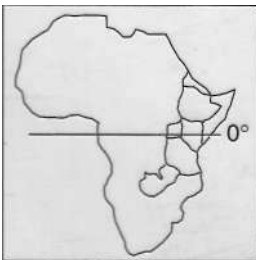


# USEFUL TREES AND SHRUBS IN ERITREA

Identification, Propagation and Management  
for Agricultural and Pastoral Communities



**E**Bein  
**B** Habte  
**A** Jaber  
**A**nn Birnie  
**B**o Tengnas

# Useful Trees and Shrubs in Eritrea

# Useful Trees and Shrubs in Eritrea

Identification, Propagation and Management  
for Agricultural and Pastoral Communities

E. Bein, B. Habte, A. Jaber, Ann Birnie and Bo Tengnas

REGIONAL SOIL CONSERVATION UNIT, RSCU/SIDA  
Nairobi  
1996

Published by the Regional Soil Conservation Unit (RSCU), P.O. Box 52840, Nairobi, Kenya

© 1996 Regional Soil Conservation Unit (RSCU)

Cover photo: A large *Ficus vasta* tree

General **editor:** Bo Tengnas, Natural Resources Management Consultants Ltd., Torsabergera, S-310 38 Simlångsdalen, Sweden

Copy editing, design **and** typesetting: Caroline Agola, P.O. Box 21582, Nairobi,

Cover: Graeme Backhurst, P.O. Box 15194, Nairobi

Cataloguing-in-publication data

Useful Trees and Shrubs in Eritrea. Identification, Propagation and Management for Agricultural and Pastoral Communities/ By E. Bein, B. Habte, A. Jaber, A. Birnie and B. Tengnas, Nairobi: Regional Soil Conservation Unit, RSCU, 1996.  
(Regional Soil Conservation Unit, RSCU, Technical Handbook Series; 12)  
Bibliography:p)

ISBN 9966-896-24-4

The contents of this handbook may be reproduced without special permission. However, acknowledgement of the source is requested. The photographers and artists concerned must be contacted for permission to reproduce illustrations.

The views expressed in the RSCU series of publications are those of the authors and do not necessarily reflect the views of RSCU.

Printed by Regal Press Limited, Bunyala Road, P.O. Box 46166, Nairobi

# Contents

Foreword . . . . .	vii
Publisher's preface . . . . .	ix
Acknowledgements . . . . .	x
Introduction . . . . .	xi
Climate, soils and land use . . . . .	xvii
The vegetation . . . . .	xxiii
Some environmental concerns . . . . .	xxvii
Future outlook . . . . .	xxxi
Illustrated glossary of some botanical terms . . . . .	xxxiii
PART I	
Common names . . . . .	1
PART II	
The useful trees and shrubs . . . . .	13
PART III	
Summary table of species and their uses . . . . .	405
Bibliography . . . . .	419
Feedback form . . . . .	421
Maps	
1. The main physical features of Eritrea . . . . .	viii
2. The main towns and villages of Eritrea . . . . .	xii
3. The main agro-climatic zones of Eritrea . . . . .	xviii

**The Technical Handbook Series of the Regional Soil Conservation Unit:**

1. *Curriculum for In-service Training in Agroforestry and Related Subjects in Kenya*  
Edited by Stachys N. Muturi, 1992  
ISBN 9966-896-03-1
2. *Agroforestry Manual for Extension Workers with Emphasis on Small Scale Farmers in Eastern Province, Zambia*  
By Samuel Simute, 1992  
ISBN 9966-896-07-4
3. *Guidelines on Agroforestry Extension Planning in Kenya*  
By Bo Tengnas, 1993  
ISBN 9966-896-11-2
4. *Agroforestry Manual for Extension Workers in Southern Province, Zambia*  
By Jericho Mulofwa with Samuel Simute and Bo Tengnas, 1994  
ISBN 9966-896-14-17
5. *Useful Trees and Shrubs for Ethiopia: Identification, Propagation and Management for Agricultural and Pastoral Communities*  
By Azene Bekele-Tessema with Ann Birnie and Bo Tengnas, 1993  
ISBN 9966-896-15-5
6. *Useful Trees and Shrubs for Tanzania: Identification, Propagation and Management for Agricultural and Pastoral Communities*  
By L. P. Mbuya, H.P. Msanga, C.K. Ruffo, Ann Birnie and Bo Tengnas, 1994  
ISBN 9966-896-16-3
7. *Soil Conservation in Arusha Region, Tanzania: Manual for Extension Workers with Emphasis on Small-Scale Farmers*  
By Per Assmo with Arne Eriksson, 1994  
ISBN 9966-896-19-8
8. *Curriculum for Training in Soil and Water Conservation in Kenya*  
Edited by Stachys N. Muturi and Fabian S. Muya, 1994  
ISBN 9966-896-20-1
9. *The Soils of Ethiopia: Annotated Bibliography*  
By Berhanu Debele, 1994  
ISBN 9966-896-21-X
10. *Useful Trees and Shrubs for Uganda: Identification, Propagation and Management for Agricultural and Pastoral Communities*  
By A. B. Katende, Ann Birnie and Bo Tengnas, 1995  
ISBN 9966-896-22-8
11. *Agroforestry Extension Manual for Northern Zambia*  
By Henry Chilufya and Bo Tengnas, 1996,  
ISBN 9966-896-23-6

# Foreword

A century ago, Eritrea was endowed with an abundant and diversified flora and fauna, but due to mismanagement during the successive periods of colonial rule, the long-drawn-out liberation war and recurrent droughts these natural resources have dwindled dramatically.

Forest resources, an integral part of the natural resource base of the country, have been devastated. Thus, woody vegetation which once covered some 30% of the total land area of the country has been drastically reduced in less than a century. This resource depletion has resulted in shortages of fuel and construction wood, excessive soil erosion, vanishing wildlife and general environmental degradation. Many economically and potentially valuable tree and shrub species are now endangered and some may even be approaching extinction.

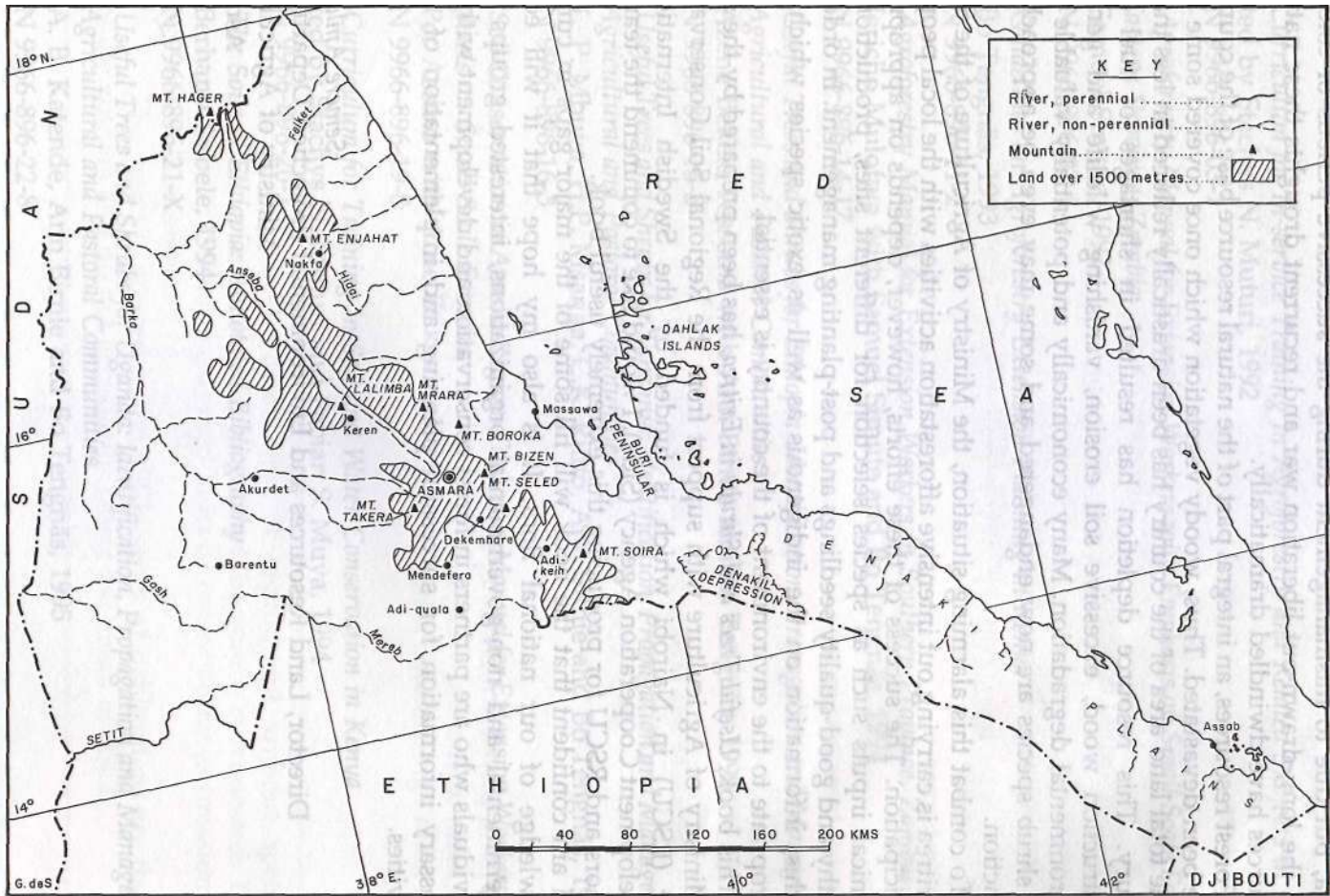
To combat this alarming situation, the Ministry of Agriculture of the State of Eritrea is carrying out intensive afforestation activities with the local people's participation. The success of these efforts, however, depends on appropriate technical inputs such as species selection for different sites, production of healthy and good-quality seedlings and post-planting management. In order to do this, information on the indigenous as well as exotic species which are appropriate to the environment of the country is essential.

This book, *Useful Trees and Shrubs in Eritrea*, has been prepared by the staff of Ministry of Agriculture with support from the Regional Soil Conservation Unit (RSCU) in Nairobi which is funded by the Swedish International Development Cooperation Agency (Sida). I would like to commend the team of authors and RSCU for producing this extremely useful book.

I am confident that the book will fill some of the major gaps in current knowledge of our national flora. It is also my hope that it will equip Governmental and non-governmental organizations, interested groups and individuals who are partners in forest conservation and development with the necessary information for successful planning and implementation of field activities.

*Semere Amlasom*  
Director, Land Resources and Environmental Protection Department  
Ministry of Agriculture  
Asmara

Map 1. The main physical features of Eritrea



*Agriculture Extension Manual for Northern Zambesi*  
 Henry Chitaya and Bo Temasha, 1996  
 N 9966-99



## Publisher's preface

In 1991, the Regional Soil Conservation Unit (RSCU) initiated a series of technical handbooks on useful trees and shrubs in eastern Africa. The aim of the series is to provide information for subject-matter specialists, extension workers and farmers on the trees and shrubs that have production and conservation potential for small-scale farmers in the region.

The volume on Ethiopian trees and shrubs was published in 1993, the Tanzania volume in 1994, and the Uganda volume in 1995.

The work on this book for Eritrea started in 1995 at the request of the Government of Eritrea. Initially, E. Bein, B. Habte, A. Jaber and B. Tengnas prepared a first draft based on findings in the field combined with information available from the earlier volumes in this series and other sources.

Ann Birnie, botanical consultant and artist based in Nairobi, edited and simplified the descriptions of the tree species. She also prepared many of the illustrations and designed their layout.

RSCU publishes this handbook with the hope that it will be widely used by extension, education and research institutions in order to foster interest in the growing and management of a wider range of tree and shrub species as part of the effort to develop sustainable land-use systems in Eritrea.

*Erik Skoglund*

Head, Regional Soil Conservation Unit  
Nairobi, October 1996

## Acknowledgements

The initial material for this book was collected by E. Bein, B. Habte and A. Jaber during a period of extensive travel in Eritrea. Discussions were held with people knowledgeable on trees and shrubs, among whom were many farmers and pastoralists. In fact, much of the information in this book derives from rural people in Eritrea who have enthusiastically shared their knowledge with us.

Special thanks go to the Director of Land Resources and Environmental Protection Department of the Ministry of Agriculture, Mr Semere Amlasom, for allowing the team to devote time to the data collection and for his wholehearted support throughout the process.

Mrs Sue Edwards of the National Herbarium, Addis Ababa, was particularly helpful in answering taxonomic queries. She is co-author of the new flora of Ethiopia and Eritrea currently in preparation.

The book is partly based on *A Selection of Useful Trees and Shrubs for Kenya: Notes on Their Identification, Propagation and Management for Use by Farming and Pastoral Communities* and on the earlier volumes in this series for Ethiopia, Tanzania and Uganda. Yet another source of information has been the *Indigenous Trees and Shrubs of Eritrea* developed by the Ministry of Agriculture in 1994. The work on the latter booklet was, in a sense, preparatory to activity for the major work on this publication that followed during 1995 and the early part of 1996.

Several people contributed to the production of the above-mentioned books and we acknowledge their contributions to this volume with thanks.

The Nitrogen Fixing Tree Association assisted us with confirmation of species that are known to be nitrogen fixing. Staff of the East African Herbarium at the National Museums of Kenya in Nairobi were most helpful in making available specimens from their collection to facilitate the development of the illustrations. They were also extremely helpful in providing taxonomic information.

Many of the plant illustrations are original drawings by Ann Birnie, primarily from *Trees of Kenya* by T. Noad and A. Birnie. Other drawings were made specially for this book, both from fresh material and from dried specimens in the East African Herbarium, Nairobi, and by Ato Asfaw Abdissa. A few drawings have been taken from *Plants in Zanzibar and Pemba* by R.O. Williams and *Kenya Trees and Shrubs* by I.R. Dale and P.J. Greenway. We also acknowledge with thanks the Royal Botanical Gardens, Kew, for permission to use some illustrations that appear in the published family volumes of the *Flora of Tropical East Africa*. Other illustrations have been taken from A.E.G. Storrs, *Know Your Trees*.

The copyright to the above illustrations remains with the original publishers. RSCU would also like to acknowledge the other sources of material listed in the bibliography.

Thanks are also due to Mrs Caroline Agola who did the editing, design and typesetting.

Finally, a word of thanks to the Swedish taxpayer who, through Sida, provided the funds necessary for the production of this handbook.

# Introduction

Eritrea is located in the north-eastern part of Africa, covering a land area of 124,432 km<sup>2</sup>. Altitudes range from 60 metres below sea level to 3,180 m above sea level.

Some areas at higher altitudes are shrouded in mist for extended periods and this enables moisture-demanding species to grow there. Temperatures are low and the vegetation is lush, whereas lowland areas are generally hot and arid. Along the coast, the climate is hot and the vegetation is influenced by the salinity of the soils and water. The depression in the Bada area is well below sea level, very hot and the soils are saline. This wide range of ecological conditions provides the environment for many species of plants and animals, and Eritrea has a wide diversity of trees.

Traditions among the people of Eritrea vary significantly from one part of the country to another. There are a number of ethnic groups with their own languages. Land-use practices also differ a great deal, not only because of different ecological conditions but also because of socio-cultural differences.

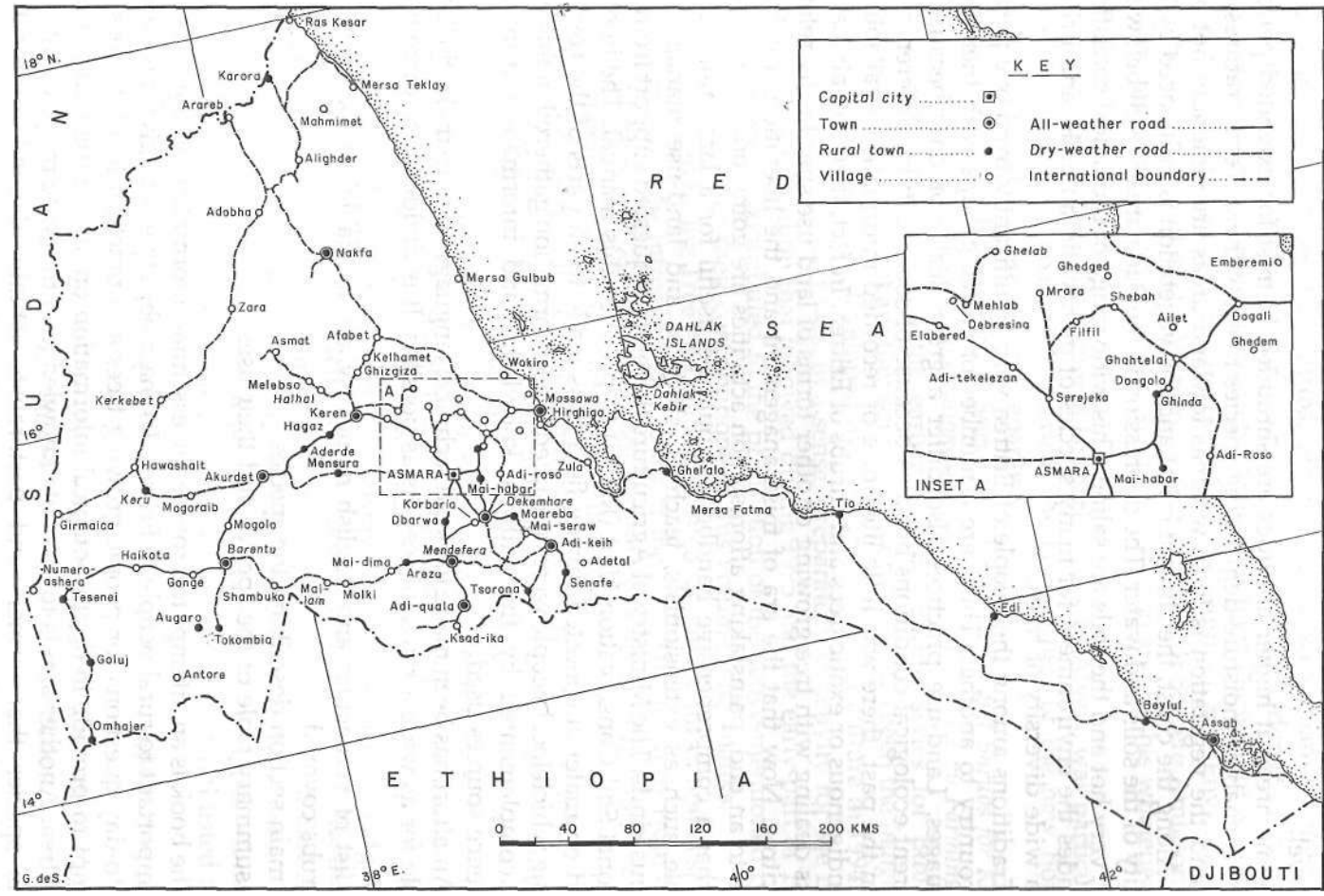
In the past, there was little literature or recorded information available on the indigenous or exotic trees and shrubs of Eritrea. In fact, there are almost no books dealing with tree growing or other forms of land use specifically related to Eritrea. Now that the era of mismanagement and the liberation war have come to an end, painstaking afforestation activities are going on. Thus it was felt that a comprehensive handbook would be useful for a large number of people such as extensionists, teachers, students and land-use managers of various kinds. The Ministry of Agriculture therefore requested support from the Regional Soil Conservation Unit (RSCU) to produce this manual. The book is based on material collected during field trips made to all parts of the country during which local people were consulted. The information gathered in this way was complemented by the authors' knowledge and information from the reference sources used.

An effort has been made to avoid technical language so as to make the book usable for as wide a range of readers as possible. It is divided into three main parts:

- A list of vernacular and English names (where available) of the trees and shrubs covered
- A main section describing the species
- A summary table of the species and their uses.

The book is an attempt to provide the essential information on the trees that are important to rural people in Eritrea. Its main objective is to give answers to day-to-day questions for people growing trees at a practical level. It does not attempt to provide in-depth botanical information on all the trees and shrubs of Eritrea. Another aim is to promote knowledge of the wide range of tree and shrub species that farmers and pastoralists actually depend on for their livelihood. All too often a few exotic species have been vigorously promoted in

Map 2. The main towns and villages of Eritrea



extension work without any attention being given to the rich indigenous flora and local knowledge of it.

Any reader who feels he can contribute to an improved second edition of this book is urged to do so by using the forms at the back.

### **Selection of the species to be included**

It was difficult to decide which of all the tree and shrub species found in Eritrea should be included and which omitted. During the extensive field visits and consultations with local people certain species emerged as being important. Both indigenous and exotic species were considered. It was decided to include *Agave sisalana*, *Aloe abyssinica* and bamboos because, although not strictly trees or shrubs, they are woody perennials that have important uses in many areas. Banana and pawpaw, which are tree-like herbs, have also been included, as were two exotic species, *Opuntia ficus-indica* and *Lantana camara*, because they have been found to be useful. We should emphasize, however, that the rapid and uncontrolled spread of the latter two species is having a detrimental impact on the local ecology.

Altogether the book covers close to 200 species of trees and shrubs. For each species, vernacular names, ecology, reported uses, botanical description, seed information and relevant management practices have been indicated.

### **Vernacular names**

Very often development workers fail to communicate effectively with local people on issues related to trees. There is often a language barrier if the two groups cannot use a common set of names for the trees and shrubs that they deal with. In Eritrea, where there is no one common language, there are obvious limitations to communication.

The average farmer uses his own vernacular names for the trees and shrubs that he is familiar with and local languages will continue to be the most commonly used for a long time. Old people often have much more knowledge about the local trees and shrubs than the younger generation. It is therefore important that researchers, development workers and extensionists use the local vernacular names that will be familiar to the older people in the community. When this handbook was developed, it was decided to include as many vernacular names as possible. But there are parts of Eritrea that have been poorly covered and where further research needs to be done.

As far as possible, vernacular names are given for nine languages, namely Afar (Af), Arabic (Ar), Bilen (Bl), Hidareb (Hd), Kunama (Km), Nara (Nr), Saho (Sh), Tigre (Tr) and Tigrigna (Tg). It is hoped that this will help development workers communicate with local people about the relevant trees and shrubs. Recognition of the existence of a communication gap between extensionists and farmers, the need to regard local farmers' experience as a focal point in any efforts to improve land use, and the importance of sustainable utilization of tree biodiversity were underlying concepts of this book.

## **Ecology**

Under this heading a brief description of the origin and present distribution of each species is given, followed by an indication of where it grows in Eritrea, together with the altitudinal range, preferred climatic and soil conditions, etc.

## **Uses**

Trees and shrubs provide a wide range of benefits to man in terms of products such as timber or medicine and services such as shade or soil improvement. Such information has been summarized for each species. It must be stressed, however, that these are *reported* uses, i.e. how the local people say they use these plants. It has not been possible to verify the accuracy of all such reported uses. In addition, the uses of a particular species may vary from one area of the country to another, or even from one community to another, and therefore it is always a good idea to verify these uses with the local people.

It must be noted also that a species cannot be grown for all of its potential uses simultaneously. Management of a particular species often aims at optimizing or maximizing a specific product or service.

## **Description**

For each species there is a general description followed by a detailed description of bark, leaves, flowers and fruit. Technical botanical terms have been kept to a minimum. The features in bold type indicate the special points to look for when trying to identify a species. It may not always be possible to identify a plant from the descriptive text alone. But we hope that when the drawings and vernacular names are also consulted, the descriptions will prove a practical guide to species identification in the field.

## **Propagation**

Wherever information on suitable methods of propagation is available, it is given under this heading. "Seedlings" indicates that seedlings are raised in a nursery, either on farm or in a central or group nursery. "Wildings" indicates that farmers propagate a certain species by collecting wildings and transplanting them to the desired farm site. Other species may be propagated by "direct sowing" of seeds, and "vegetative propagation" by cuttings is recommended for others. Coppicing ability is indicated under "management".

## **Seed information**

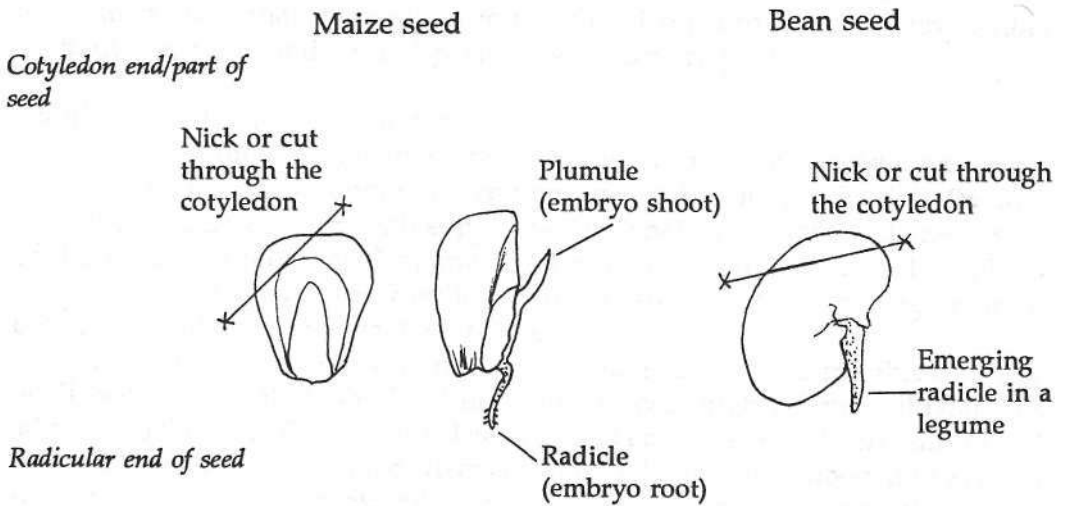
When available, information on number of seeds per kilogram, whether seeds can be stored or not, and suitable pre-sowing treatment is given. Normally, storage of seeds is to be avoided. The storage periods indicated are deliberately imprecise because there is rarely a fixed period during which seeds can be stored without harm and after which they all lose viability. Loss of viability is a gradual process, and its speed depends on many factors, mainly the storage conditions.

If seeds have to be stored for some time it is always best to keep them in a cool, dry and insect-free place.

Seed pre-treatment is done to speed up germination of viable but dormant seeds. The methods mentioned are the simple ones that can be applied under field conditions without the use of sophisticated equipment or chemicals.

Seed treatment is not needed for all species. For many, however, treatment may enhance the speed of germination. The most common methods are (a) soaking in hot or cold water, (b) nicking, and (c) de-winging. In addition, flotation can be mentioned as a simple way of separating bad (empty and thus light and floating) from good (heavy and sinking) seed.

- Soaking in water is recommended for many species and, where these are known, details of temperature and time are indicated.
- Nicking can be done by removing small pieces of the seed coat at the distal (cotyledon) end of each seed using a sharp tool such as a knife or nail clipper. Removal of the hard coat next to the storage tissue of the seed speeds up the absorption of water and hence the growth of the embryo.
- Nicking is time consuming if it has to be done to a large number of seeds, and soaking is often a more convenient alternative. Furthermore, nicking must be done with care in order to avoid damaging the vital part of the seed, i.e. the embryo itself.



*The cotyledon and radicular ends of a seed and how to nick the seed*

Winged seeds should normally be de-winged before sowing (e.g. *Combretum*, *Terminalia*).

In some species, germination is enhanced if the hard seed coat is cracked. This is a delicate operation as it is easy to damage the embryo within the seed.

As a general rule, fruits with a fleshy pulp surrounding the seeds will germinate better if the pulp is removed and the seed cleaned before sowing. Seeds of this kind often cannot be stored and should be sown soon after collection and cleaning.

### **Management**

Different management techniques allow tree growers to maximize production from trees and shrubs. Management may also be applied in order to reduce negative side effects from the presence of trees or shrubs, e.g. shading effects on adjacent crops. The most common management practices are coppicing, lopping, and pollarding.

### **Remarks**

Any other useful or interesting information is given under "remarks". Information on medicinal uses of the plants is given here. It is wise to check dosages, methods of administration, etc., with locally knowledgeable people before putting these reported uses into practice.



## Climate, soils and land use

Six main zones of Eritrea have been defined based on agro-climatic and soil parameters:

- The coastal plains
- The eastern escarpment, including the "green belt" zone
- The highlands
- The western escarpment
- The south-western lowlands
- The north-western lowlands.

(This section is adapted from Agricultural Sector Review and Project Identification, FAO, 1994, Annex 1.)

### The coastal plains

#### *Description*

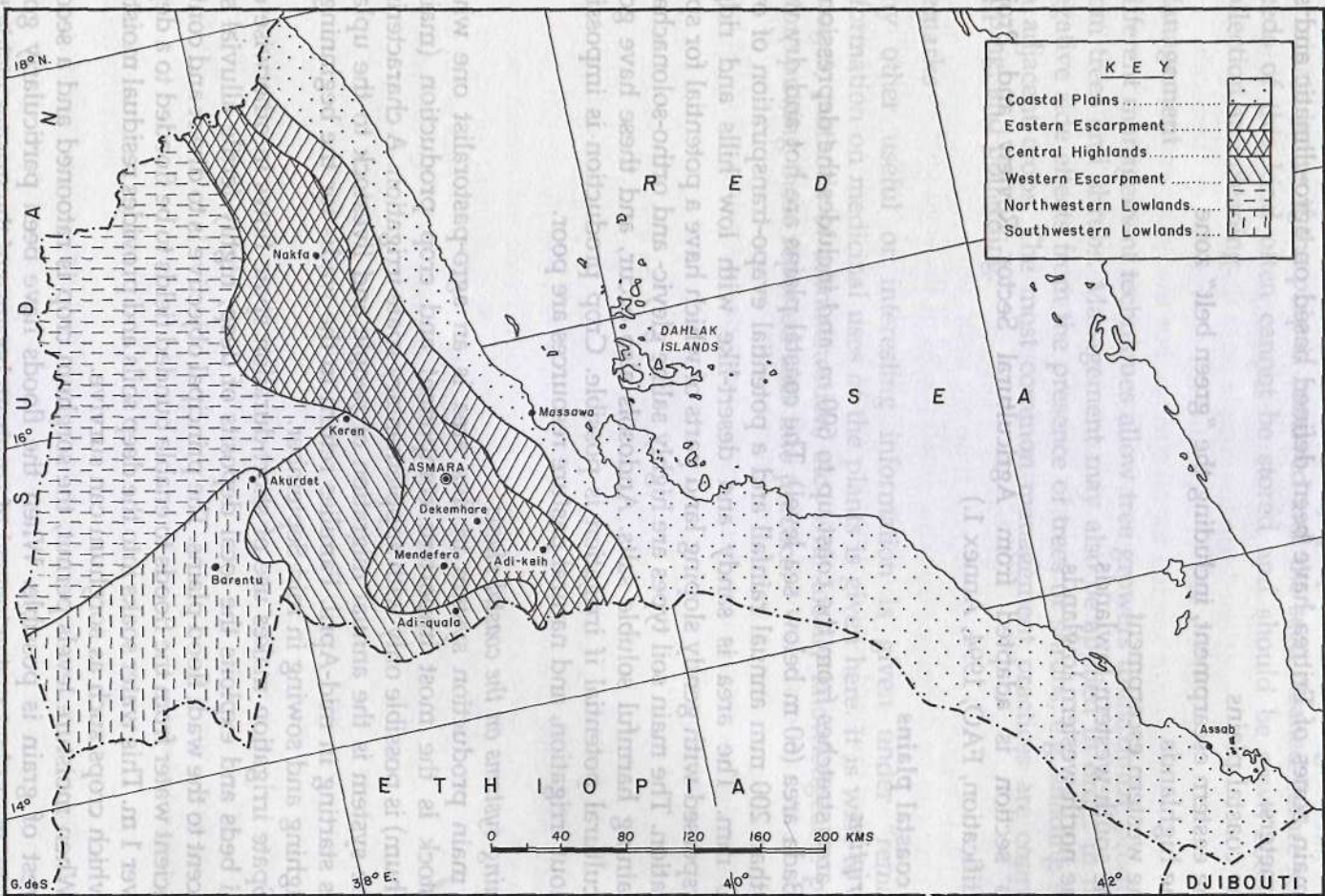
This area stretches from the coast up to 600 m, and includes the depression in the Bada area (60 m below sea level). The coastal plains are hot and dry with less than 200 mm annual rainfall and a potential evapo-transpiration of over 2,000 mm. The area is sandy and desert-like with low hills and ridges interspersed with gently sloping land parts of which have a potential for spate irrigation. The main soil types are highly saline gleyic- and ortho-solonchaks, containing harmful soluble salts. Andosols also occur, and these have good agricultural potential if irrigation is possible. Crop production is impossible without irrigation, and natural pasture resources are poor.

#### *Farming systems on the coastal plains*

The main production system in this area is an agro-pastoralist one where livestock is the most important component and crop production (mainly sorghum) is possible only with supplementary spate irrigation. A characteristic of the system is the annual migration of people and livestock to the upland areas starting in mid-April. Families return to the wadis for the beginning of ploughing and sowing in mid-September.

Spate irrigation makes use of short-duration spate flows in otherwise dry wadi beds and exploits the local deposits of deep, highly fertile alluvial silts adjacent to the wadi flood plains. The principal objective is to divert and control sufficient water from the floods to enable banded fields to be flooded to a depth of over 1 m. This water soaks into the deep soils and provides residual moisture on which crops such as sorghum can survive.

When moisture levels permit, the sorghum crop is ratooned and a second harvest of grain is possible. When the floods have been particularly good, farmers may plant maize instead of sorghum because of the greater yields that can be achieved. Minor crops include maize, pearl and finger millets, sesame, groundnut, beans, cotton and vegetables.



## **The eastern escarpment including the "green belt" zone**

### *Description*

The eastern escarpment stretches from north-east to south-west between the coastal plains and the highlands with an altitude range from about 600 m a s l to the highest peaks of Eritrea at more than 2,000 m a s l. This zone is a unique area where the rainfall exceeds 1,000 mm. It encompasses numerous micro-ecological zones determined by the interrelationship of altitude, rainfall, exposure and soils. Micro-climates in the belt range from sub-humid temperate to humid tropical. The relief is steep and requires terracing for successful farming. The "green belt" differs from all other zones as it is able to support permanent crops such as coffee without irrigation because of the bimodal rainfall pattern. Other areas in the eastern escarpment are drier than the "green belt", but still not as dry as the coastal plains.

### *Farming systems in the eastern escarpment*

The "green belt", while of considerable interest, has limited economic importance. This is because of its small area and the steep slopes which demand expensive terracing for crop production to be feasible. Currently, this area contains a substantial portion of the 53,000 ha of coniferous forest that once covered much of the Eritrean highlands. Thus, the area is also of interest from a conservation point of view.

The main production system is a mixed one including permanent tree crops such as coffee and annual crops such as wheat, barley, maize and sorghum as well as different pulses and vegetables. Livestock are also kept.

## **The central highlands**

### *Description*

The central highland zone lies at an altitude of over 1,500 m, has 500 mm of annual rainfall, a warm-to-cool semi-arid climate and potential evapotranspiration ranging between 1,300 and 1,800 mm. There are normally about three months of rain starting in June and ending in August or early September; in addition there are occasional showers in March and April. Predominant soils are chromic, eutric and calcic cambisols of a strong brown and red colour and with good agricultural potential.

There are three sub-zones with many common features, in particular major crops, but they are distinguishable by differences in altitude, annual rainfall, relief, soils, population density and degree of environmental degradation. The sub-zones are:

- Highlands: over 2,000 m altitude, 500-600 mm rainfall, very high population density
- Southern midlands: 1,500-2,000 m altitude, more than 700 mm rainfall and generally lower population density
- Northern midlands: 1,500-2,000 m altitude, less than 400 mm rainfall and low population density.

Land degradation is worst in the central and northern highlands. A long history of cultivation, grazing and fuelwood and timber harvesting without recycling of nutrients or management of organic matter has resulted in poor soils and depleted vegetation.

#### *Farming systems in the central highlands*

There are two main production systems in the highland area as a whole: a rainfed-cereals/pulses-based system and an irrigated-horticulture-based system.

- The rainfed-cereals/pulses-based system is based on the cultivation of a single cereal and/or pulse crop during the wet season with considerable reliance on residual moisture for the later part of the crop's growth.

The amount of land available for each family is very limited, varying between 0.5 and 2 ha and with an average of about 1 ha. Farmers grow a mixture of crops as a strategy for spreading risk and to satisfy diverse family requirements. Barley, wheat and taff are the main cereals, while finger millet, sorghum and maize occupy small areas. Amongst the pulses cultivated in rotation with cereals, chickpeas dominate, followed by field beans and field peas. Oilseeds such as linseed and nihug are also grown but on relatively small areas.

The system relies heavily on animal power for land preparation (oxen), threshing (oxen) and transport (donkeys and horses). The availability of oxen determines the timing of ploughing and planting during the short rainy season. The livestock population in the highlands has decreased significantly as a consequence of the drought in the 1980s, the war situation and population pressure. To complement income from crops, farmers also rear sheep and goats.

- The irrigated-horticulture-based system is practised by a minority of farmers who have been able to invest in the development of irrigation. On the irrigable plots of land, they cultivate vegetables and on the remaining land cereals under the previously described rainfed system. The main vegetables grown are potatoes, tomatoes, green peppers and onions. They can be grown almost all year round, but farmers avoid having crops in the ground between January and February because of the risk of frost.

### **The western escarpment**

#### *Description*

The western escarpment lies at an altitude of 600-1,500 m and has a warm-to-hot semi-arid climate. It is a transition zone between the highlands and the western lowlands in terms of climate, population density and farming systems. The soils are similar to those of the highlands.

#### *Farming systems in the western escarpment*

The dominant production system is an agro-pastoralist one. Farms are larger than in the highlands, averaging 2-3 hectares. The main crops are sorghum,

finger millet, taff, maize, sesame, cowpeas and chickpeas. Given the more abundant grazing resources in this area, the herds of cattle, sheep and goats are also larger. Highlanders bring down their herds of cattle to the western escarpment seasonally to take advantage of the better grazing. Shortage of fuelwood is less acute than in the highlands.

### **The south-western lowlands**

#### *Description*

This area is flat, hot and semi-arid and lies at an altitude of 600-750 m. Heavy vertisol soils are predominant. The population density, both of people and livestock, is low. Extreme climatic variations do not occur and the rainfall, though only 400-600 mm, is relatively reliable.

#### *Farming systems in the south-western lowlands*

There are four main production systems:

- Nomadic pastoralist
- Semi-sedentary agro-pastoralist
- Crop/livestock mixed production
- Commercial farming.

Most of the livestock are kept under a highly mobile nomadic pastoralist system. Many of the animals in this area have come from the highlands for the dry season and stay to browse the riverine vegetation or migrate further into Ethiopia or the Sudan. Camels are the preferred species because of their resistance to drought and because they are easier to feed during dry periods. These nomadic people are on the move in search of pasture and water for their herds almost throughout the year.

The semi-sedentary agro-pastoralist system is predominant in the area but may not easily be differentiated from the nomadic system. During the rainy season, homesteads are established close to a mountain and near the sites where sorghum and sesame will be planted. These sites are relatively permanent as the families will remain there until the crop is harvested. They return each year to plant and harvest crops. During the rainy season, most of the livestock are kept near the homestead, but at the beginning of the dry season people move with their herds to the dry-season sites. Later in the dry season, one male family member will take the cattle further south in search of pasture while the rest of the family stay at the dry-season site and later move to the rainy-season site to prepare for the cropping season.

Camels provide milk and are also used for long-distance transport of goods into the Sudan where the goods are exchanged for food. They are also used for ploughing. Male cattle are sold or slaughtered with a few being kept as breeding stock. Sheep and goats are sold whenever the need for cash arises. Donkeys are kept for short-distance transport of water and firewood by the women.

Currently there is increasing competition for land between the agro-pastoralists and commercial horticulturalists who are expanding their farms beside the major rivers which are the most important dry-season grazing reserves in the area.

In the crop/livestock mixed production system people do not shift homes during the year and crop production is more important. The livestock herds are similar to those in the agro-pastoralist system but with a tendency to keep fewer camels and larger herds of cattle. Ploughing is carried out with oxen instead of camels, though the use of camels for ploughing has increased recently because of the losses in cattle caused by the prolonged drought. The main crops are sorghum, pearl millet and sesame, which are all drought-resistant. They are never intercropped. Traditionally in this system, farmers have developed an important complementary activity: irrigated small-scale horticulture. The most common crops are tomatoes, onions, bananas and peppers, all irrigated by open shallow ditches along the river beds.

Recently, commercial farming has developed as a result of a policy of land distribution in the form of medium- and large-scale land concessions favoured after independence. Concessions may be both for large-scale rainfed production of sorghum and sesame or irrigated production of fruit and vegetables to supply Asmara and for export. The commercial enterprises have been developed by private farmers with adequate financial resources since large investments are necessary to start production in these remote areas.

### **The north-western lowlands**

#### *Description*

The north-western lowlands border on the Sudan. Altitudes are between 400 and 1,500 m and the climate is hot and arid with an average annual rainfall of 300 mm. Evapo-transpiration is between 1,500 and 2,000 mm.

Sustainable crop production is generally not possible without irrigation and pasture resources are poor to moderate. Prevalence of malaria combined with the poor agricultural potential has resulted in a low population density. Lopping trees as livestock fodder during dry periods is a common practice. In recent years, areas of riverine forest and some woodland have been converted to irrigated fields for vegetables.

#### *Farming systems in the north-western lowlands*

The main production system is a nomadic pastoralist one very similar to that found in the south-western lowlands. The nomadic people keep mixed herds, mostly camels, cattle and goats, and make long journeys, including across the border into the Sudan, in search of pasture and water.

## The vegetation

The vegetation of Eritrea varies greatly with altitude and moisture regime (see plates section after page xxviii) and Figure 1 (fold-out chart opposite page xxxviii) which is an east-west transect through the country showing the distribution of the different tree species.

Starting from the Red Sea in the east, the first notable plant species grow on the Dahlak Islands and along the shoreline. *Suaeda monoica*, a shrub, and *Avicennia marina* are the dominant mangrove species. Near the shore, and most commonly in towns, *Conocarpus lancifolius*, *Azadirachta indica* and *Prosopis* spp. have been planted. *Prosopis* is spreading rapidly on its own.

A unique place is the depression in the Bada area. Soils are saline and shallow, developed over hard rock, and the area is generally inhospitable. The most common trees here are *Hyphaene thebaica* var. *dankaliensis*, *Acacia* spp., *Cadaba* spp. and *Euphorbia* spp.

Further inland and below 500 m tree growth is sparse because of the hot and dry conditions. *Acacia oerfota* and *A. tortilis* subsp. *tortilis* are common on the flat areas, while *A. tortilis* subsp. *spirocarpa* is found only along rivers and streams. *Tamarix aphylla* grows along streams and river banks and is occasionally dominant. It usually grows as a fairly solitary species.

Between 500 and 1,500 m, *Acacia tortilis* often dominates, but because of the harsh climate there are no dense stands. *Acacia asak* occupies rocky hillsides and *A. seyal* grows in isolated localities. The baobab, *Adansonia digitata*, is also present as scattered individual trees as well as in "family" groups, generally on lower hill slopes and in valley bottoms. The degree to which these areas have been influenced by man is not easy to determine, and the current situation may not be very different from the natural climax.

Between 1,500 and 2,000 m, *Acacia tortilis* and *A. seyal* grow on steep and rocky sites in the lower areas gradually being replaced by *A. etbaica* higher up. Along rivers, *Faidherbia albida*, *Balanites aegyptiaca* and *Ziziphus spina-christi* used to form closed-canopy woodlands, albeit not very tall ones. But these are now reduced to scattered individual trees because of their exploitation for firewood and charcoal and overgrazing by goats. *Boswellia papyrifera*, exploited for frankincense, can be found locally in association with these mid-altitude woodlands. Now it appears in almost pure stands because of the removal of the *Acacia* for fuel.

Above 2,000 m, *Acacia abyssinica* used to dominate on the waterlogged plateaux. The trees have almost all been cleared leaving only occasional remnants around perennial springs.

The highland forest, dominated by *Juniperus procera* with some *Olea africana*, once covered the greater part of the highlands of Eritrea above about 2,000 m. Only where the soils are subject to seasonal waterlogging, as on the plains, have such associations given way to *Acacia abyssinica*. The forests have now been destroyed by clearing of land for cultivation and timber. On the plateau, occasional mutilated individual trees remain in farmland, while on the steeper, less desirable and accessible eastern escarpment, an estimated 53,000 ha of

degraded forest remain. Man-made plantations have been established in the highlands, where *Eucalyptus cladocalyx* dominates, especially on marginal sites. *E. globulus* grows in the wetter river valleys and *E. camaldulensis* is generally found on better arable land. Occasional use has been made of *Acacia saligna* and *A. mearnsii*, but their crooked form discouraged widespread planting.

Where the natural forest has been cleared, and the land subsequently badly degraded, a limited number of relatively aggressive pioneers establish themselves, in particular *Opuntia ficus-indica* in the highlands, *Dodonaea angustifolia*, *Carissa edulis* and *Euclea schimperi* at mid-altitudes and *Calotropis procera* and *Nicotiana glauca* in the lowlands. Although the exact area is unknown, these species cover thousands of hectares. Such a succession should not be removed, since there may be secondary species regenerating within the protection afforded, including *Euphorbia candelabrum*, *Pterolobium stellatum*, *Calpurnia aurea*, *Rumex* spp. and *Croton macrostachyus*. At the mid- and lower altitudes the climax Acacias, including *A. mellifera* and *A. tortilis*, quickly move back into degraded areas.

The vegetation density and tree size on the western escarpment vary with the amount of rainfall, which diminishes towards the north and west. Along the moister river valleys, the vegetation is mainly savannah and wooded savannah, whereas the higher slopes are covered by Combretum woodland. *Albizia amara*, *Adansonia digitata*, *Boscia angustifolia*, *Terminalia brownii*, *Balanites aegyptiaca*, *Boswellia papyrifera*, *Commiphora* spp., *Combretum molle*, *Salvadora persica*, *Faidherbia albida*, *Acacia tortilis* subsp. *spirocarpa*, *Ximenia americana*, *Ficus sycomorus*, *Ziziphus spina-christi*, *Dalbergia melanoxylon*, *Delonix elata*, *Sterculia tomentosa* and *Dombeya torrida* subsp. *torrida* are common species. *Boswellia papyrifera* is highly valued for its gum production while *Commiphora* spp. provide myrrh. The purple or brown-black heartwood of *Dalbergia melanoxylon*, which is sometimes referred to as African blackwood or African ebony, is of considerable commercial value.

In the far west of the western lowlands are extensive grasslands. *Aristida* dominates in the west and *Sorghum purpurea-Sericeum* grassland in the south-west. They are intermixed with riverine forest and large tracts of *Acacia* woodland. In the east and south-east, the vegetation includes *Acacia seyal*, *Acacia Senegal*, *Acacia mellifera* and very sparse *Balanites aegyptiaca*. *Acacia tortilis* subsp. *spirocarpa* grows along the river banks. In the driest areas, *Boscia senegalensis* and *Cadaba* spp. are also found. Large specimens of *Kigelia africana*, *Adansonia digitata* and *Acacia* spp. grow around Barentu and in the middle reaches of the River Gash.

In Figure 1, species that grow along rivers and in valley bottoms have been differentiated from ones that grow on slopes or hillsides. Riverine areas are often extremely valuable for the livelihood of people, and riverine forests are well developed along the Gash, Barka, Anseba and Setit rivers and their tributaries. It is estimated that there are some 14,000 ha of the doum palm (*Hyphaene thebaica*) in the riverine forests of Eritrea. Both the stems and leaves



of the palm have many uses. The stems are used for house construction, and those of the male plant, which are particularly durable, were used as railway sleepers by the Italians during the construction of the early Eritrean railway. The leaves have numerous uses—basketry, thatch, fuel and fodder—and the fruit and kernel have other uses. Thus, this is one of the most important trees for the rural people of Eritrea but it is now under heavy pressure from clearing for agriculture and grazing by cattle.

### **Dwindling forest resources**

It has been claimed that only a century ago, 30% of the total land area of Eritrea was covered by forest. By 1952, that figure had dwindled to 11%, and in 1960 the forest cover was estimated at a mere 5% (Pagini, 1952 in MOA, 1994).

The National Environmental Management Plan for Eritrea stated that the main causes for the reduction of the forests are:

- Expansion of agriculture: e.g. 300,000 ha of forest land is said to have been cleared for agriculture upon the arrival of the Italian colonialists (Renato, 1911 in MoA 1994)
- Consumption of fuelwood: an estimated 4.4 million cubic metres are consumed annually on a national scale (MoA, 1993 in FAO, 1994)
- Thirty years of liberation war
- Construction of traditional houses known as *hidmo*
- The attitude that trees are abundant and a gift of God to be utilized at will.

### **Tree resources and tree utilization in the different zones**

In most areas, attempts have been made to plant trees to meet local people's needs for wood as well as fruit, shade, etc.

In the **coastal plains**, tree growing has mainly been confined to areas around towns, particular around Massawa and Assab. There are small plantations of *Conocarpus lancifolius* in Massawa. *Cassia siatnea*, *Delonix regia* and *Azadirachta indica* are common along roadsides in other major towns. Approximately 10% of the fuelwood for Asmara is collected from the coastal plains.

The **central and northern highlands** are denuded of trees and there is a widespread shortage of fuel and wood for construction. Soil erosion is severe. In recent years, many tree nurseries have been established in the zone. Also some hillsides have been fenced in in an attempt to promote natural regeneration of the trees, *Juniperus procera* and *Olea africana* are among the economically and ecologically valuable trees that still grow in the zone, although they are rare. Plantations of *Eucalyptus cladocalyx*, *E. camaldulensis*, *E. globulus* and *E. rudis* have been established, especially on marginal lands and along river banks. Efforts have also been made to plant *Acacia saligna*, *A. mearnsii* and *Schinus molle*. The total area of plantations in the highlands is estimated at 10,000 hectares.

In the **north-western lowlands** woodland, savannah, bush and thicket are the main vegetation types. Some species that occur are *Acacia tortilis*, *A. mellifera*,

*Balanites aegyptiaca*, *Cadaba rotundifolia* and *Ziziphus spina-christi*. *Hyphaene thebaica* (doum palm) is common along the Barka river. Other riverine species such as *Salvadora persica* and *Tamarix aphylla* also occur. About 40% of the firewood for Asmara is collected from the upper and lower Barka areas. Doum palm leaves (about 300 quintals annually) are extracted from the Barka river bank for baskets, mats and other household items. A fibre factory 6 km north-west of Akordat, originally set up in 1950, has been renovated and is now functioning again. The factory has a capacity to utilize 26,000-40,000 tonnes of doum palm leaves, a quantity that cannot be extracted sustainably unless efforts are made to grow more of the trees.

In the savannah woodlands of the **south-western lowlands**, bushland and thicket are the major vegetation types. About 50% of the firewood for Asmara is collected from this zone. In addition, about 3,000 quintals of gum olibanum from *Boswellia papyrifera* and gum arabic are extracted annually. Doum palm leaves are cut for the production of sacks, baskets and other crafts. The major tree species of this zone are *Acacia tortilis*, *A. nilotica*, *A. Senegal*, *A. seyal*, *Balanites aegyptiaca*, *Adansonia digitata*, *Ziziphus spina-christi*, *Tamarix aphylla* and *Boswellia papyrifera*. Exotic species such as *Azadirachta indica* and *Senna siamea* are common along road sides in the major towns. *Prosopis chilensis* is dominant along the lower part of Gash river. It was introduced from the Sudan in the last 10 years.

## Some environmental concerns

A number of environmental issues which are directly related to forest resources have been highlighted in the National Environmental Management Plan for Eritrea. Those issues are:

- Shortage of fuelwood
- Construction of traditional houses
- Soil erosion
- Land/tree tenure
- Eucalyptus plantations
- The spread of the cactus *Opuntia ficus-indica*
- Clearing of woodlands for agriculture
- Fire in the woodlands and savannah areas
- The use of lime and brick kilns
- Resettlement
- Endangered tree species
- Drought and desertification
- Salinity of water
- Spate diversion and related deforestation
- Expansion of evaporation ponds (salt fields).

### **Shortage of fuelwood**

Most of the domestic energy of Asmara is fuelwood which is obtained from woodlands in the lowlands. The price of this fuelwood has increased primarily because of increasing demand and scarcity and the long distances from the collection areas to the city.

The fuelwood problem is, however, not only an urban one. There is a shortage of fuelwood in all highland areas that are intensively cultivated. This does not only bring hardship to the people, but also undermines the whole farming system since cow dung and crop residues are used as substitutes when there is no firewood. This is part of a vicious circle as it means that nutrients and organic matter that would be returned to the soil are lost, resulting in reduced crop yields.

### **Construction of traditional houses**

Another important activity that requires wood is the construction of the traditional houses called *hidmo*. Some estimates indicate that about 100 trees are felled to construct one such house in the highlands as a *hidmo* is very large and is covered with poles that provide support for the earthen roofing. *Oka africana* and *Juniperus procera* are used as pillars inside and outside the house. In the process of selecting the most appropriate trunk, many more trees are cut than is necessary. In addition, every now and then renovation is required to replace poles that become damaged. The present rate of exploitation for poles appears to be unsustainable.

### **Soil erosion**

Soil erosion is linked to deforestation. Most highland areas are badly affected by erosion because of local farming practices, overgrazing and deforestation.

### **Overgrazing**

At present, overgrazing and overbrowsing in the highlands are not serious since livestock numbers were reduced significantly by the 30 years of liberation war. The grazing/browsing pressure is, however, uneven, with certain areas still having a very high population of sheep and goats.

### **Land/tree tenure**

The *dessa* land-tenure system, involving the periodic redistribution of arable land, provides no incentive for farmers to carry out permanent improvements to the land. To make matters worse, if the farmer did not exploit the trees, the next tenant certainly would. With the new land law 58/1994, the land-tenure system is now changing.

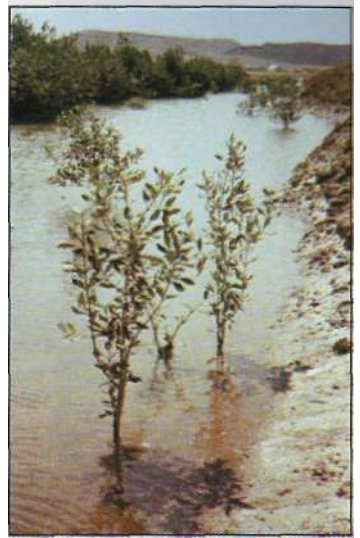
### **Eucalyptus plantations**

Eucalypts are prominent among the tree species being planted in the highlands. The cultivation of eucalypts has caused much controversy in Eritrea, as in many other countries. It has been argued that they have adverse environmental effects, including excessive water and nutrient requirements and allelopathic effects on adjacent crops. On the other hand, it has also been argued that the area under eucalypts is very small compared to the total area of the country and the effect on the environment is insignificant as long as the trees are planted away from river banks and arable land. The competition with crops can be much reduced if eucalypts are managed on a short rotation and thus never grow to become huge trees. Some researchers have also concluded that eucalypts are very efficient in the use of water and nutrients, and their competitiveness is a result of their fast growth rather than of their being "greedy" and wasteful. The decision as to whether or not to plant Eucalyptus must be made on a case-by-case basis taking into account local circumstances such as the views of the local people, land availability, competing land uses, performance of alternative tree species, forest-product requirements, and so on. Further, it must be noted that cultivation of eucalypts has the potential to contribute to improved nutrient- and organic-matter recycling in the farming system if plenty of fuelwood can be produced. This would minimize the use of cow dung and useful crop residues that should be returned to the soil. It should also be noted, however, that eucalypts will not meet all the needs of the people. Thus, they are not a substitute for a greater variety of indigenous and exotic species.

## The coastal plains



A mangrove swamp with heaps of extracted salt



Regeneration of *Avicennia marina*



Neem is a good shade tree in Massawa

## The eastern escarpment



Lush vegetation at Filfil, c. 720 m



*Ficus sycomorus* near Filfil

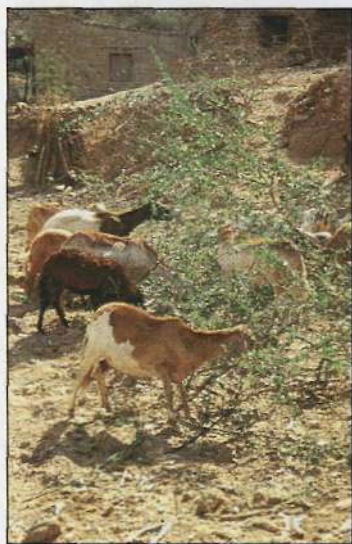
The eastern escarpment, *contd*



General view towards the coast from the middle of the escarpment with *Carissa edulis* in the foreground



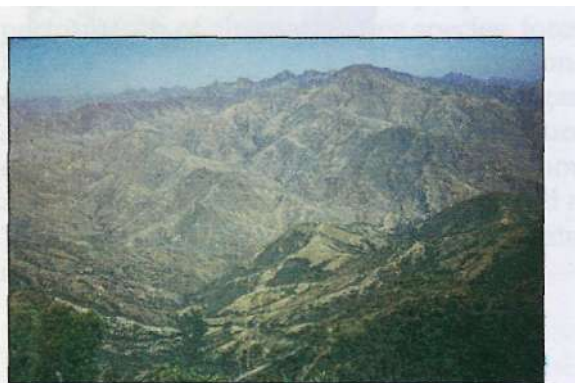
Lopping *Balanites* to feed sheep, Dongola Tahtay



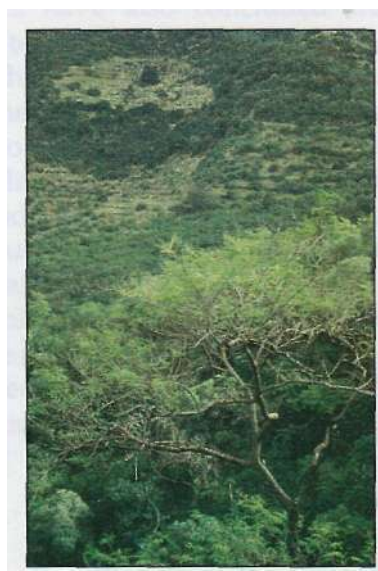
Sheep feeding on *Balanites* leaves



View of the Medhanit area on the eastern escarpment



A view of the Mutsab valley



*Entada abyssinica* at Medhanit, 1,600 m



View of regenerating natural forest in the Mt. Bizen-Gobolemin area with fog bringing moisture to the vegetation, 1,930 m

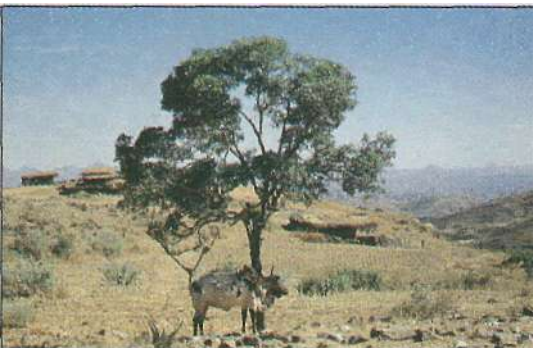


Natural regeneration of *Juniperus procera* at Mt. Mirara



In cultivated areas, there are remnant forests intermingled with Eucalyptus, 2,200 m

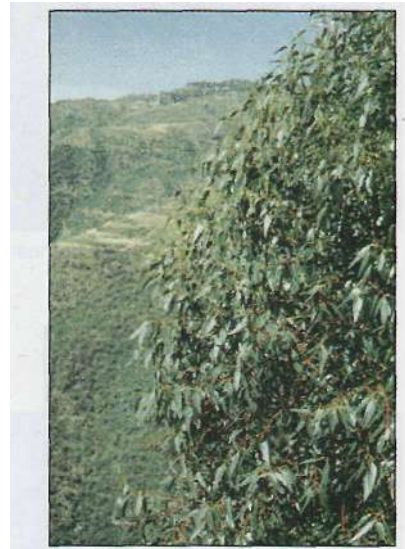
### The central highlands



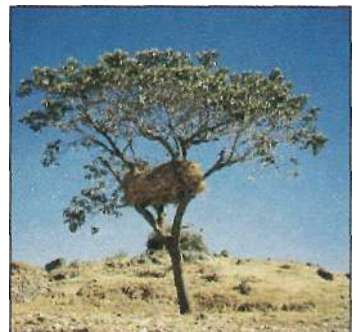
An ox rubbing against *Euclea schimperi* at Adibeza (Kohain), 1,800 m



*Diospyros abyssinica* with *Rumex* near a nursery at Mirara, 2,150 m; castor oil in foreground

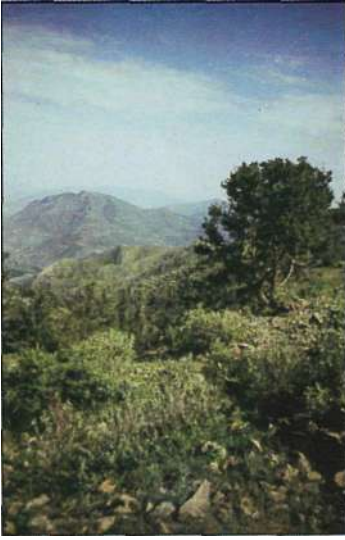


The typical shiny leaves of *Eucalyptus cladocalyx*, at the rim of the escarpment



Hay being stored in a fork of *Cordia africana* at Andelas, near Maimene, 1,800 m

The central highlands, center



Juniperus regeneration. "Weki" at the top of the escarpment



Natural regeneration with *Opuntia*, *Eucalyptus cladocalyx* and *Dodonaea angustifolia*



Animals grazing near *Olea* trees growing on old soil conservation structures, stabilizing the edge of an old terrace, 1,800 m



A beehive wedged in a *Cordia africana* tree at Andelas (Kohain), 1,750 m



Rugged terrain with grass strips along contours south of Kohain



Acacia woodland in a wide valley near Kinafina, 1,550 m



## The western escarpment



Euphorbia and a dam under construction



Huge *Ficus vasta* tree in a village

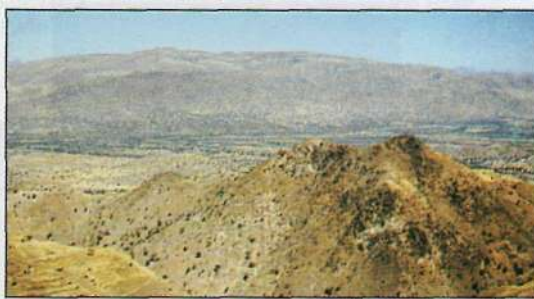


Entada pods



*Albizia amara* near Adi-neamen

## The south-western lowlands



Distant view of open scrub in the Ubel area, 1,600 m



Cows in the shade of Acacia and Balanites trees at Enda-giorgis, 1,460 m



"Parkland agroforestry" in the Ailagundet area, Enda-giorgis, 1,460 m



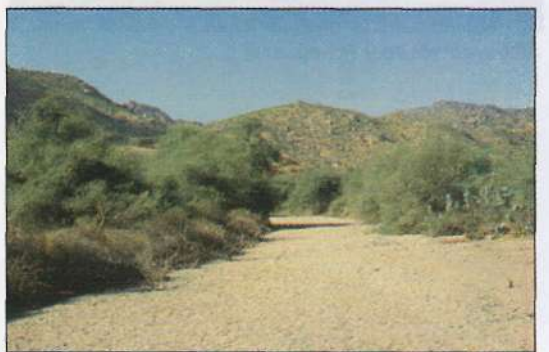
A camel browsing on Acacia

**The south-western lowlands, contd**



*Balanites aegyptiaca* used for storing dry grass out of reach of cattle

**The north-western lowlands**



River bank stabilization with *Ziziphus spina-christi* at Jengeren



*Arundo donax* along a watercourse near Elabered



*Kigelia africana* near the River Areway at Aibaba village



*Adansonia digitata* (baobab) used as a store for hay at Jengeren



*Steganotaenia araliacea* naturally growing near Geleb, 1,720 m



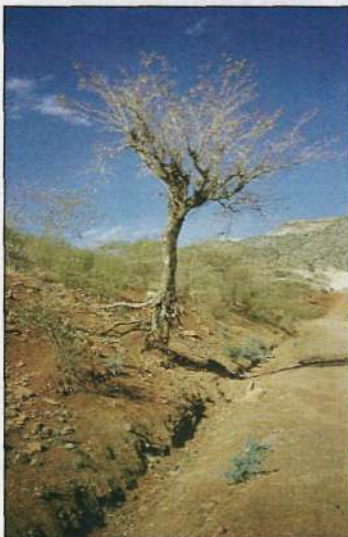
*Mimusops kummel* on the river bank near Areway, 1,580 m



*Maytenus senegalensis* near the bank of the River Belte (Mensa), 1,680 m



Goats browsing on Acacia in a very dry area, *Balanites* and *Ziziphus spina-christi* in the background



*Terminalia brownii* with roots exposed by heavy erosion at the roadside



*Balanites* with roots exposed by heavy erosion

The north-western lowlands, *contd*



Egyptian doum palms *Hyphaene thebaica*



Cows and herdsmen in the shade of *Balanites*



Dry landscape with short *Acacia mellifera* and a taller *A. tortilis*



Dorcas gazelles in Acacia country

### **The spread of the cactus *Opuntia ficus-indica***

Another environmental issue in the highlands, especially on the eastern escarpment, is the invasion of the cactus *Opuntia ficus-indica*. It is claimed that the cactus was introduced to Eritrea by missionaries in the 1830s. Gradually, it has been dispersed by people and animals, especially by monkeys in the eastern escarpment, and it now covers more than 10,000 hectares. Aside from its advantage in conserving soil and producing edible fruit, the spread of this species has an impact on the local ecology that is difficult to assess. Valuable species such as *Olea* and *Juniperus* appear not to regenerate in the areas covered by cactus, and in such areas only scattered pioneer species such as *Calpurnia aurea* and *Pterolobium stellatum* are left.

### **Clearing of woodlands for agriculture**

Some river basins, e.g. along the Mereb-Gash and Barka rivers, are fertile and thus there is an interest in agricultural expansion in such areas. Development for agriculture needs to be harmonized with other values and interests. *Hyphaene thebaica* and *Tamarix aphylla* are examples of species that merit attention.

### **Fire**

The ecological role of fires in the tropics and sub-tropics has been debated over the years. It has been argued that fires are detrimental and constitute a problem, especially in the south-western lowlands when it is very dry, windy and hot.

### **Use of lime and brick kilns**

These kilns consume significant amounts of fuelwood, especially along the rivers Gash and Sawa.

### **Resettlement**

People returning from the Sudan are settling around the Gash and Barka river basins in the south-western lowlands as well as in the north-western lowlands. These settlements lead to demands for wood for house construction and fuel as well as agricultural expansion, thus increasing the pressure on the local woody resources.

### **Endangered tree species**

*Boswellia papyrifera*, which is intensively utilized for extraction of gum olibanum in the south-western lowlands, is regarded as being endangered. *Adansonia digitata* has also been included in this category because of its poor regeneration. *Tamarindus indica* is intensively used to make mortars which are used in the production of sesame oil in areas where sesame is grown. Fruits of the tree are used for food and for medicine. As a result, the population of *Tamarindus* has decreased in some areas of the south-western lowlands. Other species that are rare in that zone are *Ximenia americana*, *Dobera glabra* and *Maerua crassifolia*.

### **Drought and desertification**

It has been argued that degradation in the north-western lowlands is rapidly leading to desert-like conditions. Browsing of camels and goats is very intense, tree regeneration is poor and the environment as a whole is becoming increasingly degraded. Similar conditions occur in the eastern coastal zone.

### **Salinity of water**

It has been noted that afforestation using conventional methods is unsuccessful in the north-western lowlands and parts of the eastern coastal zone. Seedlings die immediately after germination because of the salinity of the ground water used for watering.

### **Spate diversion and related deforestation**

People living in the eastern lowlands have practised spate irrigation for a long time. Intermittent rapidly flowing rivers from the high part of the escarpment are diverted to the agricultural fields with the help of primary, secondary and tertiary canals supported by Acacia branches. The cutting of trees and shrubs for this purpose is such that it contributes significantly to deforestation locally.

### **Expansion of evaporation ponds (salt fields)**

Evaporation ponds for salt production are expanding, particularly around Massawa. These salt fields are constructed at the coast, where mangrove vegetation is found, and thus affect the marine environment.

## Future outlook

Developments during the past decades have not been very encouraging with regard to the management of the tree resources of Eritrea. Action is required to reverse the situation. The National Environmental Management Plan proposes measures aimed at increased tree growing and reduced consumption, e.g.:

- Increasing the availability of quality tree seeds
- Encouraging establishment of on-farm tree nurseries
- Encouraging agroforestry practices including on-farm woodlots
- Promotion of energy-saving cooking practices
- Promotion of soil and water conservation
- Awareness creation
- Promotion of natural regeneration through hillside closure, for example
- Environmental education
- Research on biodiversity conservation and Eritrea's ecology.

In densely populated parts of eastern Africa there are now some positive trends with regard to restoration of tree cover. In intensively cultivated and densely populated areas the amount of woody biomass is increasing, mainly on the small plots cultivated by individual families. Often, only small areas of communal lands remain and these communal lands have long lost their importance as areas for supply of fuelwood and other resources. Farmers have responded by growing more trees on their own farms.

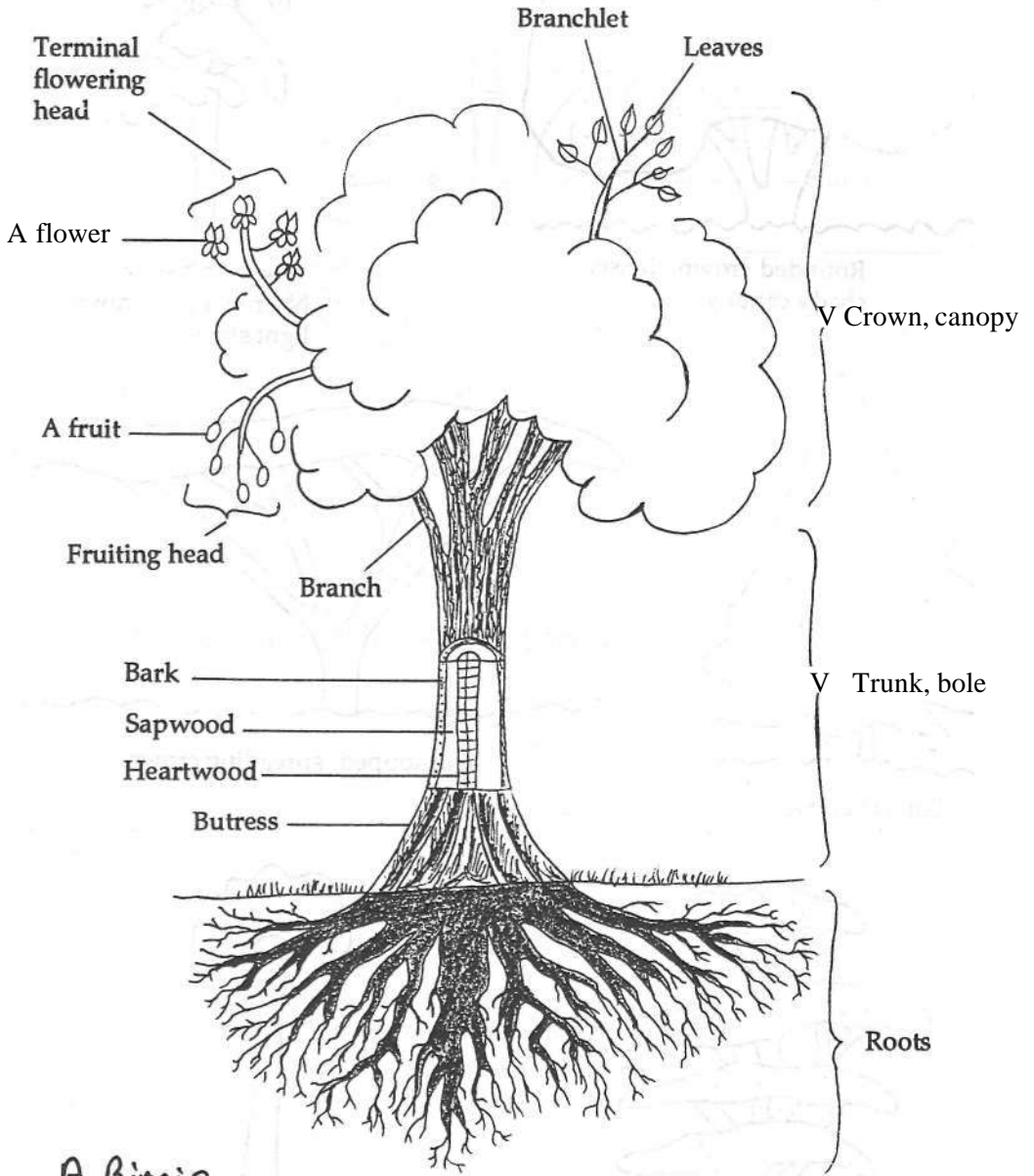
With a new era of peace and stability, new policies and new land legislation in Eritrea, there is hope that the negative trends of the past can be reversed in the coming decades.



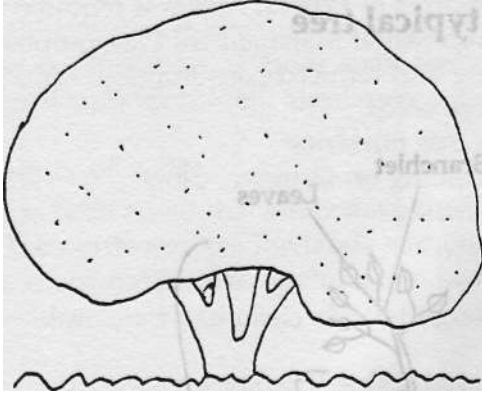


Illustrated glossary of some botanical terms

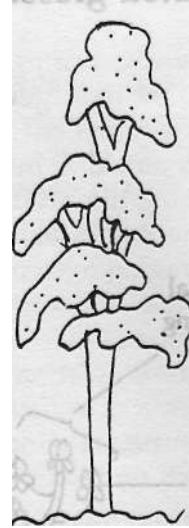
The parts of a typical tree



## Tree shapes



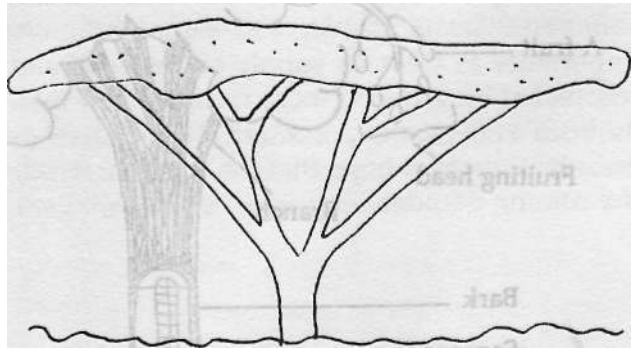
Rounded crown, dense, shady canopy



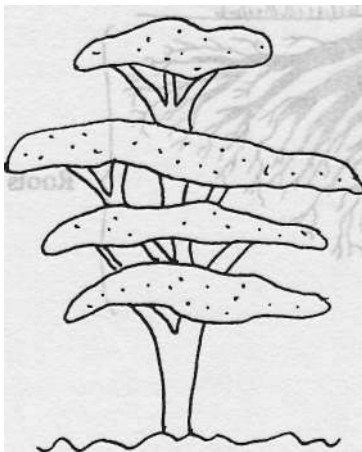
Narrow open crown, light shade



Conical crown



Flat-topped, spreading crown



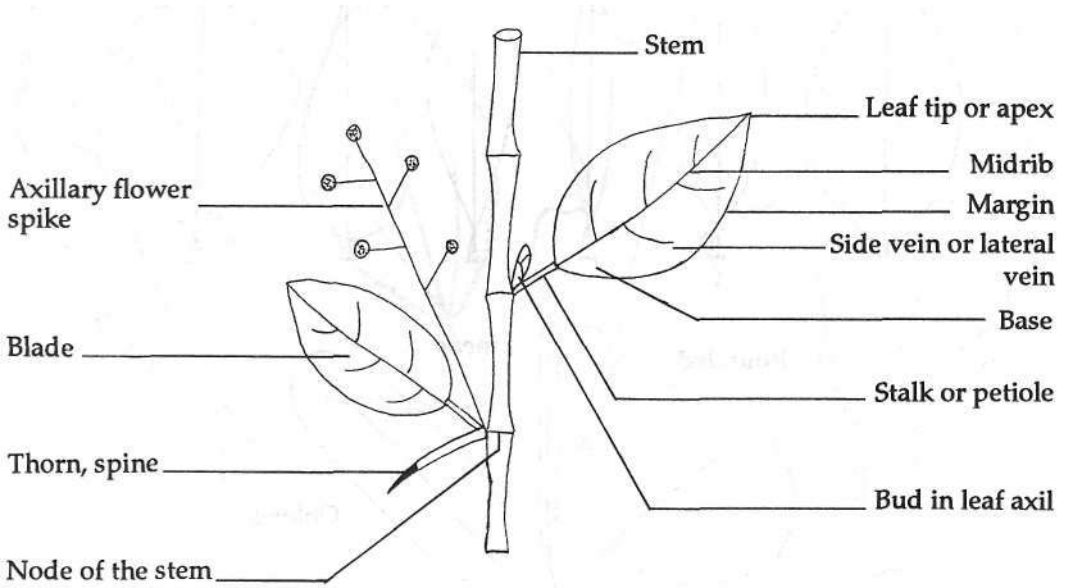
Canopy in layers



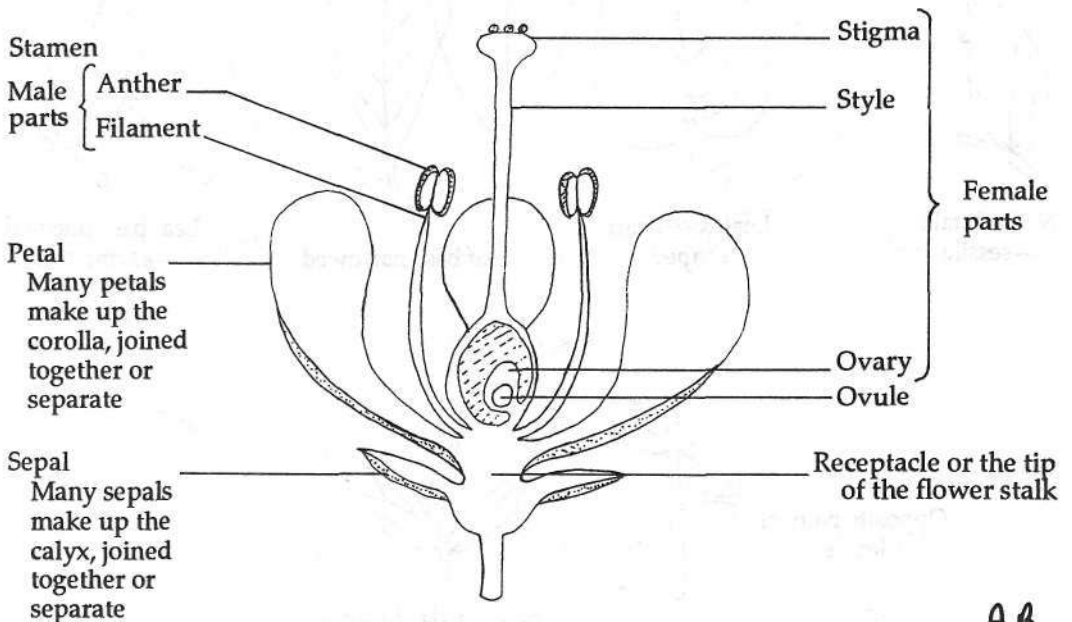
A tall bole, small dense crown

## Leaves and stems

Diagram showing two simple leaves alternate on a stem



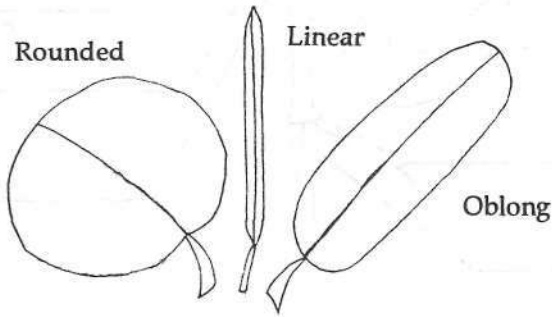
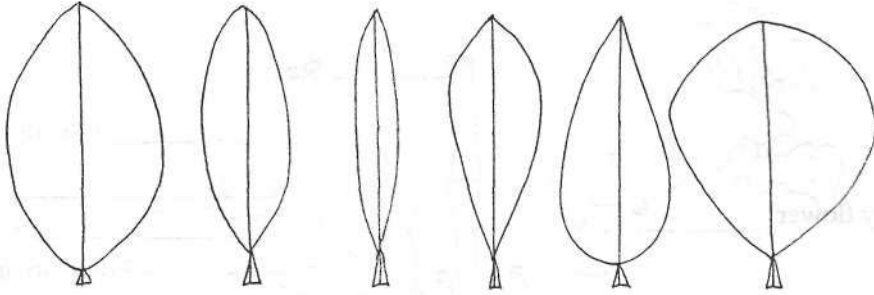
## A diagrammatic section through a typical flower



A.B.

## Leaves

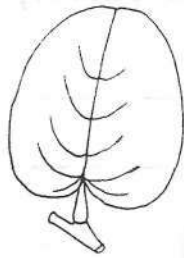
A variety of simple oval-shaped leaves



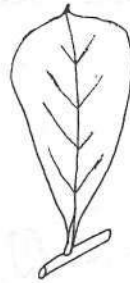
### Leaf base



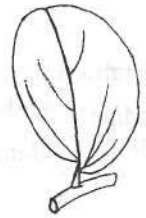
No leaf stalk  
—sessile



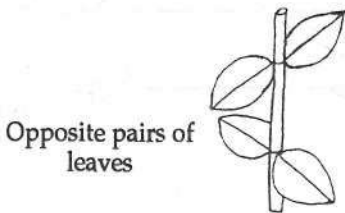
Leaf base heart  
shaped



Leaf base narrowed



Leaf base unequal  
—asymmetric

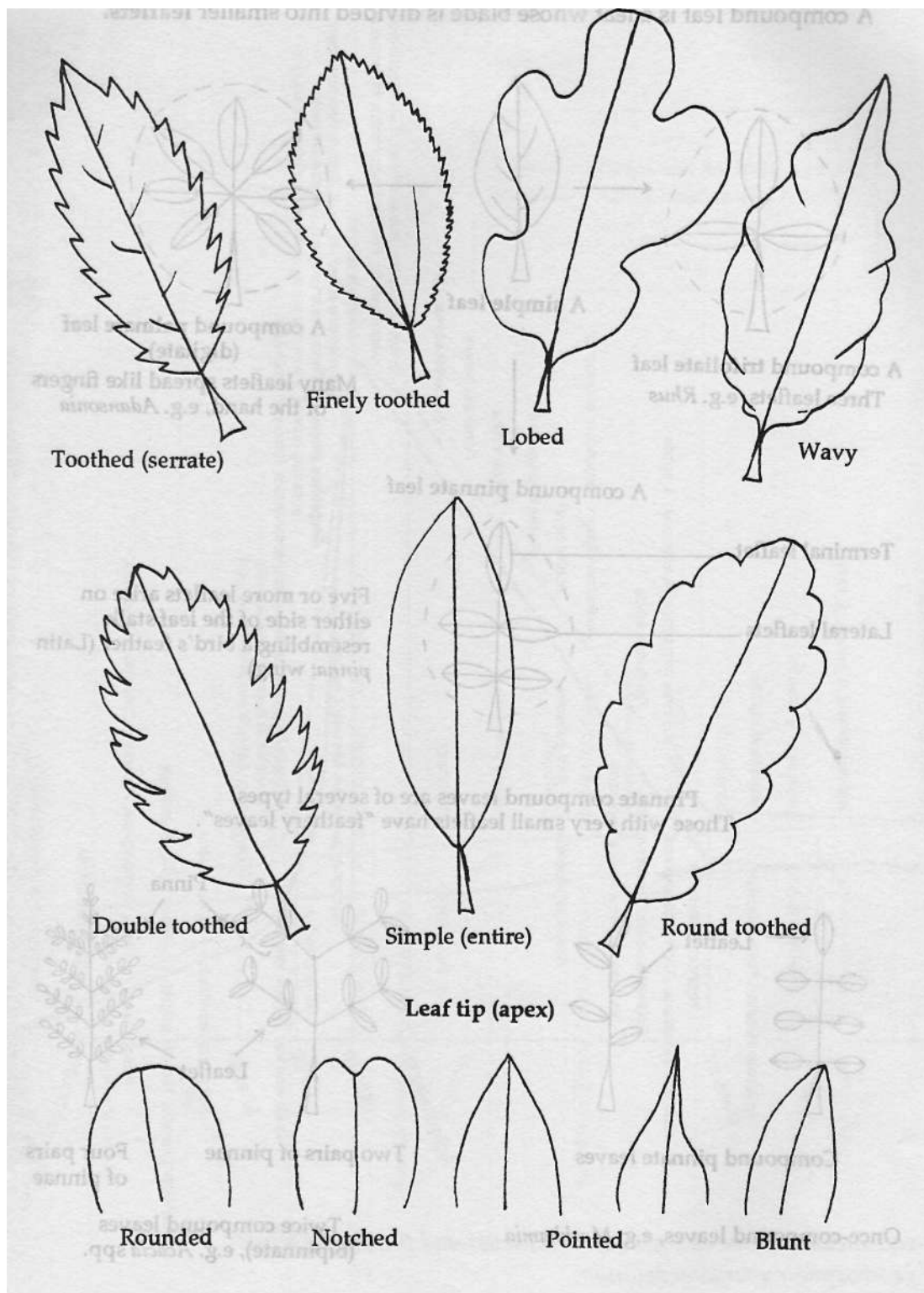


Opposite pairs of  
leaves



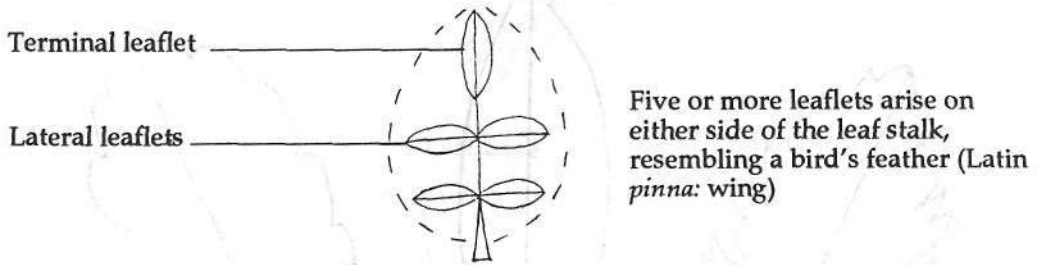
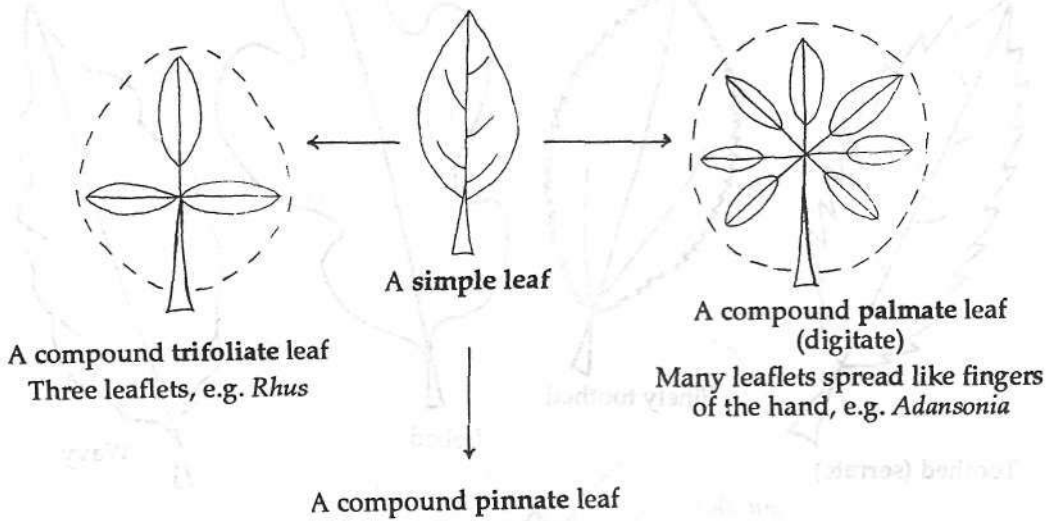
Four whorled leaves

**Leaf edge (margin)**

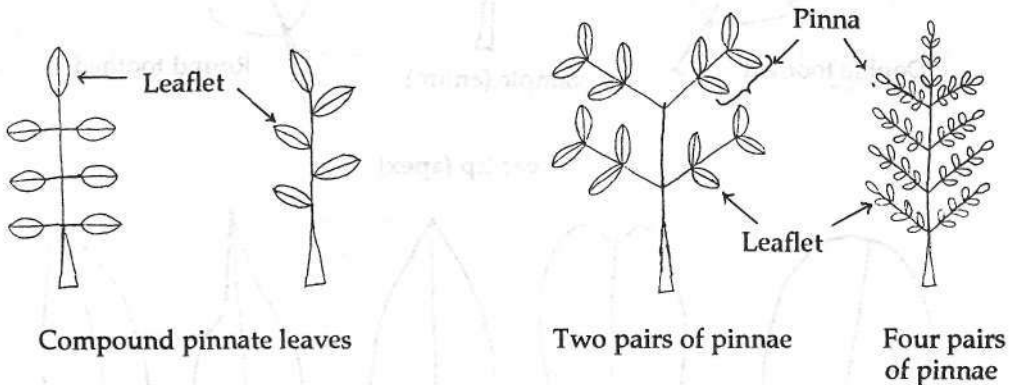


Leaves may be simple or compound.

A compound leaf is a leaf whose blade is divided into smaller **leaflets**.



Pinnate compound leaves are of several types. Those with very small leaflets have "feathery leaves".



Once-compound leaves, e.g. *Markhamia*

Twice compound leaves (bipinnate), e.g. *Acacia* spp.

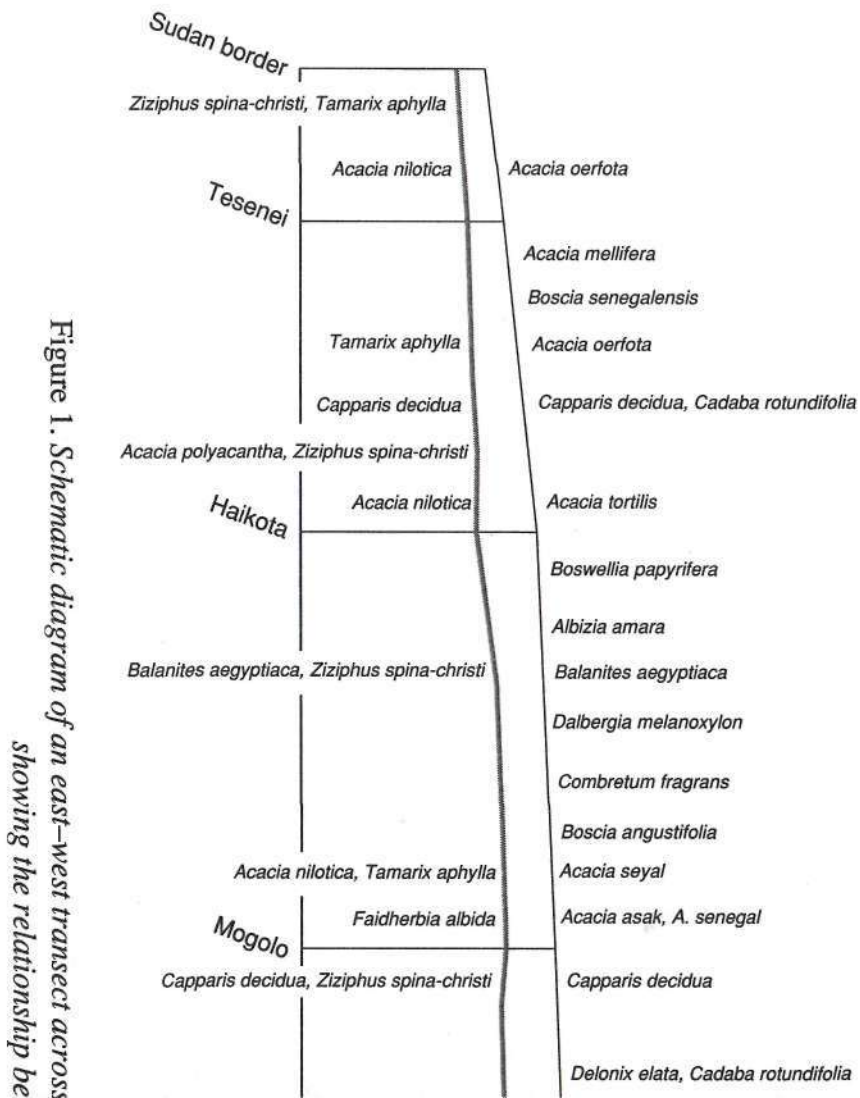


Figure 1. Schematic diagram of an east-west transect across the Sudan border showing the relationship between vegetation types and geographical features.

