<i>Bersama abyssinica</i>							X	X									
<i>Allophylus rubifolius</i>	X						X		X	X						X	
<i>Ozoroa insignis</i>							X	X			X		X				
<i>Nuxia oppositifolia</i>	X			X	X		X		X					X		X	
<i>Brucea antidysenterica</i>										X							

<i>Gymnema sylvestre</i>									X									
<i>Stereospermum kunthianum</i>					X				X	X								
<i>Aneilema woodii</i>								X										
<i>Endostemon gracilis</i>									X					X				

1. The Current Status of Forest Genetic Resources

Chapter 1

Current Status of FGR:

1.1. The Flora of Yemen

The Flora of Yemen is fairly rich. Recent studies (Al Khulaidi 2012) have recorded some 2823 species belonging to 1056 Genera and 179 Families, of which 2587 grow naturally, 125 are planted and 111 introduced.

The plant cover of Yemen is rich in endemic and near-endemic species. Some 611 plants of which 461 endemic are recorded representing 16% of the Yemeni Flora . Of these 307 exist in Socotra alone.

The salient most of these Families are listed in tables (7.1 &7.2).

Table (7.1). Plant Families with the most species and the most endemic species in Yemen:

Families with the most number of species		Families with the most number of endemic species	
Family	Species	Family	Species
<i>Poaceae (Graminea)</i>	322	<i>Asteraceae (Compositae)</i>	45
<i>Asteraceae (Compositae)</i>	216	<i>Apocynaceae</i>	43
<i>Fabaceae (Papilionaceae)</i>	205	<i>Euphorbiaceae</i>	30
<i>Apocynaceae</i>	117	<i>Acanthaceae</i>	28
<i>Euphorbiaceae</i>	106	<i>Boraginaceae</i>	24
<i>Acanthaceae</i>	100	<i>Fabaceae (Papilionaceae)</i>	24
		<i>Lamiaceae (Labiatae)</i>	23
		<i>Aloeaceae</i>	17
		<i>Rubiaceae</i>	16
		<i>Scrophuliaceae</i>	16
		<i>Poaceae (Graminea)</i>	15
		<i>Caryphyllaceae</i>	13
		<i>Malvaceae</i>	12
		<i>Burseraceae</i>	11
		<i>Convolvulaceae</i>	11

Table (7.2.) Most important Genera in Yemani Flora:

Genus	# species	Genus	# species	Genus	# species
<i>Euphorbia</i>	61	<i>Heliotropium</i>	40	<i>Indigofera</i>	35
<i>Aloe</i>	32	<i>Acacia</i>	29	<i>Hibiscus</i>	29
<i>Cyperus</i>	28	<i>Crotalaria</i>	24	<i>Bareria</i>	17

1.2. Phytogeography of Yemen

Most of the plants of Yemen belong to the Palearctic Sudanian Region according to Zohary (1973) or the Somalia-Masai Regional Centre of Endemism) according to White (1983). These zones encompass Eastern Africa, Southern Ethiopia, South Eastern Sudan, North East Uganda, Most of Kenya, Central Tanzania, Somalia and Southern Arabian Peninsula. Some of the plants of Yemen also belong to the plants of Saharo-Arabian and Saharo-Indian regions which extend from Egypt, Palestine, Southern Iraq, South West Syria & Iran or what is referred to as the (Holarctic origin). Some plants of Yemen also belong to the plants of the Mediterranean and the Irano-Turanian.

Plants of African Region dominate on the Western Highlands and in some of the Highland Plains with high rainfall. Plants of the Saharo-Arabian dominate in Coastal Plains, Eastern Mountains and East & North Saharan Plains. Mediterranean plants dominate in the humid High Altitude Mountains of Ibb & Ta'izz Governorates.

Some of the Sudanian Region Plants include:

Acacia mellifera, *A. tortilis*, *A. hamulosa*, *A. ehrenbergiana*, *A. gerrardii*, *A. origina*, *A. seyal*, *Aerva javanica*, *Asparagus africanus*, *Buddleja polystachya*, *Cadaba farinosa*, *Capparis spinosa*, *Carissa spinarum*, *Cenchrus ciliaris*, *Cissus quadrangularis*, *C. rotundifolia*, *Cordia africana*, *C. quercifolia*, *Combretum molle*, *Commiphora gileadensis*, *C. habessinica*, *Dobera glabra*, *Ficus palmate*, *F. vasta*, *Commiphora myrrha*, *Dactyloctenium scindicum*, *Grewia villosa*, *Hibiscus deflersii*, *Hypoestes forskalei*, *Indigofera oblongifolia*, *I. spinosa*, *Maerua crassifolia*, *Myrsine africana*, *Mimusops laurifolia*, *Lasiurus scindicus*, *Leptadenia pyrotechnica*, *Olea europaea*, *Panicum turgidum*, *Rosa abyssinica*, *Salvadora persica*, *Sarcostemma viminalis*, *Solanum incanum*, *Tamarix aphylla*, *Teclea nobilis*, *Tephrosia apollinea*, *Trichilia emetica*, *Withania somnifera*, *Ziziphus mucronata*, *Z. spina-christi* and others.

And of the plants belonging to the Saharo-Arabian Region, encountered in Coastal Plains and major valleys in Ma'areb, Hadramoa, Shabwa & Mahara:

Asphodelus fistulosus, *Astragalus sparsus*, *Capparis cartilaginea*, *Chrozophora oblongifolia*, *Citrullus colocynthis*, *Cymbopogon schoenanthus*, *Cyperus conglomerates*, *Dipterygium glaucum*, *Fagonia indica*, *F. paulayana*, *F. bruguieri*, *Forsskaolea tenacissima*, *Halopeplis perfoliata*, *Heliotropium rariflorum*, *Iphiona scabra*, *Lasiurus scindicus*, *Leptadenia arborea*, *Ochradenus baccatus*, *Panicum turgidum*, *Periploca visciformis*, *Phoenix dactylifera*, *Pulicaria undulata*, *Rhazya stricta*, *Senna italica*, *Tribulus arabicus*, *Withania somnifera*, *Zygophyllum simplex*, *Z. album*, *Z. decumbens*, *Z. coccineum*.

Genera & Species of Mediterranean type concentrated in Humid Mountain Highlands:

These species are scattered and well represented in the highlands mainly in Ibb and Taiz Governorates:

Ammi majus, *Anagyris foetida*, *Anarrhinum forskahlii*, *Capparis spinosa*, *Diplotaxis erucooides*, *Ephedra foeminea*, *Ferula communis*, *Lavandula dentate*, *Ruta chalepensis*, *Myrtus communis*, *Teucrium*, *Juniperus*, and *Brassica*.

.Of the Irano-Turanian plants restricted to the Eastern Desert Areas:

Calligonum spp., *Cymbopogon spp.*, *Alhagi graecorum*, *Prosopis farcta* and *Typha elephantina*

1.3. Endemic and near endemic plant species:

Yemen is rich in endemic plants (their presence restricted to Yemen only) and near-endemic plants (whose distribution is restricted to the Arabia Peninsula only). These are estimated at 611 species of which 461 are endemic (of which 307 found in Socotra Archipelago). The endemic and near-endemic plants represent 16% of the flora of Yemen.

Plants near-endemic, of restricted geographic distribution, recorded from forests & woodlands in Mahara (Yemen) and Dhaffar (Oman) include:

Aloe dhufarensis, *A. mahraensis*, *A. praetermissa*, *Anogeissus dhofarica*, *Blepharis dhufarensis*, *Blepharispermum hirtum*, *Campylanthus chascaniflorus*, *Centaurea dhofarica*, *Cleome omanensis*, *Croton confertus*, *Dhofaria macleishii*, *Dichanthium micranthum*, *Dyschoriste dalyi*, *Ecbolium strictum*, *Euphorbia orbiculifolia*, *E. smithii*, *Exacum arabicum*, *Fagonia maharana*, *Gymnocarpos dhufarensis*, *Helianthemum citrinum*, *Heliotropium fartakense*, *Hyoscyamus flaccidus*, *Jatropha dhofarica*, *Kleinia saginata*, *Lavandula dhofarensis*, *Leucas dhofarensis*, *Withania qaraitica*, *Maytenus dhofarensis*, *Mitreola petiolata*, *Ocimum dhofarensis*, *Portulaca dhofarica*, *Pulicaria nobilis*, *Suaeda moschata*, *Teucrium nummularifolium*, *Zygocarpum dhofarensis*, *Zygophyllum smithii*.

Plants restricted to the Arabian Peninsula & Horn of Africa (such as Sudan, Ethiopia, Somalia, Eritrea & Kenya) include:

Acacia edgeworthii, *A. etbaica*, *A. hamulosa*, *A. origena*, *A. tortilis*, *Acokanthera schimperi*, *Anisotes trisulcus*, *Barbeya oleoides*, *B. mucronifolia*, *B. orbicularis*, *Buddleja polystachya*, *Aristolochia rigida*, *Cadia purpurea*, *Cadaba baccarinii*, *Carissa spinarum*, *Ceropegia affinis*, *Ceropegia somalensis*, *Chloris mensensis*, *Cienfuegosia welshii*, *Commiphora gileadensis*, *C. habessinica*, *C. kataf*, *C. myrrha*, *Crotalaria leptocarpa*, *C. pteropoda*, *Diceratella incana*, *Dracaena serrulata*, *Duvalia somaliensis*, *Duvalia sulcata*, *D. velutina*, *Dyschoriste longicalyx*, *D. radicans*, *Ecbolium gymnostachyum*, *Echiochilon longiflorum*, *Erythrina melanacantha*, *Euphorbia schimperi*, *Justicia caerulea*, *Kleinia odora*, *Lavandula macra*, *Megalochlamys violacea*,

Phoenix caespitos, *Pistacia aethiopica*, *P. falcate*, *Pluchea sordida*, *Psiadia punctulata*, *Ruellia discifolia*, *Rhus natalensis*, *R. retinorrhoea*, *Rhigozum somaliense*, *Senecio hadiensis*, *Tarchonanthus camphorates*, *Taverniera multinoda*, *T. schimperi*, *Trianthema crystallinum*, *T. portulacastrum*, *T. sheilae*, *T. triquetrum*, *Trichodesma hildebrandtii*, *Ficus vasta*, *Rosa abyssinica*, *Mimusops laurifolia*, *Grewia erythraea* and *Selaginella yemensis*.

Plants recorded in Southern Arabian Peninsula & Horn of Africa include:

Caralluma arabica, *Fagonia* (*F. lahovari* and *F. luntii*), *Cystostemon heliocharis*, *Indigofera sedgewickiana*, *Lavandula setifera*, *Limoniastrum rechingeri*, *Neuracanthus robecchii*, *Pupalia robecchii*, *Rhus somalensis*, *Caucanthus edulis*, *Wendlandia arabica*, *Tephrosia dura* and *Rhytidocaulon macrolobum*.

1.4. Current Status of Forest Genetic Resources:

1.4.1. Major Forest & Woodland types in Yemen:

1.4.1.1. Mangrove Forests:

Mangroves are encountered on the Red Sea Coast particularly around Khakha north of Wadi Siham. They are also encountered in scattered stands south of Al Mukha and south of Yakhtaul (South Tihama), around Bir Ali (West of Mukkala). The principal species is *Avicennia marina*. With it are associated *Aeluropes lagopoides* and *Suaeda spp.*

1.4.1.2. *Acacia ehrenbergiana* Woodland:

Their density varies from one location to another. They are to be found on rocky soils in Tihama Plain. Associated with it are:

Lasiurus scindicus, *Rhigozum somaliense*, *Acaciatortitis*, *Acacia hamulosa*, *Commiphora myrrha*, *Fagonia indica*, *Anisotes trisulcus*, *Euphorbia cuneata*, *Indigofera oblongifolia*, *Euphorbia cuneata*, *Aloe vera*, *Fagonia indica*, *Tephrosia purpurea*, *Cissus quadrangularis*, *Commiphora myrrha*, *Maerua crassifolia*, *Commiphora gileadensis* - *Cadaba glandulosa*, *Euphorbia triaculeata*, *Panicum turgidum*, *Cymbopogon schoenanthus* and *Pennisetum divisum*

1.4.1.3. *Acacia tortilis* - *Commiphora* Woodlands:

Their density varies from one location to another. They are to be found on rocky plains interested with runnels, adjacent to foothills of Tihama, particularly on road extension linking Hes and Mukalla junction (West Yemen). Of the associate species:

Blepharis ciliaris, - *Lasiurus scindicus*, *Rhigozum somaliens*, *Acacia tortilis*, *A. hamulosa*, *A. ehrenbergiana*, *A. mellifera*, *Fagonia indica*, *Anisotes trisulcus*, *Euphorbia cuneata*, *E. triaculeata*, *Lasiurus scindicus*, *Indigofera oblongifolia*, *Aloe vera*, *Tephrosia purpurea*, *Cissus quadrangularis*, *Commiphora gileadensis*,

Commiphora myrrha, *Indigofera spinosa* *Calligonum crinitum*, *Cadaba glandulosa*, *Panicum turgidum*, *Cymbopogon schoenanthus* *Pennisetum divisum* and others.

1.4.1.4. *Acacia tortilis-Euphorbia cuneata* Woodlands:

These are open woodlands to be encountered on low hills and plateaux on coastal plains such as west Rahda, south west Burj, near Dimna & Razan. Of the associated species:

Anisotes trisulcus, *Sarcostemma viminale*, *Acalypha fruticosa*, *Aloe sp*, *Indigofera spinosa*, *Kleinia odora*, *Cissus quadrangularis*, *C. rotundifolia*, *Euphorbia inarticulata*, *Aristida sp.*, *Dobera glabra*, *Hibiscus deflersii*, *Jatropha spinosa*, *Aerva javanica* and others.

1.4.1.5. *Trichilia emetica* Woodlands:

These are small patches of forests on rocky soils opposite valleys from mountain slopes overlooking Tihama Plain such as Bruaa & Milhan. Of the associate species:

Acacia johnwoodii, *Combretum molle*, *Berchemia discolor*, *Celtis africana*, *Carissa spinarum*, *Cissus quadrangularis*, *C. rotundifolia* and *Anisotes trisulcus*.

1.4.1.6. *Combretum molle- Ficus spp* Forests:

These are forests on fertile valleys on Jebel Buraa, Milhan and Hegriya between altitude 800-1500m. Associated species include:

Ficus vasta, *F. sycomorus*, *F. cordata* subsp. *salicifolia*, *Tamarindus indica*, *Trichilia emetica*, *Mimusops laurifolia*, *Ziziphus spina-christi*, *Jatropha curcus*, *Terminalia brownii*, *Ehretia cymosa*, *Carissa spinarum*, *Breonadia salicina*, *Phoenix dactylifera*, *Ziziphus mucronata*, *Acacia asak*.

1.4.1.7. *Phoenix caespitosa* Woodlands:

These are woodlands found in valley bottoms and rocky slopes, crevasses and neglected agricultural terraces. Associate species include:

Arundo donax, *Eragrostis pilosa*, *Ficus sycomorus*, *Phoenix caespitosa*, *Trichilia emetica*, *Breonadia salicina*, *Acacia asak*, *Acalypha fruticosa*, *Tridax procumbens*, *Combretum molle*, *Cassytha filiformis*, *Senna occidentalis*, *Cissus rotundifolia*, *Kanahia laniflora*, *Ricinus communis*, *Leptadenia arborea*, *Amaranthus spinosus*, *Euphorbia hirta*, *Olea europaea* *Carissa spinarum*, *Oncopa spinosa*, *Hypoestes forskalei*, *Selaginella yemensis*, *Segetaria thea*, *Rhoicissus revoilii*, *Maytenus parvifolia*, *Oncopa spinosa*, *Pterolobium stellatum*.

1.4.1.8. *Anisotes trisulcus* Woodlands:

These are thick woodlands and shrubs to be found on rocky slopes on Western, South Western and North Western Mountains of Yemen between 350-500m such as Suk el Sabt (Buraa Mount), Jebel Milhan. *Anisotes* is the dominant sp. Others include:

Acacia mellifera, *Blepharis edulis*, *Selaginella imbricata*, *Adenium obesum*, *Grewia schweinfurthii*, *Acacia asak*, *Cissus rotundifolia*, *Coptosperma graveolens*, *Acalypha*

fruticosa, *Ruellia patula*, *Cissus quadrangularis*, *Commelina forskalei*, *Becium filamentosum*, *Opuntia dillenii*, *Digitaria nodosa*, *Blepharis edulis*, *Dactyloctenium scindicum*, *Barleria bispinosa*, *Endostemon tenuiflorus*, *Aerva javanica*, *Ocimum forskolei*, *Portulaca quadrifida*, *Indigofera spinosa*, *Pupalia grandiflora*, *Sarcostemma arabicum*, *Hibiscus deflersii*, *Aristida adscensionis*, *Grewia trichocarpa*, *Evolvulus alsinoides*, *Grewia tembensis*, *Maytenus parvifolia*, *Terminalia brownii*, *Cadaba farinose*.

1.4.1.9. *Anogeissus dhofarica* Woodlands:

These are forests on mountain slopes facing south near Hoff, Ras Firtuk (Mahara) between 600-700m. Of the associate species:

Croton confertus, *Dodonaea viscosa*, *Cadia purpurea*, *Jatropha dhofarica*, *Tamarindus indica*, *Commiphora* spp., *Acacia* spp. *Hybanthus durus*, *Maytenus dhofarica*, *Euphorbia smithii*.

1.4.1.10. *Salvadora persica*-*Tamarix* spp Woodlands:

These are woodlands of varying densities growing on valley bottoms and sides between 700-1000m such as in Tihama, West of Taaiz, Jebel Habashi, Bani Amr and Wadi Hadramoat. Of the accompanying species:

Ziziphus spina-christi, *Tamarix arabica*, *T. Flueggea virosa*, *Ficus populifolia*, *Acacia tortilis*, *Calotropis procera*, *Cissus quadrangularis*, *C. rotundifolia*, *Trichilia emetica*. *Acacia ehrenbergiana*, *A. hamulosa*, *Acokanthera schimperi*, *Indigofera oblongifolia*.

Together with others in Wadi Hadramoat only: *Rhazya stricta*, *Ochradenus baccatus*, *Ziziphus leucodermis*.

1.4.1.11. *Acacia asak* Woodlands:

Widely spread with varying densities. They are to be encountered on steep to moderate mountain slopes between 600-1000m, particularly the mountain slopes south and west of Yemen such as Taaiz, Dhalie, Abien, Lahaj, Yafie, Adeen, Sharg Town and south Baidah, Fig.(5). Associated with many other species such as:

Ruellia patula, *Aerva javanica*, *Barleria trispinosa*, *B. bispinosa*, *Acalypha fruticosa*, *Anisotes trisulcus*, *Zygocarpum yemenense*, *Blepharis ciliaris*, *Grewia trichocarpa*, *G. erythraea*, *G. schweinfurthii*, *G. tembensis*, *G. tenax*, *Kleinia odora*, *Caralluma quadrangula*, *Acacia mellifera*, *A. etbaica*, *Commiphora kataf*, *Boscia angustifolia*, *Adenium obesum*, *Psiadia punctulata*, *Commicarpus helenae*, *Becium filamentosum*, *Themeda triandra*, *Elionurus muticus*, *Eragrostis papposa*, *Hypoestes forskalei*, *Indigofera spinosa*, *Aloe vacillans*, *Cissus quadrangularis*, *Cissus rotundifolia*, *Jatropha variegata*, *Justicia odora*, *Actinopterys radiata*, *Adenia venenata*, *Annona squamosa*, *Boscia angustifolia*, *Caralluma quadrangula*, *C. cicatricose*, *Combretum molle*, *Commicarpus* sp., *Crinum album*, *Crossandra johanninae*, *Ecbolium viride*, *Ehretia obtusifolia*, *Endostemon* sp., *Euphorbia inarticulate*, *Huernia yemenensis*, *Indigofera articulata*, *Lantana rugosa*, *Plectranthus* sp., *Portulaca quadrifida*, and *Sansevieria ehrenbergii*.

1.4.1.12. *Aciaca mellifera* Woodlands:

These plant associations thrive on Tihama hill slopes, mountain slopes between 300-1600m and on derelict agricultural terraces such as on Gebel Buraa, Milhan and Rima, west of Taaiz, Gebel araies, Huth, Sharg Town, Shabwa and Hadramoat (Fig.6).

Associated species include:

Acacia ehrenbergiana, *A. asak*, *Anisotes trisulcus*, *Commiphora myrrha*, *C. habessinica*, *C. gileadensis*, *Selaginella imbricate*, *Anisotes trisulcus*, *Blepharis edulis*, *Dactyloctenium scindicum*, *Barleria bispinosa*, *Endostemon tenuiflorus*, *Aerva javanica*, *Ocimum forskolei*, *Portulaca quadrifida*, *Indigofera spinosa*, *Pupalia grandiflora*, *Indigofera spiniflora*, *Grewia tenax*, *Tribulus terrestris*, *Seddera arabica*, *Zygocarpum yemenense*, *Cissus rotundifolia*, *Coptosperma graveolens*, *Acalypha fruticosa*, *Ruellia patula*, *Cissus quadrangularis*, *Commelina forskalei*, *Becium filamentosum*, *Opuntia dillenii*, *Digitaria nodosa*, *Euphorbia cactus*, *E. inarticulata*, *Ruellia patula*, *Grewia erythraea*, *Kleinia odora*, *Indigofera arabica*, *Boerhavia repens*, *Lantana rugosa*, *Senna italica*, *Seddera arabica*, *Euphorbia schimperi*, *Heliotropium sp.*, *Hypoestes forskalei*, *Cadia purpurea*, *Grewia tenax*, *Zygocarpum yemenense*, *Seddera arabica*, *Commicarpus helenae*, *Ruellia patula*, *Euphorbia cuneata*, *Sarcostemma sp.* *Blepharis ciliaris*, *Aloe sp.*

Together with the following plants in the eastern areas of Shabwa and Hadramoat:

Zygophyllum decumbens, *Ochradenus arabicus*, *Helichrysum pumilum*, *Gnidia somalensis*, *Limonium cylindrifolium*, *Iphiona scabra*, *Turraea parvifolia*, *Crotalaria persica*, *Acacia Hamulosa*.

1.4.1.13. *Acacia etbaica* Woodlands:

These woodlands are to be encountered in level plateaux between 1400-1800m such as in Gebel Erf, south of Taaiz, east of Saada and plateaux areas of Shabwa & Hadramoat. Fig (8). Associated plants include:

Gnidia somalensis, *Ruellia patula*, *Aerva javanica*, *Aloe inermis*, *Commicarpus helenae*, *Lantana sp.*, *Zygocarpum yemenense*, *Tetrapogon villosus*, *Solanum incanum*, *Fagonia incanum*, *Euphorbia cuneata*, *E. inarticulata*, *E. cactus*, *E. schimperi*, *E. ammak*, *Cissus quadrangularis*, *C. rotundifolia*, *Blepharis ciliaris*, *Fagonia indica*, *Justicia flava*, *Solanum incanum*, *Polygala senensis*, *Cyanotis sp.*, *Grewia erythraea*, *Pulicaria somalensis*, *Seddera arabica*, *Vernonia arabica*, *Barleria spp.*, *Boerhavia repens*, *Psiadia punctulata*, *Heliotropium sp.*, *Dodonaea viscosa*, *Ziziphus spina-christi*.

Together with plants restricted to Hadramoat & Shabwa, such as:

Dracaena serrulata, *Limoniastrum arabicum*, *L. cylindrifolium*, *Euphorbia balsamifera*, *Ochradenus arabicus*, *Periploca visciformis*.

Fig (6). Areas of distribution of *Acacia asak*

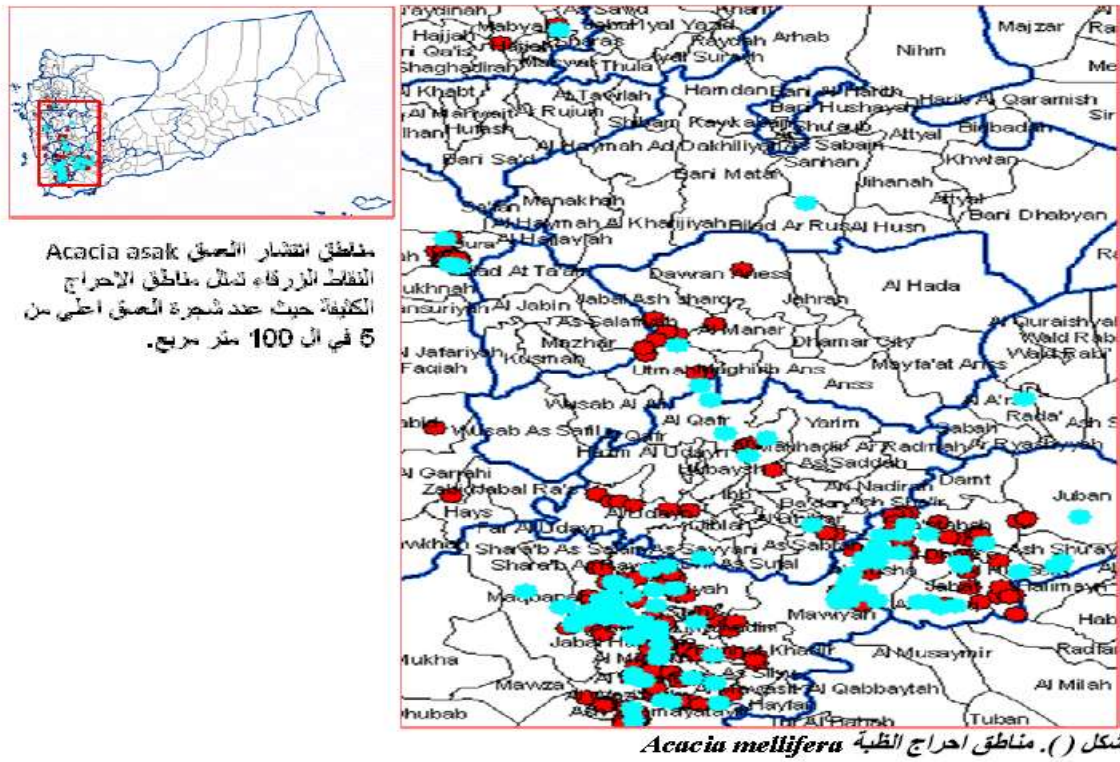


Fig (7). Areas of *Acacia mellifera*

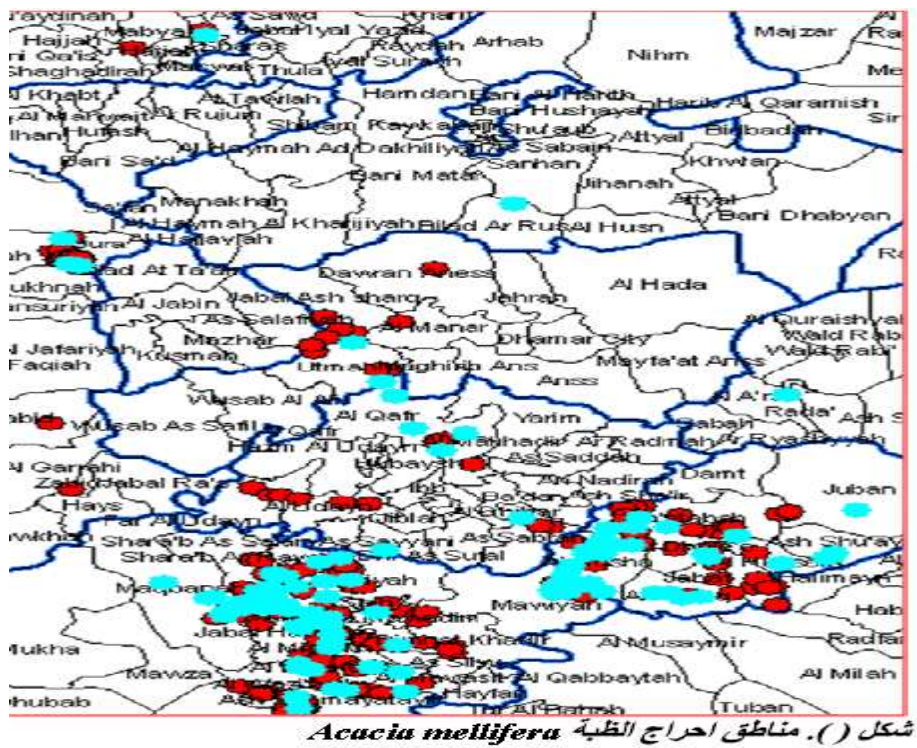
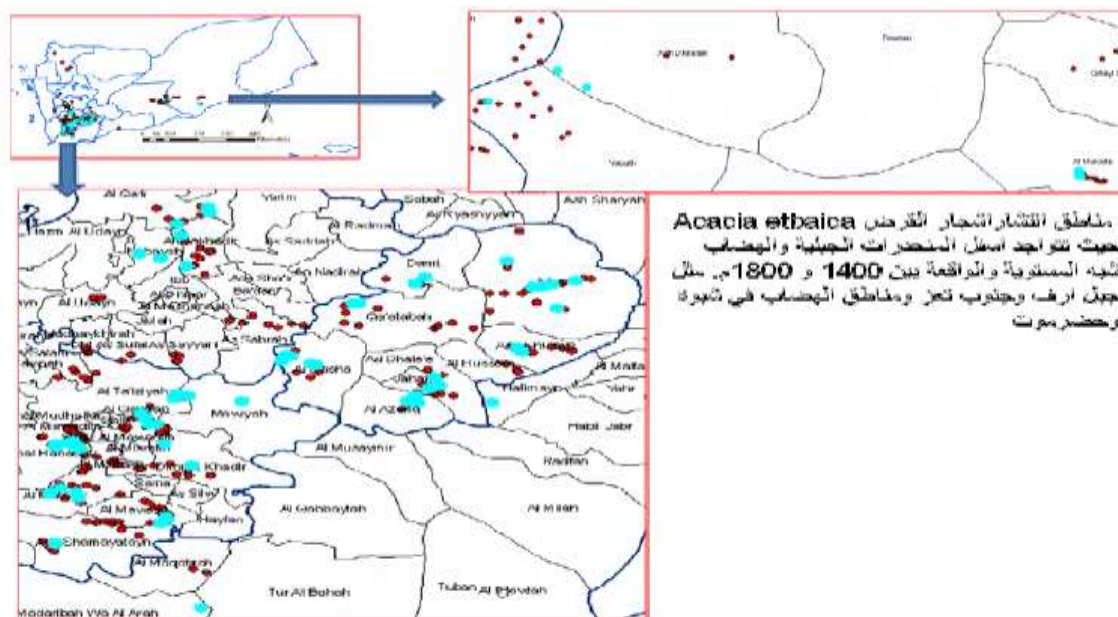


Fig.(8). Areas of *Acacia etbaica*.



شجر ()، غابات العرعر *Juniperus procera*

1.4.1.14 . *Juniperus procera* Forests:

These forests exist in level plateau and rock slopes between 1350-1450m such as in Gebel Erf (Maghatra), Thojan (Gabeeta) and Haifa. Of the associated plants:

Psiadia punctulata, *Acacia etbaica*, *Cadia purpurea*, *Teucrium yemense*, *Tetrapogon villosus*, *Barleria sp.*, *Rhus spp.*, *Carissa spinarum*, *Aristida sp.*, *Seddera arabica*, *Tarchonanthus camphoranthus* and *Commicarpus helenae*.

1.4.1.15. *Acacia yemenensis* Woodlands:

These are thick bushes on moist rocky slopes between 1400-1800m such as south of Taaiz, north of Gaieda, Gebel Habashi, Misrakh, Gebel Samara, Siani, Thi Safal, Hasha and Gihaf. Of the associated species:

Euphorbia parciramulosa, *E. inarticulata*, *E. cactus*, *E. schimperi*, *Hypoestes forskalei*, *Psiadia arabica*, *Aristida sp.*, *Kleinia odora*, *Senecio hadiensis*, *Euphorbia schimperi*, *Tagetes minuta*, *Echinops spinosissimus*, *Acacia etbaica*, *Cadia purpurea*, *Barleria trispinosa*, *Rhus retinorrhoea*, *Jasminum grandiflorum*, *Micromeria imbricata*, *Ficus cordata*, *Ficus palmata*, *Gomphocarpus fruticosus*, *Barleria bispinosa*, *Dodonaea viscosa*, *Scilla hyacinthina*, *Pancreatium maximum*, *Phoenix caespitosa*, *Wendlandia arabica*, *Aloe rivierei*, and *Aloe vacillans*.

1.4.1.16. *Acacia nilotica* subsp *kraussiana* Woodlands:

These are to be found on rocky mountain slopes in median height mountains between 900-1500m such as west of Taaiz, Gebel Habashi, Dhalie. They are also found to a lesser

extent between 1500-2000m in dry areas north of Dhalie (Gibn). The most notable associate plants include:

Acacia asak, *Acalypha fruticosa*, *Cymbopogon jwarancusa*, *Cissus quadrangularis*, *Euphorbia inarticulata*, *Euphorbia cactus*, *Kleinia odora*, *Acacia mellifera*, *Sarcostemma viminalis*, *Anisotes trisulcus*, *Indigofera spinosa*, *Aloe niebuhriana*, *Pergularia tomentosa*, *Commiphora abyssinica*, *Commiphora schimperi*, *Heliotropium aegyptiacum*, *Actinopterys radiata*, *Flueggea virosa*, *Coptosperma graveolens*, *Aerva javanica*, *Caralluma cicatricose*, *Caralluma penicillata*, *Barleria proxima*, *Ziziphus spina-christi*, *Indigofera arabica*, *Grewia tembensis*, *Euphorbia schimperi*, *Acacia nilotica ssp. indica*, *Indigofera articulate*, *Chrozophora oblongifolia*, *Aristolochia bracteolata*, *Dobera glabra*, *Ceropegia rupicola* and *Aloe inermis*.

1.4.1.17. *Acacia origena* Woodlands:

Their densities vary from one site to another. They are to be encountered on rocky slopes, flat plateaux, agricultural terraces and grounds higher than 1600m such as in Ibb, north of Turba, Gebel Sabr. This is an important component of agro-forestry systems in Yemen. However it started to retreat in the face of urban sprawl. Of the associated species: *Ziziphus spina-christi*, *Euphorbia ammak*, *Opuntia ficus-indica*, *Agave sisalana*, *Cordia africana*, *Ficus vasta*, *Ehretia cymosa*, *Carissa spinarum*, *Pennisetum setaceum*, *Andropogon sp.*, *Reichardia tingitana*, *Themeda triandra*, *Rumex nervosus*, *Acanthus arboreus*.

1.4.1.18. *Acacia campoptila* Woodlands:

These are low density woodlands to be found in valleys and banks in Maareb, Shabwa and Hadramoat between 650-1450m. The associated plant formations include:

Acacia hamulosa, *Cymbopogon schoenanthus*, *Fagonia indica*, *Tephrosia apollinea*, *Ziziphus leucodermis*, *Blepharis ciliaris*, *Rhazya stricta*, *Senna italica*, *Indigofera arabica*, *Kohautia retrorsa*, *Dipterygium glaucum*, *Panicum turgidum*, *Indigofera spinosa*, *Ochradenus arabicus*, *Dipterygium glaucum*, *Heliotropium ramosissimum*, *Crotalaria persica*, *Citrullus colocynthis*, *Aerva javanica*, *Pulicaria jaubertii*, *Pulicaria undulata* and *Tribulus arabicus*.

1.4.1.19. *Anogeissus dhofarica* Forests:

This is an area rich in unique plant diversity. It is constituted as a protected forest. The plant community is dominated by *Anogeissus dhofarica*, *Dodonaea viscosa* and *Jatropha dhofarica*. The protected forest houses plants considered native to Hoff, Gebel Fartuk (Mahara) and Dhafar. The list of important plants includes:

Maytenus dhofarensis, *Euphorbia smithii*, *Jatropha dhofarica*, *Commiphora foliacea*, *Croton confertus*, *Cadia purpurea*, *Tamarindus indica*, *Commiphora spp.*, *Commiphora kua*, *Commiphora gileadensis*, *Acacia spp.*, *Hybanthus durus*, *Nogalia drepanophylla*, *Portulaca dhofarica*, *Acacia senegal*, *Acokanthera schimperi*, *Allophylus rubifolius var. Rubifolius*, *Adiantum lunulatum*, *Alectra parasitica*, *Arthraxon junnaensis*, *Barleria Hochstetteri*, *Blepharis dhofarensis*, *Centaurothamnus maximus*, *Blepharispermum hirtum*, *Buchnera hispida*, *Buchnera hispida*, *Campylanthus hubaishanii*, *Ceratopteris*

cornuta, Ceropogia bulbosa, Ceropogia bulbosa, Cibirhiza dhofarensis, Cissus quadrangularis, Commelina erecta, Commicarpus boissieri, Corallocarpus epigaeus, Cucumis sativus, Croton confertus, Cyphostemma ternatum, Delonix elata, Dhofaria macleishii, Dichanthium micranthum, Diplocyclos palmatus, Dyerophytum indicum, Dyschoriste dalyi, Echidnopsis seibanica, Euclea schimperi, Euphorbia smithii, Exacum arabicum, Fluggea virosa, Grewia tenax, Grewia trichocarpa, Grewia villosa, Grewia bicolour, Eulophia guineensis var. purpurata, Farsetia dhofarica, Forsskaolea viridis, Galium spurium subsp. africanum, Gladiolus candidus, Habenaria myodes, Habenaria malacophylla, Hildebrandtia africana sub. arabica, Hybanthus durus, Hyoscyamus flaccidus, Impatiens balsamina. Ipomoea cairica, Ipomoea dichroa, Ipomoea obscura, Ipomoea turbinata, Jasminum grandiflorum sub. Floribundum, Justicia areysiana, Justicia heterocarpa, Lannea triphylla, Lemna perpusilla, Leucas urticifolia, Maytenus dhofarensis, Megalochlamys violacea, Olea europaea subsp. cuspidata, Oplismenus burmannii, Otostegia fruticosa subsp. Schimperi, Pancratium maximum, Pavetta longiflora, Peperomia pellucida, Physalis micrantha, Pluchea arabica, Premna resinosa, Pyrostria phyllanthoidea, Pyrostria phyllanthoidea, Remusatia vivipara, Rhamnus staddo, Rhus flexicaulis, Rhynchosia minima var. Minima, Ruellia praetermissa, Ruttya fruticosa, Tarenna graveolens sub. Arabica, Tephrosia mahrana, Sageretia thea, Samolus valerandii, Sclerocarpus africanus, Sclerocephalus arabicus, Sideroxylon mascatense, Tinospora bakis, Trichodesma hildebrandtii, Volutarella dhofarica

1.4.1.20. *Croton socotranus* Forests:

These are thick forests and shrubs to be encountered in the coastal plains of Socotra between sea level and 300m. The most important associate plants include:

Pulicaria stephanocarpa, Jatropha unicostata, Maerua angolensis var. Socotrana, Euphorbia arbuscula, Dendrosicyos socotrana Commiphora ornifolia, Cissus subaphylla Trichocalyx orbiculatus, Metolepis intricate, Heliotropium odorum, Ballochia atro-virgata, Leucas virgata, Heteropogon contortus, Euryops arabicus, and Seddera glomerata.

1.4.1.21. *Dracaena cinnabari* Woodlands:

These are to be encountered in plateaux and rocky slopes in Socotra Island between 500-1300m. Important associate species include: *Adiantum balfourii, Buxanthus pedicellatus, Croton socotranus, Croton sulcifructus, Cocculus balfourii, Trichocalyx orbiculatus, Ballochia atro-virgata, Aloe perryi, Cissus hamaderohensis, Euphorbia arbuscula, Euphorbia socotrana, Euryops arabicus, Jatropha unicostata, Aerva lanata, Indigofera nephrocarpoides, Trichocalyx obovatus, Adenium obesum ssp sokotranum, Helichrysum balfourii, Euclea divinorum, Allophyllus rhoidiphyllus.*



Fig. (9). Plant Associations- Socotra Island- Yemen



Fig. (10). *Croton socotranus*- Socotra Island-Yemen



Fig. (11). *Dracaena cinnabari* -Socotra Island-Yemen

1.5. Previous Studies on Species Diversity in Yemen

Table (8) summarizes plant surveys conducted during the previous two decade in Yemen:

Table (8). Recent Plant Surveys Implemented in Yemen

Year	Survey	Financing Agency
1996	Protected Natural Areas in Yemen	Ministry of Agriculture & water Resources, DGFDS Project: FAO/GCP/YEM/015/SWI (1996)
1996	Vegetation Survey of Wadi Rimaa Basin	Soil & Water Conservation Project (Forestry Component). UTF/YEM/023/Sana'a, Yemen
1996	Vegetation Survey of Wadi Sharash Basin (Hijja).	Soil & Water Conservation Project (Forestry Component). UTF/YEM/023/Sana'a, Yemen
1997	Vegetation Types of Upper Wadi Risian-Taaiz (with map @ 1:50 000).	Water & Natural Resources Bureau. UND?DSMS-YEM93/010-Dar El Yemen Taiz, Yemen
2003	Inventory & Assessment of Vegetation Cover of Gebel Buraa Protectorate	Environment Sustainable Management, Sana'a, Yemen
2005	Environmental Impact Assessment on Vegetation Cover of Wadi deem, Hadramoat	Dove Energy
2007	Environmental Impact Assessment on Vegetation Cover in Hadramoat/Shibam	OMV Oil Company
2009	Environmental Impact Assessment on Vegetation Cover in Shabwa.	OMV Oil Company
2010	Survey of Vegetation Cover & Range Resources in Dhalie Governorate	Community Resources Management Project
2010	Natural Vegetation Cover of Wadi Annah/Al Adeen	Social Development Fund
2010	Environmental Impact Assessment on Vegetation Cover in Hat/Mahara.	OMV Oil Company
2012	Study of Wild Plants in Ibb	Social Development Fund

1.6. Procedures & Scientific Methods Followed in Inventory & Assessment of Species Diversity:

A number of methods and procedures were followed in description and assessment of Plant Genetic Resources Diversity in forest and woodland areas of Yemen. These include:

1.6.1. A detailed assessment of vegetation cover was conducted using TWINSpan-Blaquet Braun accompanied by classification characterization of plants,

1.6.2. A study of Diversity , Replication and Importance Value for each species was conducted using advanced software such as Multivariant Statistical Programme (MVSP) together with 'Bio-Diversity Professional Beta',

1.6.3. An Inventory & Assessment of Plant Diversity in Forest & Woodland Areas was conducted using Geographic Information System (GIS) together with other computer programmes such as DIVA-GIS, ERDAS- Imagine & ArcGis.

1.7. Future Requirements for Capacity Building to Improve Inventory & Assessment of Species Diversity:

1.7.1. Training on use of Satellite Imageries & GIS in Delineation & Survey of Forest & Woodland Areas,

1.7.2. Training on Forest Survey & Maintenance Methods,

1.7.3. Establishment of Forest Genetic Resources Banks & Their Management,

1.7.4. Future Study & Information gathering on Current Status of Biodiversity and Traditional Utilization Methods of Wild Plants,

1.7.5. Study of Threats to Endangered Genetic Resources, Causes of Forest & Woodlands Genetic resources Degradation,

1.7.6. Development of Capacity & Means of Local Communities in aspects such as Collection & Safe-keeping Economic Wild Plants,

1.7.7. Preparation of maps of Biodiversity Areas, Important Plant Areas (such as Vegetation Cover & Land-use Maps),

1.7.8. Coordination & Cooperation with Neighbouring Countries in Forest Resources Assessments.

Endangered Forest Tree & Shrub Species:

There are no activities in Yemen aiming at determining priority forest tree species for conservation or sustainable management.

Table (9). Portrays the trees, shrubs & main forest plant species that are considered endangered.

Table (9). List of Endangered Trees, Shrubs & Forest Plant Species in Yemen

Scientific name

Adansonia digitata L.
Allophylus rubifolius (Hochst.) Engl.
Bonatea steudneri (Reichb.f.) Dur. & Schinz
Boswellia sacra Flueck
Bridelia scleroneura Muell.-Arg.
Brucea antidyssinterica J.F.Mill.
Celtis africana Burm.f.
Cometes abyssinica R.Br.
Commiphora quadricincta Schweinf. Ex Engl.
Croton macrostachyus Hochst. Ex Del.
Cussonia holstii Harms ex Engl.
Diospyrus mespiliformis Hochst. Ex A.DC.
Disa pulchella Hochst. Ex A. Rich.
Dracaena serrulata Baker
Edithcolea grandis N.E.Br.
Endostemon gracilis (Benth.) M.Ashby
Epipactis veratrifolia Boiss.
Eulophia clavicornis Lindl.
Eulophia guineensis Lindl.
Eulophia petersii (Reichb.f.) Reichb.f.
Eulophia streptopetala Lindl.
Ficus ingentiodes Hutch.
Grewia arborea (Forssk.) Lam.
Gymnema sylvestris (Retz.) r.Br. Ex Schult.
Holothrix aphylla (Forssk.) Reichb.f.
Holothrix arachnoidea (A.Rich.) Reichb.f.
Juniperus procera Hochst. Ex Endl.
Lannea fruticosa (Hochst.) Engl.
Livistona carinensis (Chiov.) Dransfield & N.Uhl.
Maytenus undata (Thunb.) Blakelock
Meineckia phllanthoides Baill.
Mimusops laurifolia (Forssk.) Friis
Nervillia umbrosa (Reichb.f.) Schultr.
Nuxia oppositifolia (Hochst.) Benth.
Olea europaea L.
Oncocalyx doberae (Schweinf.) A.G.Mill. & J.A.Nyberg

Ormacarpum dhofarens Hillcoat & Gillett
Ozoroa insignis (Del.) O.Kuntze
Piliostigma thonningii (Schumach.) Milne-Redh.
Pittosporum viridifolium Sims
Primula verticellata Forrsk.
Rhizophora mucronata Lam.
Rhus abyssinica Hochst. Ex Oliv.

Rhus flexicaulis Baker
Satyrium brachypetalum A.Rich.
Stereospermum kunthianum Cham.
Trema orientalis (L.) Bl.
Triumfetta pendandra A. Rich.
(endemic) _)*_
Acacia campoptila Schweinf.
Acacia pennivenia Schweinf.
Aerva artemisioides Vierh. & Schwartz subsp. artemisioides
Aeschynomene arabica Deflers
Aloe abyssicola Lavr. & Bilaidi
Aloe austroarabica Lavr
Aloe castellorum J.R.I. Wood
Aloe doei Lavr.
Aloe eremophila Lavr.
Aloe fulleri Lavr.
Aloe inermis Forssk.
Aloe irafensis Lavranos, Al-Gifri & McCoy
Aloe jawiyon Christie, Hannon &
Aloe lavranosii Reynolds
Aloe luntii Baker
Aloe menachensis (Schweinf.) Blatter
Aloe niebuhriana Lavr.
Aloe pendens Forssk.
Aloe perryi Baker
Aloe rivierei Lavr. & Newton
Aloe rubroviolacea Schweinf.
Aloe sinensis Lavr.
Aloe splendens Lavr.
Aloe squarrosa Balf.f.
Aloe tomentosa Deflers.
Aloe vacillans Forssk.
Andrachne schweinfurthii (Balf.f.) Radcl.-Sm.
Andropogon bentii Stapf
Andropogon crossotes Cope
Aneilema woodii R.B.Faden
Angkalanthus oligophylla Balf.f.
Anogeissus bentii Baker.
Aristida anaclasta Cope

Aristida pennei Chiov.
Asplenium schweinfurthii Baker
Ballochia amoena Balf.f.
Ballochia atro-virgata Balf.f.
Ballochia rotundifolia Balf.f.
Barleria argentea Balf.f.
Barleria popovii Verdc.
Barleria tetracantha Balf.f.
Becium serpyllifolium (Forssk.) Wood

Begonia semhaensis M.Hughes & A.G.Mill.
Blepharis kuriensis
Blepharis linariifolia Pers.
Blepharis spiculifolia Balf.f.
Blepharispermum yemense Deflers
Boswellia aff. *ameero*
Boswellia ameero Balf.f.
Boswellia bullata Thulin ined.
Boswellia dioscorides Thulin ined.
Boswellia elongata Balf.f.
Boswellia nana Hepper
Boswellia popoviana Hepper
Boswellia socotrana Balf.f.
Cadaba insularis A.G.Mill.
Calligonum crinitum Boiss subsp. *arabicum* (Soskov) Soskov
Campylanthus milleri Thulin
Campylanthus pungens Schwartz..
Campylanthus yemenensis A.G.Mill.
Caralluma lavranii Rauh & Wertel
Centaurea yemensis Wagenitz
Centaurothamnus maximus (Forssk.) Wagen. & Dittr.
Cephalocroton socotranus Balf.f.
Ceropegia foliosa Bruyns
Ceropegia sepium Deflers
Ceropegia yemensis Meve & Mangelsdorff
Chapmannia gracilis (Balf.f.) Thulin
Chapmannia reghidensis Thulin & McKean
Chapmannia sericea Thulin & McKean
Chapmannia tinireana Thulin
Chascanum yemenense Sebsebe
Chorisochora minor (Balf.f.) Vollesen
Chorisochora striata (Balf.f.) Vollesen
Cistanche rosea E.G.Bak
Cleome macradenia Schweinf.
Clerodendrum galeatum Balf.f.
Clerodendrum leucophloeum Balf.f.
Coelocarpum haggierensis A.G.Mill.

Commicarpus adenensis Miller.
Commicarpus arabicus Meikle
Commicarpus stenocarpus (Chiov.) Cuf.
Commiphora foliacea Sprague.
Commiphora kataf (Forssk.) Engl.
Commiphora ornifolia (Balf.f.) Gillett
Commiphora parvifolia (Balf.f.) Engl.
Commiphora planifrons (Balf.f.) Engl.
Commiphora socotrana (Balf.f.) Engl.
Convolvulus sericophyllus T. Anders.
Convolvulus thymoides O. Schwartz

Corchorus cinerascens Deflers
Crotalaria socotrana (Balf.f.) Thulin
Crotalaria squamigera Deflers
Croton sarcocarpus Balf.f.
Croton sulcifructus Balf.f.
Croton wissmannii Schwartz
Cryptolepis macrophylla (Radcl.-Sm.) Ventner
Cryptolepis socotranus (Balf.f.)
Cyanotis nyctitropa Deflers
Cynoglossum sabirense (R.Mill & A.G.Mill.) Wood
Cynoglossum yemenense (R.Mill & A.G.Mill.) Wood
Cystostemon kissenioide (Delf.) A.G.Mill. & H.Riedl
Dactyloctenium hackelii
Daucus yemenensis Deflers
Dendrosicyos socotrana Balf.f.
Dianthus uniflorus Forssk.
Dichrostachys dehiscentis Balf.f.
Dipcadi balfourii Baker
Dipcadi kuriensis A.G.Mill.
Diplotaxis kohlaanensis A.G.Mill. & J.Nyberg
Dirachma socotrana Schweinf.
Dobera glabra (Forssk.) Poir.
Dorstenia gigas Schweinf. ex Balf.f.
Dorstenia socotrana A.G.Mill.
Dracaena cinnabari Balf.f.
Drimia porphyrostachys Baker
Duvaliandra dioscoridis (Lavr.) M.G.Gilbert
Dyerophytum pendulum (Balf.f.) Kuntze
Dyerophytum socotrana J.R.Edm.
Dyschoriste longicalyx (Deflers) Lin.
Echidnopsis squamulata (Decne.) P.R.O.Bally
Echidnopsis bentii N.E.Br. ex Hook.f.
Echidnopsis globosa Thulin & Hjertson
Echidnopsis inconspicua Bruyns
Echidnopsis insularis Lavr.

Echidnopsis milleri Lavr.
Echidnopsis seibanica Lavr.
Echidnopsis socotrana Lavr.
Echidnopsis squamulata (Decne) Bally
Echinops spinosissimus Turra.
Echiochilon pulvinata A.G.Mill.
Erythroxyllum socotranum Thulin
Euphorbia abdelkuri Balf.f.
Euphorbia applanata Thulin & Gifri
Euphorbia arbuscula Balf.f.
Euphorbia fodhliana Deflers
Euphorbia fractiflexa S.Carter & Wood
Euphorbia hajhirensis Radcl.-Sm

Euphorbia hamaderoensis Radcl.-Sm.
Euphorbia inarticulata Schweinf.
Euphorbia kuriensis Vierh.
Euphorbia leptoclada Balf.f.
Euphorbia meuleniana O. Schwartz
Euphorbia obcordata Balf.f.
Euphorbia parciramulosa Schweinf.
Euphorbia qarad Deflers
Euphorbia quaitensis S. Carter
Euphorbia rubriseminalis S. Carter
Euphorbia schweinfurthii Balf.f.
Euphorbia seibanica Lavr. & Gifri
Euphorbia socotrana Balf.f.
Euphorbia sp. aff. schimperi
Euphorbia uncinulata Radcl.-Smith ined.
Euphorbia uzruk S.Carter & J.R.I.Wood
Eureiandra balfourii Cogn.
Exacum affine Balf.f.
Exacum caeruleum Balf.f.
Exacum socotranum Balf.f.
Fagonia socotrana
Farsetia inconspicua A.G.Mill.
Farsetia socotrana B.L.Burt
Festuca cryptantha T.Cope
Forskohlea griersonii A.G.Mill.
Fuirena felicis Hooper
Gaillonia jolana Thulin
Gaillonia putorioides (A.R. Smith) Petruss. & Thulin
Gaillonia thymoides Balf.f.
Gossypium areysianum Deflers
Gossypium incanum (Schwartz) Hillcoat
Graderia fruticosa Balf.f.
Grewia bilocularis Balf.f.

Grewia milleri Abedin
Grewia turbinata Balf.f.
Gymnocarpos argenteus Petruss. & Thulin
Gymnocarpos bracteatus (Balf.f.) Thulin
Gymnocarpos kuriensis (Radcl.-Sm.) Thulin
Gymnocarpos maharanus Petruss. & Thulin
Helianthemum argyraeum Baker
Helichrysum arwae J.R.I. Wood.
Helichrysum dioscorides R. Atkinson
Helichrysum forskahlii (J.F.Gmel.) Hillia. & Burt+B295
Helichrysum nimmoanum Oliv. & Hiern
Helichrysum samhaensis R. Atkinson
Helichrysum socotranum r. Atkinson
Helichrysum suffruticosum Balf.f.
Heliotropium aff. *socotranum* Vierh

Heliotropium azzanum O.Schwartz
Heliotropium bottae Deflers.
Heliotropium cimaliense Vierh.
Heliotropium congestum Baker
Heliotropium deflersii Schwartz
Heliotropium dentatum Balf.f.
Heliotropium derafontense Vierh.
Heliotropium kuriense Vierh.
Heliotropium makallense Schwartz
Heliotropium nigricans Balf.f.
Heliotropium paradoxum Vatke.
Heliotropium paulayanum Vierh.
Heliotropium riebeckii Schweinf. & Vierh.
Heliotropium shoabense Vierh.
Heliotropium wagneri Vierh.
Heliotropium wissmannii Schwartz.
Hemicrambe townsendii Gómez Pompa
Herniaria maskatensis Bornm.
Hibiscus dioscorides A.G. Mill.
Hibiscus malacophyllus Balf.f.
Hibiscus noli-tangere A.G.Mill.
Hibiscus scottii Balf.f.
Hibiscus socotranus G.Lucas
Holothrix socotrana Rolfe
Huernia hadhramautica Lavr.
Huernia marnieriana Lavr.
Huernia rosea L.E.Newton & Lavr.
Hypericum balfourii N.Robson
Hypericum fieriense N.Robson
Hypericum socotranum subsp. *smithii* N.Robson
Iphionia anthemidifolia (Baker) A.Anderb.

Iphionia teretefolia A.Anderb.
Isoleucas arabica Schwartz
Jatropha variegata (Forssk.) Vahl
Justicia alexandri R.Atkinson
Justicia takhinensis R.Atkinson
Kalanchoe alternans (Vahl.) Pers.
Kalanchoe bentii C.H.Wright subsp. *bentii*
Kalanchoe robusta Balf.f.
Kalanchoe yemensis (Deflers) Schweinf.
Kickxia petiolata D.Sutton
Kickxia qaraticus D.A.Sutton
Kickxia sabaea D.Sutton
Kickxia sabarum V.W.Sm. & D.A.Sutton
Kickxia saccata D. A. Sutton
Kickxia scalarum Schweinf. ex D.Sutton
Kickxia spiniflora (Schwartz) D.A.Sutton
Kickxia woodii D.A.Sutton

Kleinia deflersii Deflers
Kleinia scottii (Balf.f.) P.Halliday
Kniphofia sumarae Deflers
Kohautia socotrana Bremek.
Kraussia socotrana Bridson
Lachnocapsa spathulata Balf.f.
Lansea transulta (Balf.f.) Radcl.-Sm.
Launaea almahrahensis N.Kilian
Launaea crepoides Balf.f.
Lavandula citriodora A.G.Mill.
Ledebouria insularis A.G.Mill.
Lepturus calcareus Cope
Lepturus pulchellus Cope
Lepturus tenuis Balf.f.
Leucas alba (Forssk.) Sebald
Leucas flagellifolia (Balf.f.) Guerke
Leucas haggierensis Cortez-Burns & Gifri
Leucas penduliflora Cortez-Burns & Gifri
Leucas samhaensis Cortez-Burns & Gifri
Limeum arabicum Friedr.
Limoniastrum arabicum J.R.Edm. Ined.
Littonia obscura E.G.Baker.
Lotus mollis Balf.f.
Maerua angolensis DC. subsp. *socotrana* (Schweinf. ex Balf.f.) Kers var.
socotrana
Marsdenia robusta Balf.f.
Meineckia filipes (Balf.f.) G.L.Webster
Melhania milleri Abedin
Melhania muricata Balf.f.

Metaporana obtusa (Balf.f.) Staples
Nanorrhinum kuriensis (Radcl.-Sm.) A.G.Mill.
Nepeta woodiana Hedge.
Nesocrambe socotrana A.G.Mill.
Neuracanthus aculeatus Balf.f.
Nirarathamnos asarifolius Balf.f.
Ochradenus spartioides (Schwartz) Abdulla
Ocimum suave Willd.
Oldenlandia aretioides Vierh.
Oldenlandia ocellata Bremek.
Oncocalyx doberae (Schweinf.) A.G.Mill. & Nyberg
Orbea araysiana (Lavr. & Bilaidi) Bruyns
Orbea chrysostephana (Deflers) Bruyns
Orbea wissmannii (O.Schwartz) Bruyns
Oreofraga morissiana M.Watson & E.Barclay
Ormocarpum dhofarensis Hille. & Gillett
Ormocarpum yemenense Gillett.
Orthosiphon brachystemon Deflers
Orthosiphon ferrugineus Balf.f.

Panicum socotranum Cope.
Pavonia subaphylla Schwartz.
Pelargonium insularis Gibby & A.G.Mill.
Peucedanum areysianum Deflers
Phagnalon harazianum Deflers
Phagnalon retecta Qaiser & Lack
Phagnalon scalarum Schweinf. E Schwartz
Phagnalon woodii Qaiser & Lack
Phagnalon yerrimense Qaiser & Lack
Phragmanthera austroarabica A.G.Mill. & Nyberg
Phyllanthus hodjelensis Schweinf.
Picris scabra Forssk.
Piloselloides hirsuta (Forssk.) C.Jeffrey
Pimpinella menechensis Schweinf. ex Wolff.
Pimpinella woodii C.Townsend
Plantago cylindrica Forssk.
Plectranthus asirensis J.R.I. Wood
Plectranthus hyemalis J.R.I. Wood
Plectranthus ovatus Benth.
Pluchea glutinosa Balf.f.
Pluchea obovata Balf.f.
Polycarpaea hassalensis D.F.Chamb.
Polycarpaea haufensis A.G.Mill.
Polycarpaea kuriensis Wagner
Polycarpaea paulayana Wagner
Polygala kuriensis A.G.Mill.
Portulaca samhaensis A.G.Mill.

Portulaca sedifolia A.G.Mill.
Prenanthes amabilis Balf.f.
Psiadia schweinfurthii Balf.f.
Psilotrichum aphyllum C.C. Townsend
Pulicaria aromatica (Balf.f.) King-Jones & N. Kilian
Pulicaria disocoridis R. Atkinson
Pulicaria grandidentata Jaub. & Spach.
Pulicaria lancifolia Schwartz
Pulicaria nivea Schwartz
Pulicaria rauhii Gamal-Eldin
Pulicaria vieraeoides Balf.f.
Punica protopunica Balf.f.
Pyrostria socotrana (Radcliffe-Smith) D.M. Bridson
Rhus flexicaulis Baker
Rhynchosia flava (Forssk.) Thulin
Rhytidocaulon maccoyii Lavr. & Mies
Rhytidocaulon ciliatum Hanacek & Ricanek
Rhytidocaulon splendidum McCoy
Rhytidocaulon tortum (N.E.Br.) M.G. Gilbert
Rubus arabicus (Defflers) Schweinf.
Ruellia kuriensis Vierh.

Ruellia longicalyx Defflers
Ruellia paulayana Vierh.
Rughidia milleri M. Watson & E. Barclay
Ruta amoena Schwartz.
Ruta mollis Schwartz.
Saltia papposa (Forssk.) Moq.
Salvia areysiana Defflers
Sarcostemma socotranum Lavr.
Satureja remota (Balf.f.) Vierh.
Scaevola socotraensis St John
Schweinfurthia latifolia (.Baker.ex) Oliver
Scorzonera musilii Velen.
Scrophularia arguta Ait.
Secamone cuneifolia Bruyns
Seddera fastigiata (Balf.f.) Verdc.
Seddera hadramautica R.R. Mill ined.
Seddera pedunculata (Balf.f.) Verdc.
Seddera secundiflora Jaub. & Spach
Seddera semhahensis R.R. Mill ined.
Seddera spinosa (Vierh.) Verdc.
Senecio asirensis Boulos & Wood
Senecio haraziansis Defflers
Senecio sumarae Defflers
Sideroxylon fimbriatum Balf.f.
Socotrella dolichonema Bruyns

Solanum platacanthum Dun.
Sonchus saudensis Boulos
Spinulima discolor (A.R. Smith.) I.Friis.
Stachys yemenensis Hedge
Sterculia africana var. *socotrana* (K.Schum.) Fiori
Swertia polynectaria (Forssk.) Asches. ex C.Chr.
Swertia woodii Shah.
Taraxacum sp A [fide Wood]
Taverniera albida Thulin
Taverniera glauca Edgeworth
Taverniera multinoda Thulin
Taverniera schimperii Jaub. & Spach.
Taverniera sericophylla Balf.f.
Tephrosia socotrana Thulin
Teucrium eximium Schwartz
Teucrium paulayanum Schwartz.
Teucrium rhodocalyx O. Schwartz
Thamnosma socotrana Balf.f.
Thymus laevigalus Vahl
Trichocalyx obovatus Balf.f.
Trichocalyx orbiculatus Balf.f.
Trichodesma scottii Balf.f.
Tricholaena vestita (Balf.f.) Stapf & C.E.Hubb

Trigonella falcata Balf.f.
Turraea socotrana White & Styles
Valerianella affinis Balf.f.
Verbascum bottae (Deflers) Huber-Mor.
Verbascum luntii Baker
Verbascum melhanense (Murb.) Huber-Mor.
Verbascum yemense Deflers
Vernonia areysiana Deflers
Vernonia bottae Jaub. & Spach
Vernonia unicata C.Jeffrey
Volutarella dhofarica Wagenitz
Volutaria albicaulis (Deflers) Wood
Wellstedia socotrana Balf.f.
Zygophyllum simithii Hadidi

Near- endemic plants

Abrus botte Deflers
Acacia origena Hunde
Aloe fleurentinorum Lavr. & Newton
Aloe sabaena Schweinf.
Aloe yemenica J.R.I.Wood
Anogeissus dhofarica A.J.Scott
Atractylis kentrophylloides (Baker) F.G.Davis

Blepharis dhofarensis A.G.Mill.
Blepharispermum hirtum
Boscia arabica Pestalozz.
Campylanthus chascaniflorus A.G.Mill.
Capmpylanthus pungens O. Schwartz
Caralluma arabica N.E.Br.
Caralluma adscendens *Caralluma subulata* (Forssk.) Decne.
Caralluma awdeliana (Deflers) A.Berger
Caralluma cicatricosa (Deflers) N.E.Br.
Caralluma flava N.E.Br.
Caralluma hexagona Lav. *Caralluma foulcheri-delboscii* Lavr.
Caralluma awdeliana (= *Caralluma petraea* Lav.)
Caralluma quadrangula (Forssk.) N.E.Br.
Caralluma solenophora Lavr.
Caralluma tuberculata N.E.Br.
Centaurea dhofarica Baker
Centaurea pseudosinacia ssp. *nieburhii*
Cerantonia oreothauma subsp. *oreothauma*
Ceropegia arabica Huber
Ceropegia aristolochioides Decne subsp. *deflersiana* Bruyns
Ceropegia rupicola Deflers
Ceropegia tihamana Chaudh. & Lavr.
Chrysopogon macleishii Cope
Cibirhiza dhofarensis Bruyns
Cichorium bottae Deflers
Cleome albescens Fran. subsp. *omanensis* Chamb. & Lamond

Cleome austroarabica Chamb. & Lamond. subsp. *austroarabica*
Cocculus balfourii Schweinf. ex Balf.f.
Convolvulus hystrix ssp. *dhofarica* R.R.Mill ined.
Crinum album (Forssk.) Herb.
Cucumis canoxyi Thulin & Gifri
Dhofaria macleishii A.G. Mill.
Dianthus deserti Kotschy
Dipcadi biflorum Ghaz.
Dracaena serrulata Baker.
Dyschoriste daily A.G.Mill.& J.Biagi
Echidnopsis scutellata (Deflers) A.Berger
Echiochilon arabicum (Schwar.) I.M.Johns.
Echiochilon callianthum Lonn
Euphorbia ammak Forssk.
Euphorbia dhofarensis S.Carter
Euphorbia fruticosa Forssk.
Euphorbia reibeckii Pax
Euphorbia smithii Carter
Fagonia maharana Beier
Farsetia dhofarica Jonsell & A.G.Mill.

Farsetia linearis Decne. Ex Boiss.
Farsetia latifolia Jonsell & A.G. Mill.
Gaillonia yemenensis Thulin
Gymnocarpus dhofarensis Petruss & Thulin
Gymnocarpus rotundifolius Petruss. & Thulin
Gypsophila umbricola (J.R.I.Wood) Clement
Halothamnus bottae Jaub. & Spach
Helianthemum citriunum Ghaz.
Heliotropium fartakense Schwartz
Heliotropium sp. nov. [Thulin]
Hildebrandtia africana subsp arabica Sebsebe
Huernia laevis J.R.I.Wood
Huernia lodarensis Lavr.
Huernia velutina Lavr.
Hybanthus durus (Baker) Schwartz
Hyoscyamus flaccidus Wright
Indigofera rubromarginata Thulin
Iphiaena senecionoides (Baker) A. Anderb.
Jatropha dhofarica R.Sm.
Justicia areysiana Defl.
Launaea castanosperma F.G.Davies
Launaea fragilis (Asso) Pau. subsp. *asirensis* N.Kilian
Lavandula dhofarensis A.G.Mill.
Leucas dhofarensis Hedge & Sebald
Maytenus dhofarensis Sebsebe
Maytenus forsskaoliana Sebsebe
Nepeta deflersiana (Schweinf. ex) Hedge
Nogalia drepanophylla (E.G.Baker)Verdc

Ochradenus arabicus Chaudhary, Hillc. & A.G. Mill.
Ochradenus gifrii Thulin.
Ocimum dhofarensis (Sebald) Paton = *Becium dhofarensis* (E.G.Baker) Sebald
Orbea deflersiana (Lavr.) Bruyns= *Caralluma deflersiana* Lavr.
Orbea luntii (B.E.Br) Bruyns = *Caralluma luntii* N.E.Br.
Orbea sprengeri subsp *commutata*
Orbea wismannii (O.Schwartz) Bruyns
Oreoschimperella arabiae-felicis C. Townsend
Panocratium maximum Forssk.
Parietaria umbricola A.G.Mill.
Pavetta longiflora Vahl
Peucedanum inaccessum C. Townsend
Plectranthus arabicus Bruce.
Polygala tinctoria Vahl
Pulicaria argyrophylla subps *oligophylla* Gamal-Eldin
Pulicaria cylindrica (Baker) O. Schwartz
Pulicaria nobilis Gamal-Eldin

Pulicaria omanensis Gamal-Eldin
Reseda sphenocleoides Deflers
Rhytidocaulon macrolobum Lavr.
Ruellia longiflora Vahl
Sarcostemma arabicum Bruyns & P.Forster
Schweinfurthia spinosa A.G.Mill. Sutton & Short
Scutellaria arabica Jaub. & Spach
Seddera intermedia Hoschst. & Steud.
Suaeda moschata A.J.Scott.
Teucrium nummularifolium Baker
Teucrium yemense Deflers
Trichodesma laccophilum R.R.Mill
Withania qaraitica A.G.Mill. & J.Biagi
Xerophyta arabica (Baker) N. Menezes
Xerotia arabica Oliver.
Zizyphus leucodermis O. Schwartz
Zygocarpum dhofarensis (Hillc. & J. B. Gillett) Thulin & Lavin

Preliminary National IUCN Criteria for Endangered plant species in Yemen:

18 such plants have been listed as per table 10 (Hall *et al* 2008).

Table (10). IUCN Regional Assessment of Plant Species in Tropical Forests of Yemen.

#	Species	IUCN Regional Assessment Listing
1	<i>Antiaris toxicaria</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
2	<i>Diospyros mespiliformis</i>	EN B 1ab(iii), 2ab(iii)
3	<i>Triumfetta pentandra</i>	CR B 1ab(iii), 2ab(iii), C2a(i,iii)
4	<i>Mimusops laurifolia</i>	EN B 1ab(iii), 2ab(iii)
5	<i>Bauhinia tomentosa</i>	CR B 1ab(iii), 2ab(iii), C2a(i)
6	<i>Piliostigma thonningii</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
7	<i>Bridelia scleroneura</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
8	<i>Meineckia phyllanthoides</i>	EN B 1ab(iii), 2ab(iii)
9	<i>Croton macrostachyus</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
10	<i>Bersama abyssinica</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
11	<i>Allophylus rubifolius</i>	EN B 1ab(iii), 2ab(iii)
12	<i>Ozoroa insignis</i>	CR B 1ab(iii), 2ab(iii), C2a(i)
13	<i>Nuxia oppositifolia</i>	EN B 1ab(iii), 2ab(iii)
14	<i>Brucea antidysenterica</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
15	<i>Gymnema sylvestre</i>	CR B 1ab(iii), 2ab(iii), C2a(i)
16	<i>Stereospermum kunthianum</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
17	<i>Aneilema woodii</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D
18	<i>Endostemon gracilis</i>	CR B 1ab(iii), 2ab(iii), C2a(i), D

EN: Endangered- CR Critically Endangered

1.8. Threats to Forest Genetic Resources in Yemen:

Global forest area lost annually to deforestation is estimated at 13 million ha, largely through changing the land to other landuses. This area is compensated for partially through contemporary reforestation activities. 507 million ha are reforested annually. Still some 200km² of global forestland is lost daily.

It is difficult to accurately assess the genetic losses from deforestation and woodland removal & degradation or ways of redressing the situation in Yemen due to the lack of knowledgeable forestry personnel in the country. However, the threats to wild plants in forest & woodland areas of Yemen can be enumerated in the following:

1.8.1. Population Growth and Attendant Challenges:

Population growth invariably entails change of natural habitats into residential areas, factories, roads etc, thus destruction of habitats and loss of GR,

1.8.2. Invasive Alien Species:

Very few people appreciate the danger of some invasive plants on GR in forest & woodland areas. After the introduction of such plants many farmers and animal herders suffered after these plants dominated, competed with and eventually smothered the native species. Mesquite (*Prosopis juliflora*) for instance invaded several areas of Yemen and dominated many economic range and other plants. Mesquite has totally dominated woodland plant associations there originally dominated by such trees as *Salvadora persica*, *Tamarix spp*, *Acacia tortilis*, *A. campoptila* and *Ziziphus spina-christi* in many valets in Hadramoat, Tihama Plains and Shabwa and is still spreading. Its control is almost impossible. Another invasive plant is *Opuntia dillenii* which invaded forest & woodland areas on the slopes of Tihama hills and became dominant. Another plant, *Opuntia ficus-indica* invaded fertile agricultural fields in highlands like Gebel Samara.

1.8.3. Climate Change (CC):

With the global CC, conservation of GR became more difficult than before:

1.8.3.1. Drought:

Drought: Drought negative affected many plants in Yemeni environs. In desert and semi desert areas like Mahara, Hadramoat, Shabwa, drought and lack of rains have affected many plants leading to high mortality. Plants mostly affected by drought include: *Ziziphus leucodermis*, *Z. spina-christi*, *Tamarix aphylla*, *Boscia arabica* and *Acacia tortilis*.

1.8.3.2. Floods:

Repeated floods negatively impacted FGR in particular areas especially the fertile valleys of Hadramoat. These areas, rich in FGR were transformed to sparse grasslands. Forest tree which used to dominate these areas like *Anogeissus bentii*, *Ziziphus leucodermis*, *Z. spina-christi*, *Balanites aegyptiaca* and *Commiphora kua* became rare and scattered. The GR richness was greatly affected by floods and gravel sedimentation that followed. Forestlands dominated by *Phoenix dactylifera* and *Ziziphus spina-christi* are reduced to bare lands

covered by rocks & gravel together with less valuable plants like *Argemone Mexicana*, *Zygophyllum album* and *Calotropis procera*.

1.8.3.3. Sand Encroachment:

Sand and dune encroachment greatly impacted forest plant communities. Fertile valleys of Hadramoat and Shabwa that were covered with forests dominated by *Ziziphus spina-christi*, *Acacia ehrenbergiana* and *A. tortilis* were reduced to dry poor rocky soils dominated by secondary plants such as *Zygophyllum album*, *Citrullus colocynthis*, *Dipterygium glaucum*, *Alhagi graecorum*, *Tribulus arabicus*, *Cleome scaposa*, *Panicum turgidum*, *Calotropis procera*, *Tephrosia apollinea*, *Senna italic* and *Prosopis juliflora*.

1.8.4. Grazing:

Grazing plays a prominent role in ecological imbalance, rarity of palatable annual range plants and eventually leads to GR poverty. Grazing is more intense during the rainy season. Due to intense grazing, valuable & palatable plants like *Panicum turgidum*, *Lasiurus scindicus*, *Merremia hadramautica* and *Boerhavia elegans* were reduced to plant communities dominated by unpalatable plants such as *Fagonia indica*, *Rhazia stricta*, *Heliotropium ramosissimum*, *Tephrosia apollinea*, *Calotropis procera*, *Citrullus colocynthis* and *Argemone Mexicana*.

1.8.5. Wood Pillage:

Many people in rural areas of Yemen rely of FGR for collection of wood and other plant parts for fuel wood (fire wood and charcoal), building, food and medicinal purposes. These activates have rendered many forest & woodland species extinct or greatly endangered-table (11).

1.8.6. Petroleum Exploration Activities:

During the last two decades. Petroleum exploration and attendant activates like road & facilities construction have played a notable role destruction of ecosystems rich in endemic & near endemic forest & woodland plant species. This is particularly noticeable in valley bottoms Hadramoat, Ma'areb & Shabwa. These activities have also depleted the seed banks of valuable plants and rendered the areas therein susceptible to invasion by invasive species like Mesquite. Plants known to have been badly affected include: *Commiphora kua*, *Crotalaria persica* *Fagonia bruguieri*, *Hochstetteri schimper* , *Kohautia retrorsa*, *Periploca visciformis*, *Silene macrosolen*, *Glossonema varians* *Euphorbia rubriseminalis*, *Anogeissus bentii*, *Ochradenus arabicus* and *Ziziphus leucodermis*.

The closure of exploration areas denied herders access to traditional grazing areas and forced them to seek replacement in forests & woodlands, thus exerting more pressure on them.

Table (11). Wild Plants Cut for Various Purposes in Yemen

#	Plant	Purpose of Collection
1	<i>Acacia tortilis</i>	Charcoal making
2	<i>Aloe vera</i> , <i>Aloes inermis</i> , <i>Aloe doei</i> , <i>Aloe irafensis</i>	Medical use & unorganized export

3	<i>Berchemia discolor</i>	Building wood
4	<i>Boerhavia elegans</i> subsp <i>elegans</i>	Traditional food
5	<i>Boswellia</i> spp	Collection of Resin (Olibanum)
6	<i>Cometes abyssinica</i>	Traditional food
7	<i>Opuntia ficus-indica</i>	Food
8	<i>Opuntia dillenii</i>	Food
9	<i>Rumex nervosus</i>	Popular food
10	<i>Cissus rotundifolia</i>	Popular food
11	<i>Commiphora myrrha</i>	Popular medicine (Resin)
12	<i>Cordia africana</i>	Building wood
13	<i>Cyphostemma digitatum</i>	Popular food
14	<i>Thymus laevigatus</i>	Popular food
15	<i>Cymbopogon jwarancusa</i>	Fire igniter for charcoal making
16	<i>Portulaca oleracea</i>	Popular food
17	<i>Dianthus uniflorus</i>	Popular food
18	<i>Dodonaea viscosa</i>	Popular flavouring
19	<i>Dracaena serrulata</i>	Popular handicrafts
20	<i>Edithcolea grandis</i>	Horticulture
21	<i>Epipactis veratrifolia</i>	Horticulture
22	<i>Eulophia clavicornis.</i>	Horticulture
23	<i>Eulophia guineensis</i>	Horticulture
24	<i>Eulophia petersii</i>	Horticulture
25	<i>Eulophia streptopetala</i>	Horticulture
26	<i>Ficus sycomorus</i>	Building Bee-hives
27	<i>Grewia</i> spp.	Making sticks
28	<i>Habenaria</i> spp	Horticulture
29	<i>Nervillia umbrosa</i>	Horticulture
30	<i>Ocimum forskolei</i>	Popular food
31	<i>Orbea wissmannii</i>	Popular food
32	<i>Pulicaria jaubertii</i>	Popular food
33	<i>Rhamnus staddo</i>	Popular flavouring
34	<i>Sageretia thea</i>	Wood
35	<i>Ziziphus spina-christi</i>	Building wood
36	<i>Foeniculum vulgare</i>	Popular food

Chapter 2

The Status of in-situ Genetic Conservation in Yemen

2.1. Introduction:

Conservation of GR in their natural habitat (in-situ) is the ideal way to protect environmental diversity in plants and animals. Vast areas in highlands, valleys and coastal plains of Yemen were draped with dense Forests & woodlands as was pointed out by many historians, travellers and orientalist who visited Yemen during the 17th Century and up the beginning of the 20th Century. However, degradation started to be evident on renewable natural resources from the mid 1970s. Degradation factors encompassed wood cutting, grazing, wild land fires and poaching together with recurrent drought spells. Fertile areas were decertified or rendered unproductive. There were numerous traditional norms in Yemen which used to regulate land use activities such as the ‘Hima’ system of grazing regulation which kept the environment fairly intact.

2.2. Protected Areas (PA) & Areas proposed for declaration as PA:

With the continuously rising population , collapse of traditional norms of natural resources management , rising demand for their products and to conserve what is left of wildlife (fauna & flora), a number of PA have been constituted & declared or are in the process of being so. 47 sites have been delineated and proposed as PA together with 9 sites already constituted & declared as PA. (EPA 2012)- Table (12).

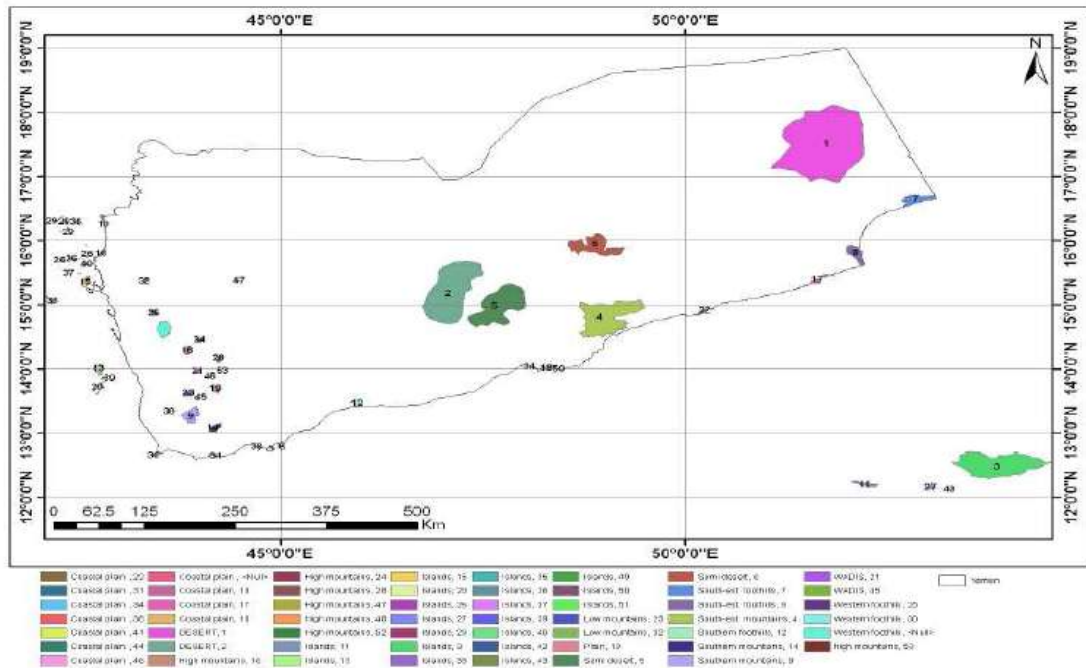
Table (12). Main Forest & Woodland Areas Constituted as Protected Areas (1) or Proposed for the Purpose (2)

#	Name	Ecosystem	Governorate	Class	Area km ²
1	Hat	Desert	Mahara	2	11184.4
2	Jardan Shabwa	Desert	Shabwa	2	5103.5
3	Socotra	Islands	Hadramoat	1	3704.1
4	Jebel Tour Siban	South Eastern Mountains	Hadramoat	2	3222.4
5	Shabwa	Semi-desert	Hadramoat/Shabwa	2	3113.5
6	Treem	Semi-desert	Hadramoat	2	1441.4
7	Hof	Southern Mountains	Mahara	1	468.9
8	Ras Fartuk	Southern Mountains	Mahara	2	346.5
9	AL-Maafir	Southern Mountains	Taaiz	2	397.6
10	Al-Lihia wa Meadi	Coastal Plains	Hudieda, Hija	2	178.6
11	Abdel Kouri	Islands	Hadramoat	2	133.5
12	Jebel Aries	Southern Mountains	Abien	2	128.1

13	Zegar	Islands	Hudieda	2	121.4
14	Jebel Erf	Southern Mountains	Lahaj	2	120.9
15	Kamran Island	Islands	Hudieda	1	106.7
16	Wassab Aali	High Mountains	Zamar, Ibb	2	104.0
17	Gashan	Coastal Plains	Mahara	2	97.0
18	Bir Ali	Coastal Plains	Shabwa	2	96.4
19	Al-Hoban(ljaund)	Highland Plains	Taaiz.Ibb	2	95.1
20	Haniesh Kubra	Islands	Hudieda	2	71.4
21	Wadi Ani (Al-Adeen)	Valleys	Ibb	1	67.3
22	Sharma and Jathmoun	Coastal Plains	Hadramoat	2	62.2
23	Hajda (Maghbana)	Low South Mountains	Taaiz	2	57.5
24	Atma	Western Moutains	Zamar	1	448.5
25	Jebel Buraa	Western Moutains	Hudieda	1	47.5
26	Intofash Island	Islands	Hudieda	2	42.5
27	Small Islands	Islands	Hardamoat	2	42.2
28	Jebel Smara	High Mountains	Ibb	2	39.0
29	Zamhar	Islands	Hijja	2	38.2
30	Mukha Junction	Western Moutains	Taaiz	2	35.1
31	Khor Amairah	Coastal Plains	Lahaj	2	34.3
32	Jebel Milhan	Western Moutains	Mihweet	2	29.6
33	Al Zubair	Islands	Hudeida	2	23.0
34	Billhaf	Coastal Plains	Shabwa	2	20.5
35	Baghlan	Islands	Hijja	2	12.7
36	Maium	Islands	Aden	2	12.2
37	Al Badi	Islands	Hudeida	2	11.0
38	Ras Omran	Coastal Plains	Aden	2	10.5
39	Haniesh Sughra	Islands	Hudeida	2	10.2
40	Al Armak	Coastal Plains	Hudeida	2	8.8
41	Bab Al-Mandab	Coastal Plains	Taaiz	2	8.5
42	Jebel Al tair	Islands	Hudeida	2	8.4
43	Galansia	Islands	Hadramoat	2	8.2
44	Ras Omran	Coastal Plains	Aden	2	6.4
45	Wadi Dhabab	Valleys	Taaiz	2	5.0
46	Al Areera	Coastal Plains	Taaiz	2	4.4
47	Jebel Al Loz	High Mountains	Sana'a	2	4.2
48	Jebel Taaker	High Mountains	Ibb	2	3.7
49	Small Islands	Islands	Hijja	2	2.7
50	Small Islands	Islands	Shabwa	2	1.0
51	Small Islands	Islands	Aden	2	0.7
52	Jebel Sabr	High Mountains	Taaiz	2	0.4
53	Hisn Habb (Baadan)	High Mountains & Fortresses	Ibb	2	0.3
54	Al Huddaya (Rima)	Western Moutains	Rima	2	345.6

55	Al Haswa	Coastal Plains	Aden	1	4.1
56	Aden Lake	Coastal Plains	Aden	1	0.9
57	Aden Lake	Coastal Plains	Aden	1	10.7
58	Al-Mamlah	Coastal Plains	Aden	1	10.7
59	Wadi Kabir	Coastal Plains	Aden	1	1.3
60	Khor Bir Ahmed	Coastal Plains	Aden	1	13.1

Fig. (12). Declared & Proposed Protected Areas in table (12)



خريطة (.) المناطق (.) اهم المناطق الغابوية والحراجية في اليمن والتي اعلن او تم اقتراحها لتكون محميات طبيعية والمذكورة في الجدول اعلى (EPA, 2012).

Table (13). Forest & Woodland Areas Declared as Protected Areas'

Name	Location	Declaration	Date Declared	Management Plan	Current Status
Atma	Zamar	C.M. #137	05.07.1999	Not Ready	No Plan Executed. Some Activities from NGOs
Socotra	Hadramaot	Pres.# 275	27.09.2000	Prepared	Management Plan prepare through International Support
Hof	Mahara	C.M. #260	16.08.2005	Prepared	Plan not executed

Gebel Buraa	Hudieda	C.M. #24	17.01.2006	Prepared	Implementation of plan started September 2007 through Assistance from SRNMPI
Wetlands Aden	Aden	C.M. #304	01.08.2006	Prepared	Implementation of plan started by NGOs through Assistance from SRNMPI
Kamran Island	Hudieda	C.M. #310	16.08.2009	Not ready	No Plan Executed

C.M. #: Council of Ministers Decree No. - Pres. # 275: Presidential Decree N0.

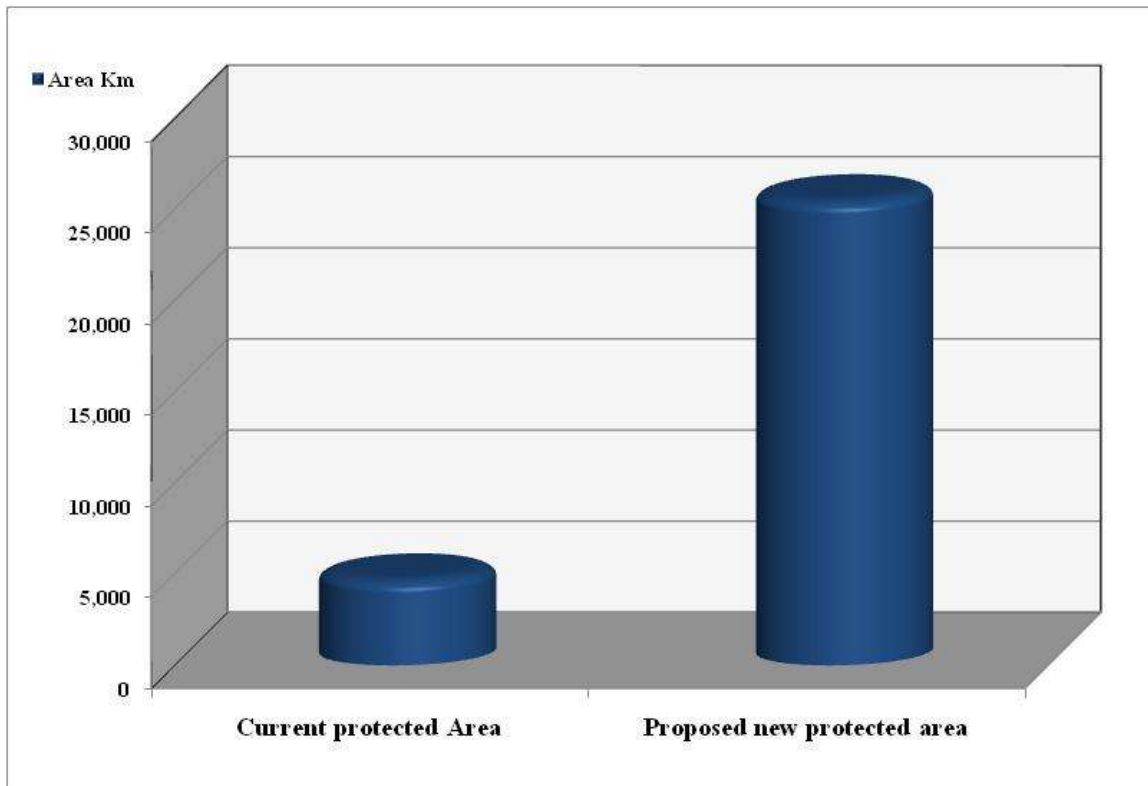
'Noting that there are no particularly targeted species or actually managed in the context of GRC programme *in-situ*. There are no national associations or clubs for stakeholders/enthusiasts on natural habitats or PAs.

2.3. Major Obstacles in PA establishment and Improvement of Conservation Systems:

- Land tenure & ownership, is perhaps the biggest obstacle as it is difficult to convince owners to give up their property,
- Weakness and inability of the State represented by Ministry of Endowments & Property in exerting its influence on these estates,
- Inability of the Authorities to stop unplanned buildings on natural habitats and absence of physical planning in natural areas rich in GR,
- Lack of enforcement of laws & regulations that protect GR in PAs and general forestlands,
- Rarity or even absence of knowledgeable & trained personnel in survey, mapping and management of Forest & woodland GRs,
- Paucity of funds and requirements for capacity building and priorities in activities protection of natural habitats,
- Difficulties of management of PAs and difficulties in stopping encroachment on lands around PAs,
- Difficulties in establishing infrastructural facilities and availing conducive environment for PA wardens coupled with difficulties of resolution of conflicts over interests,
- PAs are not sufficient to protect & conserve GR and there are no periodic assessments to identify snags, weakness points in PA management on sustainable basis,

- Lack of coordination between relevant authorities like research centres, universities, line ministries,
- Lack of effective administration of GRs,
- Current PAs do not span all geographic locations/ecosystems,
- Paucity of personnel, lack of capacity in PAs,
- Lack of criteria to define endangered habitats.
-

Fig. (13). Areas Declared as PA and Proposed



Total actually PA is 4269.14km². Areas proposed for declaration as PA is 25592.13km². The total area of constituted and proposed PA only represents 6% of the total area of the country. More than half the proposed areas represent the Desert Ecosystems of Yemen. The proposed areas encompass forest & woodland areas which house rare plants & natural resources. The already declared areas have helped a lot in protecting natural resources and GR of forest & woodlands. By declaring the proposed areas, many endemic & near-endemic species will be protected & conserved.

Table (14). Biodiversity Importance of some Proposed Regions

#	Region	# Genetic Resources & important ecosystems
1	Al Maagir and Shamateen (South of Taaiz)	23 endemic & near-endemic plants
2	Mokha Junction (West of Taaiz)	14 endemic & near-endemic plants
3	Jebel Al-Aries (Abien)	23 endemic & near-endemic plants
4	Jebel Erf (Lahaj)	<i>Juniperus procera</i> forests
5	Hajda (West of Taaiz)	<i>Acacia asak</i> woodlands
6	South Hadramoat Plateau	67 enedemic & near-endemic plants together with <i>Dracaena serrulata</i> forests
7	Wadi Al-Dhabab (South of Taaiz)	Unique Agro-forestry System
8	Al-Jindiya (South East Taaiz)	Acacia etbaica woodlands together with 10 endemic & near-endemic plants
9	Jebel Sabr (Taaiz)	<i>Dracaena serrulata</i> forests
10	Jebel Fartik	Anogeissus dhofarica woodlands together with enedemic & near-endemic plants

Chapter 3

Status of ex-situ Genetic Resources Conservation in Yemen

3.1. Introduction:

There are several centres for GR conservation in Yemen. Almost all of them are only concerned about GR of agricultural crops. Their number had increased from 7 in 1996 to 22 in 2006. There are of course many global centres for conservation agricultural GRs.

In an attempt to establish ex-situ conservation of GR and in collaboration with WANANET, some GRs of horticultural crops like figs and pomegranate were collected in planted Northern Highlands of Yemen.

There is however no efforts to collect Forest Genetic Resources in Gene Banks in Yemen. There are such banks in the country as indeed there are museums for biological diversity.

There is no botanic garden (BG) in Yemen at the moment. The only BG in Taaiz was destroyed its infancy. There were small BGs in Regional Agricultural Research Station in Al Kud Town.

The main authorities concerned with collection/conservation of GRs in Yemen are:

3.1.1. Agricultural Research & Extension Authority (AREA),

3.1.2. Faculty of Agriculture, Sana'a University,

3.1.3. Royal Botanic Gardens in Kew and Edinburgh.

3.2. Botanic Gardens (BG):

There are some 2500 BGs in the world. (http://www.kaig.net/1_About/IC_01.asp).

BGs were initiated at the time of Theophrastus (200-300 BC). It is believed that oldest BG existed in Egypt. The oldest in existence is perhaps the one in Paris established 1543. followed by the Royal Botanic Garden in Edinburgh established 1670 and the Royal Botanic Garden in Kew, established in 1759.

Of the old BGs is the one established in the 12th Century in Italy for Medicinal Plants. Some of the oldest BGs were established in European countries during the 16th Century. They evolved into University Gardens for planting Medicinal Plants. They evolved further to collect preserves and eventually classify plants .i.e. Herbaria. Gradually during the 18th Century libraries and Herbaria became integral parts of Botanic Gardens.

In 1992 the Convention on Biological Diversity (CND) was signed by 175 nations in Rio de Janeiro- Brazil. Some 20 objectives were developed for Botanic Gardens in the Second International Conference held in Barcelona.

Table (15). Number of Botanic Garden in Asia & Arab Region

# BG	Country	# BG	Country
3	Algiers	11	Malaysia
1	Iraq	2	Pakistan
1	Kuwait	6	Russia
1	Libya	1	South Korea
3	Morocco	3	Srilanka
2	Palestine	2	Taiwan
2	Kingdom of Saudi Arabia	3	Thailand
3	Tunisia	1	Vietnam
1	United Arab Emirates	2	Oman
1	Bangladesh	83	Japan
6	Egypt	4	Indonesia
16	India	5	Islamic Republic of Iran

Table (16). Endangered Genetic Resources of plants of Forests & Woodlands Collected by Public Bureau for Agricultural Research & Extension (2009 Report).

Scientific Name	Areas from which collection took place	# Plants collected		
		Live plants	Cuttings	Seeds
<i>Acokanthera schimperi</i>	Nageel Ibil, taaiz	4		
<i>Adenia veneta</i>	Misragh, Nageel Ibil, Taaiz	4		
<i>Aloe lanata</i>	Al Dimnah, Taaiz	5		
<i>Aloe inermis</i>	Al Nasham, Taaiz	6		
<i>Aloe niebuhriana</i>	Al Nasham, Al Dimnah, Misragh, Taaiz	8		
<i>Aloe rivierei</i>	Jebel Habashi, Al Siani, Taaiz & Ibb	9		
<i>Aloe serrivensis</i>	Jebel Al Aries, Abien	2		
<i>Aloe spp.</i>	Misragh, Taaiz	2		
<i>Aloe spp.</i>	Al Kalanba, Taaiz	2		
<i>Aloe spp.</i>	Siaoun, Hadramoat	1		
<i>Aloe spp.</i>	Wadi Bani Kholan	2		
<i>Aloe spp.</i>	Nageel Ibil, Taaiz	2		
<i>Aloe spp.</i>	Hadramoat	2		
<i>Aloe spp.</i>	Hadramoat	2		
<i>Aloe spp.</i>	Warzan, Taaiz	3		
<i>Aloe spp.</i>	Hadramoat	2		

<i>Aloe spp.</i>	Al Dimna, Taaiz	5		
<i>Aloe spp.</i>	Hajda, Taaiz	2		
<i>Aloe spp.</i>	Hajda, Taaiz	2		
<i>Aloe spp.</i>	Sharaab	3		
<i>Aloe spp.</i>	Manakha	3		
<i>Aloe spp.</i>	Khamis Bin Saeed	4		
<i>Aloe spp.</i>	Haraz	3		
<i>Aloe vacillans</i>	Banu Hammad, Taaiz	6		
<i>Aloe vera</i>	Al-Sukhna, Hudieda	6		
<i>Aloe mahraensis</i>	Mahara	1		
<i>Aloe tomentosa</i>	Sabr, Taaiz	7		
<i>Cadaba glandulosa</i>	Hajda, Taaiz		10	
<i>Caralluma adscendens</i>	Al Dimna, Taaiz	6		
<i>Caralluma penicillata</i>	Al Nasham, Hajda, Al Dimna, Misragh, Taaiz	14		
<i>Caralluma quadrangula</i>	Al Nasham, Hajda, Al Dimna, Misragh, Taaiz	12		
<i>Caralluma spp</i>	Hadarmoat	3		
<i>Ceratonia siliqua</i>	Sabr, Taaiz	12		
<i>Commiphora gileadensis</i>	Hajda, Taaiz		10	
<i>Commiphora myrrha</i>	Al Nashma, Taaiz		3	20
<i>Commiphora spp</i>	Al Nashma ,Hajda, Taaiz		5	10
<i>Dorstenia foetida</i>	Al Nashma, Nageel Ibil Taaiz	4		
<i>Duvalia spp</i>	Hadarmoat	9		
<i>Echidnopsis spp</i>	Hazran, Taaiz	6		
<i>Eulophia sp</i>	Al Nashma ,Hajda, Taaiz	16		
<i>Euphorbia uzruk</i>	Al Nasham, Taaiz		13	
<i>Euphorbia balsamifera</i>	Hadarmoat	1		
<i>Euphorbia rubriseminalis</i>	Hadarmoat	3		
<i>Ficus populifolia</i>	Jebel Habashi, Taaiz		8	
<i>Huernia spp</i>	Al Dimna, Taaiz	8		
<i>Jatrova cucas</i>	Hajda, Taaiz			12
<i>Juniperus procera</i>	Sabr, Taaiz		25	
<i>Kalanchoe spp</i>	Jebel Habashi, Taaiz	1		
<i>Kalanchoe bentii</i>	Hadarmoat	3		
<i>Kleinia pendula</i>	Nageel Ibil Taaiz	2		
<i>Kleinia semperviva</i>	Nageel Ibil Taaiz	2		
<i>Kleinia deflersii</i>	Jebel Al Aries, Abien	1		
<i>Moringa olifera</i>	Hajda, Taaiz			10
<i>Pandanus odoriferus</i>	Hajda & Dhabab, Taaiz	4		
<i>Plectranthus spp</i>	Nageel Ibil Taaiz	2		

<i>Ricinus communis</i>	Al Nashma, Taaiz			32
<i>Sarcostemma spp</i>	Hazaran, Taaiz	4		
<i>Sterculia africana</i>	Hajda, Taaiz		12	20
<i>Tamarindus indica</i>	Jebel Habashi and Hajda, Taaiz			30
<i>Wendlandia arabica</i>	Bani Hammad, Taaiz	7		

3.3. Gene Banks (GB):

Most or all GBs in Yemen focus on GR of agricultural crops. Generally they limited resources and experience. Some of the most difficulties in collecting FGRs are the lack of these institutions in technical personnel who can classify wild plants in Forest & other ecosystems.

AREA is the biggest institution in Yemen which deals with ex-situ GRC in various settings. AREA owns the National Gene Resources Centre at its HQs in Zamar. The Centre also supervises propagation activities and assessment in its stations in Taaiz, Tihama, Hadramoat, Abien & others.

The Faculty of Agriculture of Sana'a University houses the second largest BG in Yemen. The Faculty also has numerous activities in documenting traditional agricultural knowledge, popular usage of Forest & Woodland GRs.

The Royal Botanic Gardens in Edinburgh & Kew of the UK house many Yemeni plant specimens as live plants or herbarium material.

Chapter 4

The State of Use & Sustainable Management of Forest Genetic Resources

There is no programme that subjects FGRs to improvement. All GBs in Yemen focus on improving agricultural GRs. The latter include those in AREA and Faculty of Agriculture, Sana'a University

Chapter 5

The Status of National Programmes, Research, Education, Training & Legislation in FGRC

5.1. Introduction:

Some 76 countries have formulated or revised their forest policies since 2000. Also some 69 countries, mostly European and African promulgated new forest legislations or revised existing ones.

The policies of the Government of Yemen towards protection & conservation of FGR are clear, hence the signing & ratification of CBD in 1995 together with the promulgation of the Environment Act the same year which in its 11th, 13th & 14th Articles prohibits tree or wild plant cutting and reaffirms the establishment of PAs.

Projects directly related to desertification and forests include:

- Forest Development Project 1985-1997,
- Urban Forest Development Project 1995-1997.

5.2. Institutes which Participate in Field & Laboratory Work Related to FGRC

Table (17). 5.2. Institutes which Participate in Field & Laboratory Work Related to FGRC

Institution	Category	Activities
Agricultural Research & Extension Authority (AREA)	Government Research Centre	-Gene banks, mostly of agricultural crops, - GR of wild plants, particularly endangered spp, - National Herbaria for wild plants
Faculty of Agriculture, Sana'a	Government University	Gene banks, mostly of agricultural crops

5.3. Data Bases & Networks:

It is imperative to assemble authentic data & information on the geographic location at the appropriate time. This is becoming a prerequisite for sound planning and implementation of sustainable management of natural resources & environment protection. These data & information are expensive to assemble. Developing nations including Yemen suffer immensely from the inability to allocate the necessary resources.

Available maps are old. Developing countries lack the expertise to use GIS. SI techniques and GIS are not available in Yemen. There are no national networks to link the various agencies concerned with desertification control. There are however, several information

centres which render various data & information on natural resources management & protection and desertification control. These include:

5.3.1. General Administration for Forests & Desertification Control:

GAFDC which encompass 20 Regional Departments is mandated to protect Forest & Rangelands, Watershed and Desertification Control. Its responsibilities include production of maps together with monitoring & evaluation of natural resources. GAFDC lacks the expertise in and resources to establish & use GIS. The available expertise on the matter is old and of obsolete knowledge. Efforts are being exerted to update the system.

5.3.2. Agricultural Research & Extension Authority

5.4. Biosafety Convention:

The final formulation of Cartagena Protocol on Biosafety in the context of CBD was concluded recently. The Protocol focuses on trans boundary movement of Genetically Modified Organisms. Yemen signed the Protocol. That enables the country to receive support from the Global Environment Facility (GEF) "Capacity Building in Biosafety" Project/Initiative.

One of the important data base in support of GR is site of the National Mechanism for Information Exchange: <http://www.pgrfa.org/gpa/yem/description.html>

Chapter 6

The Status of Regional & International Cooperation

6.1. Introduction:

Yemen participated in IPGRI/WANANET Regional Network since 1992. Yemen is a member of Plant Genetic Resources Committee. The country signed and ratified the Rio Conventions. Yemen participated in UNDP, FAO and Arab Organization for Agricultural Development (AOAD) projects on plant diversity.

Yemen signed United Nations Convention on Desertification Control (UNCCD) in June 1996. The Convention was ratified by the Yemeni Legislature on 28 November, 1996.. GAFDC of the Ministry of Agriculture & Irrigation was named as national focal point for UNCCD, being the mandated authority on the activity. The National Network for Desertification Control was established in 1998 through a directive from H.E. the Minister of Agriculture & Irrigation. Its mandated activities include:

6.1.1. Formulation of plans/programmes aiming to develop Forests & Rangelands and their rational management that ensures perpetual productivity without degradation,

6.1.2. Preparation & enforcement of Forests & PAS Legislation in collaboration with relevant authorities,

6.1.3. Supervision of Forest & rangelands mapping,

Many Near East & North African (NENA) countries, including Yemen have signed a cooperation agreement in support of their activities in GR Diversity and to promote international policies, treaties, work plans and guidelines for Global GR Management.

The International Consultative Group on Agricultural Research (CGIAR) in collaboration with the International Centre for Research in Dry Areas (ICARDA) provided technical & financial support towards establishment of Gene & Seed Banks for several NENA countries.

The Arab Center for the Study of Arid Zones and Dry LandsArab (ACSAD) was one of the pioneer institutions which trained forestry personnel from Syria & Morocco and involved them in field trips & Forest Inventory in Arab Countries.

In 1995 Yemen ratified CBD.

Yemen participates in the Network of West Asia & North Africa for Plant Genetic Resources (WANA), collaborates with ICARDA and GTZ.

Table (18). Biodiversity Projects funded by GEF since 1994

Biodiversity Projects	Total Projects
7	16

Table (19). Number of Agreements signed with International Centres

Country	ICARDA	ICRISAT	ILRI	CIMMYT	CIAT	AVRDC
Yemen	290	2 459	13	2	1	4

ICARDA assumed a major role in 1998 in the implementation of GR Programme which was part of UNDP's 'Sustainable Environmental Management in Yemen' Project. In collaboration with Yemen, the following was achieved:

1. The Cold Storage Facilities were modernized & operated,
2. GR material was placed in Medium-period Storage,
3. Most of the equipment for GRs activities were procured and handed over to AREA,
4. A Consultation was implemented for the National Programme on PGR Conservation in-situ and a paper was prepared on Agricultural Genetic Resource Conservation for facilitating deliberations in the National workshop scheduled for 1999.
5. Most of the GRs form Yemen kept in ICARDA were returned to AREA,
6. AREA staff were trained on seed processing.

Chapter 7

Access to Forest Genetic Resources & Sharing of Benefits Arising for Their Use

- International Agreements on Access to Forest Genetic Resources
- National Legislations on Providing Access to Benefits Arising from Utilization of FGR ,
- Importance of ensuring Access to FGR and Sharing of Benefits Arising from their Utilization

Chapter 8

The Contribution of Forest genetic Resources to Food Security, Poverty Alleviation & Sustainable Development

30% of global forest areas are utilized for production of wood & Non-wood Forest Products (NWFPs). Some 1.2 billion ha are managed for basically for the production of wood & NWFPs and another 949 million ha (24%) are devoted for other uses which include, in many cases, production of wood & NWFPs. The area originally devoted to productive functions has been reduced by more than 50 million ha since 1990.i.e. 0.22% annually. The area assigned to multiple uses increased by 10 million ha during the same period. Plantation Forests Area is on the increase and now represents 7% of total forestland areas. Some 7% of total forest & woodland area (264 ha) is planted for various purposes. Plantation Forest Area has increased between 2000-2010 by some 5 million ha. Most of these areas were established through reforestation i.e. afforesting areas that were not classified as forests before, largely in China (FRA 2010).

Most of reforestation activities in Yemen focused on use of introduced tree species. There is a tendency to use indigenous species but not implemented so far. Paradoxically enough, institutions concerned with tree planting on road sides and public amenities use introduced species only.

Yemen, characterized with wide plant diversity can play a significant environmental and socio- economic role in development of forests, food & agriculture. These resources are yet to be judiciously utilized.

Table (20) portrays the number of wild plants in Forest & Woodland Areas of Yemen which can be utilized in achieving food security & poverty alleviation together with tangible environmental benefits. Wild plants in Forests & Woodland Areas of Yemen are collected on a limited scale for purposes of food & medicine. Some 148 species were recorded in 'Medicinal & Aromatic Plants of Yemen' book (Al Dubae & Al Khulaidi, 1997).

Many plants in Yemen are collected as popular food such as:

Ficus palmata, Punica protopunica, Dianthus uniflorus, Carissa spinarum, Ziziphus spina-christi, Annona squamosa, Opuntia ficus-indica, Opuntia dillenii, Pulicaria jaubertii, Rumex nervosus, Cissus rotundifolia, Cyphostemma digitatum, Thymus laevigalus and Portulaca oleracea.

Recent studies (Al Khulaidi, 2006) enumerated some 523 plants belonging to 75 Families that can effectively contribute in Environmental & Socio-economic Development of Food, Agriculture & Forests.

Table (20). Economic Plants in Plant Families in Yemen:

I. Genus; II.Species; III.Endemic; IV.Near Endemic; V.Edible Food; VI.Fodder;
VII.Timber;VIII.Medicine; IX. Fibre; X.Oil; XI. Cultivated Crops; XII. Gums/Resins

#	Family	I	II.	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	<i>Acanthaceae</i>	9	13	7		4	8						
2	<i>Aizoaceae</i>	1	1			1							
3	<i>Aloeaceae</i>	1	33	19	13				33				
4	<i>Amaranthaceae</i>	2	3				3						
5	<i>Anacardiaceae</i>	3	6	2		5						1	
6	<i>Annonaceae</i>	1	1										
7	<i>Anthericaceae</i> <i>Apiaceae</i>	2	3	1		1	2						
8	<i>Umbelliferae</i>	5	5			1						4	
9	<i>Apocynaceae</i>	3	5			3			2				
10	<i>Areaceae</i> <i>(Palmae)</i>	5	7			3						4	
11	<i>Ascepiadaceae</i>	3	3			1	2						
12	<i>Asparagaceae</i>	1	1			1							
13	<i>Asteraceae</i> <i>(Compositae)</i>	7	7	1		4	2					1	
14	<i>Balanitaceae</i>	1	1			1							
15	<i>Basellaceae</i>	2	2			2							
16	<i>Bignoniaceae</i>	1	1							1			
17	<i>Bomaceae</i>	1	1						1				
18	<i>Boraginaceae</i>	3	6	1		5	1						
19	<i>Brassicaceae</i> <i>(Cruciferae)</i>	1	3			1					1	1	
20	<i>Burseraceae</i>	2	7	5			1						6
21	<i>Cactaceae</i>	1	2			2							
22	<i>Caesalpiniaceae</i>	2	2			2							
23	<i>Capparaceae</i> <i>(Capparidaceae)</i>	2	3			3							
24	<i>Caryophyllaceae</i>	2	3			2						1	
25	<i>Chenopodiaceae</i>	3	3			1						2	
26	<i>Combretaceae</i>	1	1				1						
27	<i>Commelinaceae</i>	2	2				2						
28	<i>Convolvulaceae</i>	5	9	3					8			1	
29	<i>Cucurbitaceae</i>	1	12				5					7	
30	<i>Cupressaceae</i>	1	1				1						
31	<i>Cyperaceae</i>	2	6				1		5				
32	<i>Dioscoreaceae</i>	1	1	1			1		1				
33	<i>Dracaenaceae</i>	1	1				1						
34	<i>Ebanaceae</i>	2	3			2	1						
35													

36	<i>Euphorbiaceae</i>	3	4	3		1	3						
37	<i>Flacourtiaceae</i>	1	1			1							
38	<i>Juglandaceae</i>	1	1									1	
39	<i>Lamiaceae</i>	8	10			9						1	
40	<i>Liliaceae</i>	2	3									3	
41	<i>Linaceae</i>	1	1							1			
41	<i>Malpighiaceae</i>	1	1	1		1							
42	<i>Malvaceae</i>	3	9			1		3				5	
43	<i>Mimisaceae</i>	4	28	5		1	27						
44	<i>Moraceae</i>	1	6			6							
45	<i>Moringaceae</i>	1	2			2							
46	<i>Myrtaceae</i>	3	3			1						2	
47	<i>Oleaceae</i>	1	1			1							
48	<i>Orchidaceae</i>	1	1	1		1							
49	<i>Oxalidaceae</i>	1	1			1							
50	<i>Pandanaceae</i>	1	1			1						1	
51	Papaveraceae	1	1										
52	Papilionoidaceae (Fabaceae)	28	64	16	1	5	48					11	
53	<i>Pedaliaceae</i>	1	1									1	
54	<i>Piperaceae</i>	1	1			1							
55	<i>Plantaginaceae</i>	1	3			3							
56	<i>Poaceae</i> (Gramineae)	44	149	9	1		141					8	
57	<i>Polygonaceae</i>	2	2			2							
58	<i>Portulacaceae</i>	1	4	2		4							
59	<i>Punicaceae</i>	1	2	1		2							
60	<i>Ranunculaceae</i>	1	1									1	
61	<i>Rhamnaceae</i>	2	3			3							
62	<i>Rosaceae</i>	6	11	1		4						7	
63	<i>Rubiaceae</i>	3	4	3			3					1	
63	<i>Rutaceae</i>	3	8										6
65	<i>Salvadoraceae</i>	2	2			2							
66	<i>Sapindaceae</i>	1	1			1							
67	<i>Scrophulariaceae</i>	1	1				1						
68	<i>Solanaceae</i>	6	11	1		6						5	
69	<i>Sterculiaceae</i>	1	1			1							
70	<i>Tiliaceae</i>	2	12			12							
71	<i>Ulmaceae</i>	1	2			2							
72	<i>Verbenaceae</i>	1	1	1			1						
73	<i>Vitaceae</i> (Vitidaceae)	4	5	1		4						1	
74	<i>Zingiberaceae</i>	1	1									1	
		235	523	87	15	133	261	0	36	4	2	71	12
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

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