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Christian Relief and Development Association

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On
Agroforestry

CCRDA

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CONTENT

	Page
Some Socio-Economic Issues of the Southern Region of Ethiopia.	1
Agricultural Potentials and Constraints	6
State and Quality if the Environment of S.R	10
Concepts and Definitions	11
Tree Crop Interaction	19
Agroforestry for Fuelwood	22
Potential of Agroforestry for Soil Conservation	26
Agroforestry for Livestock Production	33
Diagnostic Techniques for Agroforestry Development	37
Spatial Arrangements for Trees in Agroforestry	47
Management of Trees in Agroforestry	49
Criteria for Selection of Agroforestry Trees Species	54
Nursery Practices, Maintenances and Policies	57
The Social and Economic Significance of Agroforestry	59
Agroforestry Extension	61
Monitoring and Evaluation	63
Appendix	

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THE NEED FOR THE TRAINING

1. Unlimited farmers wishes, potentials, limitations and technologies.

2. Too foreign reforestation and land care technologies to be propagated by farmers.

3. Mistrust by the farmers about the validity of reforestation and rehabilitation technologies,

4. Rejection of DA-propagated afforestation and rehabilitation know-how by the farmers,

5. Natural rehabilitation and management of closed areas proved to be very slow and poor. Before the degraded lands recover more lands become exhausted.

Chapter I

SOME SOCIO-ECONOMIC ISSUES OF THE SOUTHERN REGION OF ETHIOPIA[1]

Southern Ethiopia is noted for the diversity of its people, topography, climate, soil and vegetation, providing the bases and potential for a wide range of agricultural production system. Vegetation types range from arid, through savannah and tropical forest to alpine shrub and grassland.

Food production systems vary accordingly, with trans-human pastoralist mooring over the semi-arid lands, sedentary farmers using animal draft to grow cereals and planter communities in the higher rainfall areas subsisting on enset and a range of tuber crops, and growing coffee and other perennials for cash.

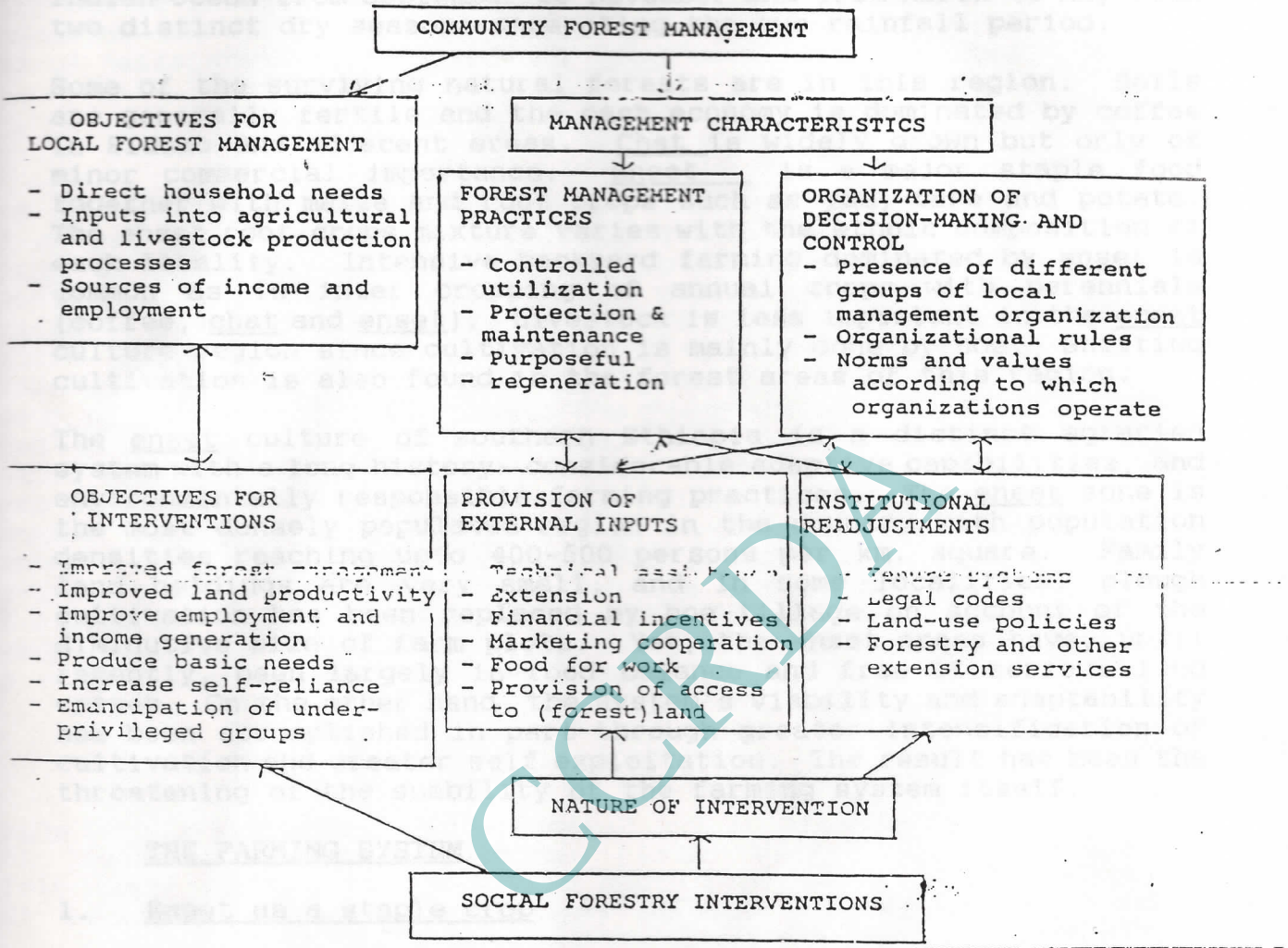
The southern region of Ethiopia has been an important area with numerous and diverse nationality groups inhabiting different parts of the region and adopted distinct types of production systems and agro-technologies. Those who inhabit around Omo river are largely agro-pastoralists who cultivate tuber crops, enset, sorghum, maize and rear cattle. The Burji-Konso-Geleb group are known for their stone-wall terraces, irrigation, manuring and crop rotation. The Gurage, Hadya and Wolaita depend largely on the cultivation of enset and other cereals. The Sidama and Gedeo cultivate coffee, enset and cereals.

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[1] The text is adapted from the Study of Traditional Conservation Practices by Tahel Consultants (1988).

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Figure 1 Framework for analyzing social forestry strategies



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In general, the region is noted as a high potential non-cereal zone. This zone is generally of itermediate altitude (1500-2800 meters). It has high rainfall with a mono-modal pattern and going up to 2200mm per annum. However, there are also places in the region with a bimodal rainfall regime receiving rain from the Indian ocean from September to November and from March to May with two distinct dry seasons separating the two rainfall period.

Some of the surviving natural forests are in this region. Soils are generally fertile and the cash economy is dominated by coffee in Sidamo and adjacent areas. Chat is widely grown but only of minor commercial importance. Enset is a major staple food together with maize and root crops such as yam, taro and potato. The enset root crops mixture varies with the ethnic composition of each locality. Intensive backyard farming dominated by enset is common as is inter cropping of annual crops with perennials (coffee, chat and enset). Livestock is less important in the enset culture region since cultivation is mainly done by hoe. Shifting cultivation is also found in the forest areas of this region.

The enset culture of southern Ethiopia is a distinct agrarian system with a long history- considerable adaptive capabilities, and environmentally responsible farming practices. The enset zone is the most densely populated region in the country with population densities reaching upto 400-500 persons per km. square. Family land holdings are very small, and in some localities, plough cultivation has been replaced by hoe tillage on account of the diminutive size of farm plots. Yet, the enset areas have, until recently, been largely in food balance and free of serious food crises. On the other hand, the system's viability and adaptability has been accomplished in part through greater intensification of cultivation and greater self exploitation. The result has been the threatening of the suability of the farming system itself.

THE FARMING SYSTEM

1. Enset as a staple crop

Enset is the main staple food of the people living in the south eastern part of the highlands in Shewa, in the Rift Valley and partly in the Sidamo portion of the Eastern Highlands. The people included in this dreary culture are : the Gurage; the Hadya, Kembata and Tambarro; the Sidamo and the Gedeo.

1.1 The Gurage

The traditional economic and social life of the Gurage rests on the cultivator of enset which satisfies many of their essential subsistence needs. They practice a system of shifting cultivation, marked by the extensive use of manure and crop rotation that enables them to use the same plots

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indefinitely. Cash and food crops are usually inter-cropped between enset plants.

1.2 The Hadya, Kemata and Tambarro

These three groups live on the Western escarpment of the Rift Valley southwest of the Gurage and north of the Wollaita. They rely heavily on enset and their crops are similar to the Gurage.

1.3 The Sidamo

They live south of Lake Awassa, partly in the Rift Valley and partly in the Eastern highlands of Sidamo. The region is characterized by large enset plantations as well as enset coffee gardens around Dilla. The gardens are traditional types of agro-forestry. Inter-cropping with cereals, pulses and tubers is common including fallowing. Only enset, coffee and cabbage are manured and enset plots undergo periodical shifting. In the enset and coffee plantation erythrina trees are planted to profit from the nitrogen generated by root bacteria. Outside the intensively cultivated homestead coffee and enset plots, shifting cultivation on forest land is used to produce cereals. Altitude zoning of crops is common; coffee, maize being dominant at 1800-2000 meters, wheat, barley and pulses are dominant from 2000 to 2500 meters. Cereals and pulses alternate in loose rotation. No manure is applied and mainly the hoe and digging sticks are used. Above 1900 meters, use of bamboo for fencing and construction of hunts is common.

1.4 The Gedeo

They live south of the Sidamo. They depend heavily on enset and meat. They rarely use dung an manure. Except for cabbage, other food crops play a modest part in their diet. Coffee is an important cash corp. Their place gives the impression of a large coffee-enset plantation.

2. Enset as a co-staple with cereals and tubers

In North west Sidamo (Wollaita), Gamo Gofa (Amarro and east and west Gamo Gofa tribes) and Keffa (Janjero, Keffa), enset shares its roles as a staple food with cereal and tuber crops.

2.1 The Wollaita

They live in Northwest Sidamo north of lack Abaya and between the Omo and Bilate rivers. They grow more crops than the Sidama and in different proportions. Enset covers only about one fifth of the cultivated area. They have a distinctive land use pattern around the homestead

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with coffee, vegetables enset planted nearby, inter-cropped plots of cereals, pulses and cabbage next and, finally, fields with pure stands of teff, careals, tubers etc. Manure is applied in distant fields as well.

In the most remote fields, crops are rotated and irregular fallowing is practiced. The inter-cropping practices are worthy of mention as well as the under-sowing of maize which serves as a shade crop for taro (colocasia esculenta). Ridging of Oromo potato is also practiced. Terracing is also quite common. Double cropping of barley below 2500 meters is also common in Wolayta.

2.2 The Amarro

They live on the east side of the Rift Valley on the steep mountains of the Amarro. Large terraces and fields surrounded by stone walls are found on the slopes. Manuring of enset and irrigation of taro and yam are practiced. Fallowing, crop rotation and double cropping of peas/beans followed by barely is common below 2300 meters.

2.3 The East Gamo Gofa People

They live on the Gamo highlands west of the Rift Valley. Besides enset and barely, Oromo potato (coleus edulis) is an important food crop which is not grown by ridging as in Wollaita but on beds constructed on land that has been fallowed for one or more years. The beds are divided by deep ditches which serve to collect runoff. The east Gamo Gofa consists of the following ether groups.

2.3.1. The Dorze

They inhabit east of Chencha. They use stone and earth terraces for the cultivation of wheat and barely which is double cropped. Green manure made from leaves of trees such as croton machrostachys and vermonia is applied in the fields. This technique may be called rudimentary agroforestry.

2.3.2. The Ochollo

They live in villages east of the Dorze and resemble the Konso in their conservation practices. Most fields are on stone terraces on the eastern escapement of the Gamo highlands and the use of both human and animal manure is common on fields of barley, wheat, maize, teff and Oromo

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potato. Enset is inter cropped with cabbage, grain, barely and flowers in homestead plots.

2.3.4. The Dita

They live in the central port of the Gamo highland south of the Dorze. Their enset plantations are smaller than that of the Dorze. Stone and earth terraces are common for the cultivation of barely, wheat and cabbage. Oromo potato is cultivated on land unsuitable for other crops alternating only with follow periods. Land permanently cultivated is intensively manured and irrigated. Arable land and pasture are strictly kept apart. They collect manure by keeping animals in stables on a bamboo gate above a deep pit into which dung falls.

2.3.5. The Janjero

They inhabit the are between the little Gibbe and Omo rivers. They cultivate a relatively stock of food plants in addition to enset. Mono culture is the rule except the horse beans and block peas which are inter crop period. Despite conservation measures like contour ploughting, drainage, step terracing, crop rotation, manuring and fallowing, extensive farming has led to serous erosion in Janjaro.

2.3.6. The Kaffa

They live south of the Gojeb river. Enset is a staple food cultivated near the homestead. Shifting cultivation is common for the cultivation of additional food crops. Crop and grass residues are burnt and ash is spread over the fields. Inter cropping of sorghum and beans is practiced.

2.3.7. The West Gamu Gofa tribes

They live in mountain of the Omo river near lake Rudolf. Above 1800 meters, the enset cultivating Basketto and Dime are found. The Basketto rely on manuring and fallowing to retain soil fertility. The Dime cultivate enset, taro, yam on large stone terraces. Taro and yam are inter-cropped while all other corps are grown on pure stands.

2.4. Enset not as a co-staple with tuber crops dominant and cereals of secondary importance

In this farming system enset has lost its role as a co-staple to tuber crops cereals are being neglected. This system is practice in Kefa among the Gimira tribes such as the Chako and

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Maji. These tribes live in West Keffa in a rain forest area. The Gimira agriculture hardly practise terracing, manuring, irrigation and crop rotation. Shifting cultivation is applied on a larger scale mainly with yam, taro and enset. The Maji, on the other hand, till the soil intensively and have established terraces for cultivation of yam, taro and enset.

2.5. Enset not a co-staple with cereals dominant and tubers of secondary importance

This farming system is common in Wellega, Illubabor and Keffa. There cereals are dominant but enset is also cultivated. Enset is relegated to the role of a garden crop along its tubers, pulses and other vegetables. Irrigation and terracing do not play an important role. The plough is the principal farm implement.

Chapter II

AGRICULTURAL POTENTIALS AND CONSTRAINTS: The socio cultural aspects

Southern Ethiopia peoples Regional Administration consists of 11 zonal administrative units. Physically it covers 13 percent (111,452 km^2) of the land of Ethiopia.

2.1. Agroforestry potentials of the Region

2.1.1 The Sidama and Gedeo zones with the Amaro and Burgi Woredas.

These are known for traditional farm forestry practices and individual woodlots of eucalyptus. Although agroforesty in its proper sense of the term (i.e. the practice of combining trees, in space or time, with herbaceous crops and/or animals on the same unit of land) is said to be uncommon in traditional Ethiopian agriculture, the indigenous tree-crop pattern observed in Sidamo and Dilla may be the closest to agroforesty. The multi-variety coffee-enset gardens near Dilla are one of the most important potentials. Farmers in these areas ensure that on their land they have trees which provide essential needs with respect to fuel, building poles, some fruit and shade for man, animals, and coffee.

2.1.2. The Gurage, Hadiya, Kembata and North Omo zones with Derashe and Konso Weresas

These are the other areas where agroforestry practices are deeprooted and woodlot of ecalyptus are found in most of the homesteads.

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The intensive enset farming systems in these areas are close to agroforestry systems as tubers and cereals are inter cropped with enset which clearly benefit from manure used for enset cultivation.

The large variety of trees found on the Knoso terraces are also agroforestry systems. Among the Konso a cabbage tree locally known as "Shiferaw" moringa stenopetala is a multi-purpose tree. Its leaves are edible and fruits are important for purifying water.

2.1.3. The areas of Dawro in North Omo, Kaficho, Bench and Shakicho

are rich in remnants of natural forest and are still potential areas for further conservation of agroforestry production. These shifting cultivators usually prefer to clear their fields adjacent to the older fields which are still being cultivated. A household never clears a new field alone, since all depend all the labour of neighbour-hood.

2.2. Some constraints for agroforestry in the region

2.2.1. Demographic pressure

Southern Ethiopia is the most densely populated region with around 400 - 500 persons per km. square. The remaining natural forest has increasingly been replaced by intensive agricultural land. In particular the population density in some enset growing region is about 8.6 times higher than the national average. As a result an individual's share of land is diminutive. An average size of land holding in 1982 in Chaha Woreda was 0.68 ha (MoA, 1984). In general, the enset culture area favors high fertility rate and the high carrying capacity of the enset plant when the share of individual land holding decreases, the participation in agroforestry practices may be frustrated.

2.2.2. Wealth distribution

Where economic differentiation is polarized and poverty is widespread, many impoverished households find it difficult to mobilize labour and other inputs for conservation purpose. When people are land starved, they are likely to experience environmental problems. short-term cash needs out-weigh conservation investments among the poor. The mobilization of labour for compensating the low level income with additional earnings from the livestock sector and/or off farm activities determines the level of participation in agroforestry.

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Although local people are well aware of the consequences of deforestation, their socio-economic priorities promote the cutting of trees, thus leading to the disappearance of the indigenous agroforestry system.

2.2.3. Market Linkage

The market situation for forest products is likely to change local resource use. Increased commercialization attracts outside entrepreneurs who are likely to have different set of interests and, in general, may be less concerned with resources conservation. Since the middle-men are the ones who usually determine the price, they can persuade local people to plant trees that are outside the components of he indigenous agroforestry system. Fore example, although eucalyptus offers farmers immediate income, it has become a devastating effect on the indigenous agroforestry system. The water requirement of eucalyptus is said to be extremely high that can deplete ground water for other crops.

2.2.4. Tenure insecurity

There is general agreement that tenure security is one determinant for farmers' willingness to make investment in land improvement. There are often uncertainties concerning the relations between individual's right to land and the claims of the state. Officially the state owns all rural land. On the other hand, the planting of trees by local farmers is traditionally perceived as a means whereby claims on land are articulated. The tree planter may claim a right to transfer the planted land to another person through sale and/or inheritance. In this situation farmers lack confidence in the capacity of the state to regulate resource use, creating ambiguities over who has legal access to trees.

2.2.5. Constraints related to infrastructure and politics

Lack of access to credit to repay loans is leading to the disappearance of indigenous agroforestry system. Prices for inputs and produce, the market infrastructure and services, agro-climatic condition, political instability and others are also likely to play important roles in participating in agroforestry.

2.2.6. Other Constraints

Other constraints are lack of legislation and legal frameworks which support local resource management, poor extension system which is usually administrated hierarchi-cally from the top,

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disseminating one-way messages from ministries. Extension agents are accountable to their superiors than to locally defined needs. Last but not least is the existence of a dependance syndrome in drought affected areas which inhibits the strategy of local initiative in agroforestry.

AGRICULTURAL POTENTIALS AND CONSTRAINTS: The Physical Aspects

The socio-economic constraints discussed above are further exacerbated by unfavourable physical problems. Unabated food, wood and feed shortages as well as resource base depletion characterize the region. Although the soils appear to be deep and fertile in most places most of them heve been leached and require heavy input. Slopes are steep and prone to erosion. The seemingly green vegetation, once cleared, disappears for good.

The core of the problem in this region as in the other parts of the country is destruction of the resource base --- productive land and natural resources (esp. forests) through time. The following table could depict this.

Type of the natural resource	A M C U N T			
	In 1500s		In mid 1900s	
	In 1000 Ha	%	In 1000 Ha	%
Forest	41200	34.8	8653	7.3
Arable land	76075.6	64.24	70210	59.3
Non agricultural land	72	0.06	38510	32.5
Water body	1051	0.9	1051	0.9
Total	118424	100	118424	100

Sources:

Compiled from FAO of the UN (1953) and Forestry and Wildlife Conservation and Development (1979)

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As described in the sections above, the already very small land holding is exacerbated by further fragmentation for various agricultural productions such as root crops, fruit trees, cereal crops, etc.

On top of that, lack of agricultural inputs such as agricultural knowledge, fertilizer, improved seed, herbicides, incsectcides, etc are common. These constraints could not enable farmers to overcome the land physical constraints such as soil depth, soil fertility and excessive slopes.

Chapter III

STATE AND QUALITY OF THE ENVIRONMENT IN THE SOUTHERN REGION

The forests of the southern region are largely broad leaved although in relatively smaller areas Podocarpus falcatus and Juniperus procera exist. Most of the remaining forests occur in Bonga forest, Bele forest, Ameya forest and Kolbu forest. The forests in Bulki and Malakoza are severely degraded. The ridges and mountain tops of the lower areas of the zone such as the Kibish, Muwi mountain chain, the Geleb and Hammer are mainly composed of the wooded grasslands, bush lands and scrubs as well as thorny scrubs. The cover of those lands is not satisfactory either.

Valleys of most of the southern regions are rich in their flora and fauna. Although it may be very difficult to utilize, there are valuable timber species such as Anningeria adolf fredrichii, Juniperus procera, Olea welwitschii, Cordia africana, Croton macrostachys, Syzigium guineense etc.

The agricultural landscapes depict various forms of tree planting especially Eucalyptus. Eucalyptus are planted in the form of boundary planting, woodlot and live fences. Unfortunately, because a large part of the areas get an annual rainfall of less than 1500 mm which is the optimal moisture requirement of Eucalyptus species, the undergrowth is hampered due to moisture shortage. To this effect, most of the lands that occur in lower slopes of the Eucalyptus woodlots are almost always badly eroded. Eucalyptus by the farm boundary are also in conflict with the adjoining cereal crops.

Degradation of bio-diversity, environmental damages due to extensive mining for gold, soda ash, silicate, etc. have a significant role in the region too. The land use conflict that resulted from the production interaction has been disadvantageous to tree cropping which usually has got a long gestation period.

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Management of trees for improved interaction such as planting at low stocking rate, identifying short and tall growing species as well as light demanding and shade tolerant species as they are suited to the type of interaction is very necessary. When so, it is necessary to know that the successes are introduced to the area under rehabilitation (say after mineral exploitation), as they are fitted in the vegetation succession. Trees /shrubs that are suited in these kinds of interaction would have to be decided as they are fit to the Agroclimatic zones of the areas under consideration.

ChapterIV

CONCEPTS AND DEFINITIONS

The conceptual understanding of forestry showed revolutionary change as of the mid 1970s. Depending on issue of emphasis through time, different definitions have evolved through time for each of the forestry terms as indicated below.

4:1 Definitions

A. Forestry

1. Forestry is a practical science with the objective of ensuring a sustained production of forest products and services to man kind.

2. The study of trees and forests

3. A profession embracing the science, business and care of creating, conserving and managing forests and forest land for the continuing use of their resources. (Ford-Robertson 1971).

From the above definition, three generalizations were drawn.

1. Forestry is what foresters have been learned to do.

2. Professional foresters know best what is best for forests.

3. Even omnipotent forests are in the best position to determine which forest mgt. practices are for the greater public interest. (Behan, 1966)

B. SOCIAL FORESTRY

1. A development strategy of professional foresters and other development organizations with the aim to increase active involvement of local people in forest

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management activities. (K. F. Wiersum, Wageningen Agricultural University.The Netherlands)

2. The use of socially sensitive strategies and techniques for the involvement of people in a community in implementing production oriented forest management systems. WSU.

C. FARM FORESTRY

Private tree production on farms. EFAP, 1993

D. COMMUNITY FORESTRY

1. A tree growing production oriented activity conducted with the purpose of providing forest products for the direct benefit of the local community that take part in the activity. (Community Forests and Soil Conservation and Development Department (Then))

2. It is a theory and practice of establishment, management and utilization of trees and forests that can serve purpose. (Azene Bekele-Tesemma (Unpublished).

3. Any forest management activities understand by rural people as part of their livelihood strategies. (K. F Wisrsum Washington State University)

F. AGROFORESTRY

1. Agroforestry is a type of land use system that successfully satisfies the crop farmer, the forestry/ or livestock framer. (Mr. Mafuru, Ministry of Agriculture, Lesotho)

2. Agroforestry denotes all activities in land utilization where the production of food goes hand-in-hand with the production of wood. (Seekiman Atmosodarye State Forest Corporation, Indonesia)

3. Agroforestry involves the combinations of systematic land use in space or time with either crops or animals production or both, in order to achieve a stable production system for the benefit of rural population. (G.Budowski, Centre Agronomic Tropical Costa Rica).

4. Agroforestry is a forestry-agriculture integrated land use system by which ecological (conservation) and economic (production)concerns are addressed simultaneously. (Azene Bekele-Tesemma, unpublished)

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5. Agroforestry is a collective name for land use systems and technologies in which woody perenials are deliberately combined on the same land management unit with herbaceous crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economic interactions among the different components. (ICRAF).

4.2. AGROFORESTRY SYSTEMS

A. Agri-silvi-culture - conscious and deliberate use of land for the concurrent production of agricultural crops and forest crops.

B. Silvi-pasture- a land use system where feed crops such as grasses and herbaceous legumes and combined with wood perennial.

C. Agri-silvi-pasture- A system in which land is managed for the concurrent production of agricultural and forest crops and for the rearing domesticated animals.
In effect, it a combination of agri-silvi-culture and silvi pasture.

D. Homestead

This AF land use system is a system in which many system complements such as herbs, trees grasses, etc. are packed in a coup hirer by especially by women prefer.

IN SUMMARY: Agroforestry is a land-use system where:

1. there is a deliberate association of forestry and agricultural components and,

2. healthy co-existence between the system components themselves and the land is secured and,

3. at least two outputs are to be obtained within a production cycle extending beyond one year and

4. the farm process is culturally compatible, technically simple, relatively more advantageous than mono-system within acceptable time zone, local problem solving to the farm owner.

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4.3 LIMITATIONS OF AGROFORESTRY

1. Establishing, protecting, and managing plants requires its own skill and consistency that the framers must learn repeatedly.
2. Needs more time to manage more than one crop.
3. Minimizing negative interaction and optimizing positive between various AF component needs research that the forms can not do easily.
4. Under farm situation, the farmer's primary objective limit the required stock.
5. Effectiveness of the measures depends on many attributes.
6. Some tree types and tree positions can exacerbate the erosion problem.

4.4 AGROFORESTRY AND ITS COMPONENT

Searching for better farming method has continued ever since man domesticated plants and animals at the birth of agricultural revolution. Agroforestry has become an important part of the new thrust to develop more sustainable land use to replace destructive techniques since the agricultural revolution.

Traditionally people produced a wide variety of food and other materials for their diverse needs and with more developmet, they began specializing in particular crops, specially cash crops and such cropping pattern led to single farming system.

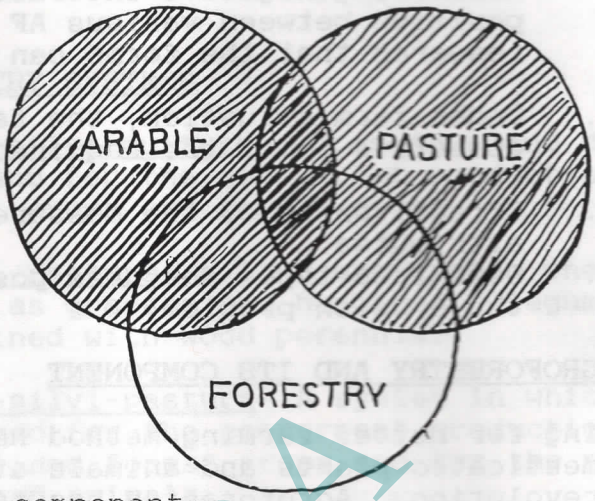
In addition to complete clearance of forest, the prevailing farming system is leading farmers to grow only few crops in mono-cultural. On the other hand, forest and agricultural professionals know and develop only a narrow portion of the life sciences. And Despite enormous effort made in developing agriculture for many years, the problem of land degradation, hunger and malnutrition continues to be a serious threat to the country.

Drawing from the wealth of knowledge of science on land management and ecology in integrated system for a sustainable production seems to be a practical option. Such new interdisciplinary approach of obtimizing system in ecological and economic sense, of short and long-term in farming is a sound approach in rural farming.

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On the surface of it, agroforestry may seem a simple amalgamation of farming and forestry. However, it encompasses other components of the natural resources and management in given time aspect.

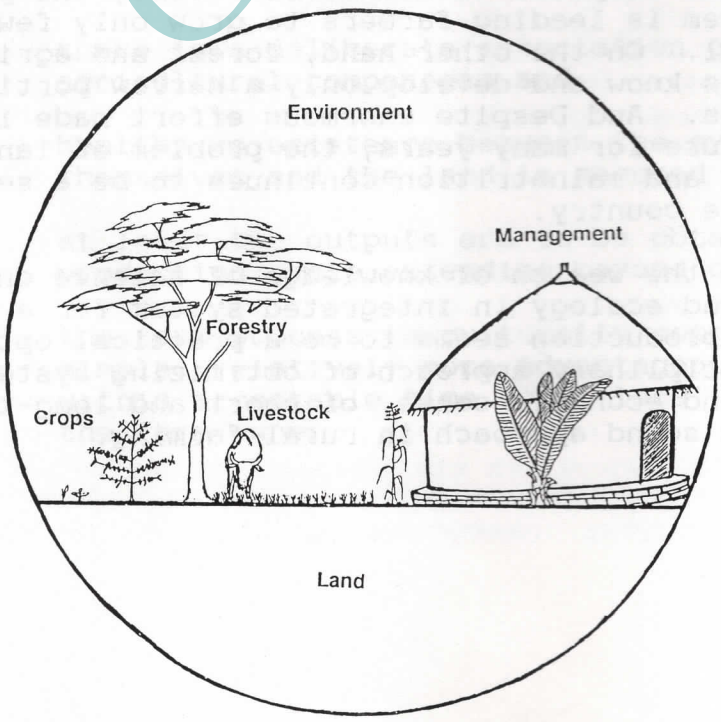
Simple Agroforestry Component in area term



Actaul Agroforestry component:-

The five major components from which agroforestry definition developed are the following.

- Land
- Environment
- Agriculture (livestock + crop) component
- Forestry component
- Management strategy



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The result of the complex interaction between the above five components of the system defines agroforestry system.

To select the appropriate agroforestry system that suits the farmers objectives, a number of the component may be varied in agroforestry.

The agroforestry system in Guragie highland is predominantly line planting of Eucalyptus tree for wind break in home garden, where the trees can ultimately be used for construction and fuel. In the Rift Valley on the other hand, intensive livestock farming is combined with maintaining of Acacia tortolis for livestock shade and ultimately for charcoal production for cash income.

The variation here is dictated by differences in land location, environmental factors, agricultural production system, socio-economic and Ethenological differences. The management system of the forest resources also varies accordingly.

4.4 GOAL AN OBJECTIVES OF AGROFORESTRY DEVELOPMENT

Considering farmers perspectives, it is obvious that they they are much more interested in short-term objectives. Trees growing is of necessity along-term investment and it is this basic contradiction that made tree farming less accepted/promoted by farmers than the other components of agriculture. However, such gap can be narrowed by looking into possibilities, like selection of fast growing, and short rotation trees and applying different management options. Mixing of trees with short time requiring components like crop farming and livestock will spread the risk over time as the tree intervention will imcrease production specially if selected on the basis of its complementarity.

Generally, a farmer introduces or retains a tree on his farm with the following direct objectives:

- For dodder and food production
- to development seed producing trees.
- for flowering for honey production
- as fruit tree
- Trees for fuel, construction and wood production
- for medicinal and essential oils etc.

Indirect (service role) objectives of agroforestry includes,

- Shade and shelter provision
- Boundary and life fence
- Erosion and salinity control
- worship and
- Water balance

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The goal/objectives of agroforestry can therefore be identified as:

a) Long term economic stability.
b) Complementary production
c) Environmental protection and control
d) Better use of marginal (poor) land

These will further be explained below:

a) Economic stability

In agroforestry system, direct production of tree products for varicus end uses is possible and this can form basis for the following cottage and other industries.

i) Wood products:- logs, veneer, fire wood, telegraph posts, chips, particle boards, poles for construction, farm and house-hold tools

ii) Food and fodder products, pods and leaves as food, and fodder

iii) Miscellaneous products: honey, essential oils, medicine

The above products demand strict conditions to be economically viable. These are:

- improved genetic stock for guaranteed yield
- quality site suited to the tree species
- well planned planting design
- Defined management practice for tending and harvesting
- transporting and marketing facilities with the economic reach.

b) Complementary production

Agroforestry systems are developed with the objective to complement rather than supplement to and/or compete with conventional agricultural enterprises on a farmer's farm. The complementarity is enhanced through efficient use of environmental resource (light, nutient, water etc) in improving production feed for livestock and crops for humans. Feed high nutritional value, protein rich tree foliage can be available to livestock in summer when the shortage is very critical.

c) Environmental protection

Tree planting or retaintion protects the environment and ameliorates the soil through:

- controlling soil erosion
- minimizing land degradation

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- preserving rural wild life
- stablizing exterme temperature etc.

d) Better use of poor land

Planting of the appropriate tree species can have positive effects and can be used to:

- reclaim saline proned land
- improve soil structure and drainage
- control weeds
- bring leached nutrient to surface (recycled)
- improve fertility status of the soil through nitrogen fixation

Out puts and benefits of agroforestry can be summarized as.

- tree planting in rows along contour stabilizing soils on slopes as a biological structure.
- agroforestry with a diversity of production has an advantage over other components of agriculture in being flexible form of land use.
- allows livestock and crop production on same unit of land without complete displacement.
- crop/fodder yield increase by complementary relationship etc,
- The major livestock production problem is the non-availability of feed particularly in the dry season. Agroforestry supplements an out-of-season fodder, in the form of green feed and protein rich supplement.

4.5 AGROFORESTRY ROLE IN THE LAND SCAPE

Tree configuration in agroforestry allows a mix of other plants of shallow rooted crops or pasture to grow with least problem. The trees generally play a deeper biological conservation role in less intense density in tree crop or tree-pasture mix.

In general, trees in the land-scape perform the following functions:

- when trees are planted/retained as wind break they reduce ground level wind velocity thereby reducing losses of soil moisture

- Reduce rain drop impact, thus reduceing detachment of soil particles which is the primary cause of soil erosion by water;

- Increase infiltration, reduce run off and surface erosion and subsequent reservoir siltation

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- Provision of high quantity organic matter supplied as leaf and bark litter promotes soil aggregation which in turn, decreases the susceptibility of the soil to erosion;
- Tree roots bind the soil together, strengthening and consolidating the immediate area reducing soil movement;
- From the environmental point of view, trees enhance the hydrological cycle
- Trees can combat salinity. The presence of deep rooted trees reduce saline water table down, while the removal of trees and replacement with shallow rooted crops or pasture will increase the volume of water recharge to the ground water which will results in raising salt to the furface and causes salinity.

CHAPTER V

TREE CROP INTERACTION

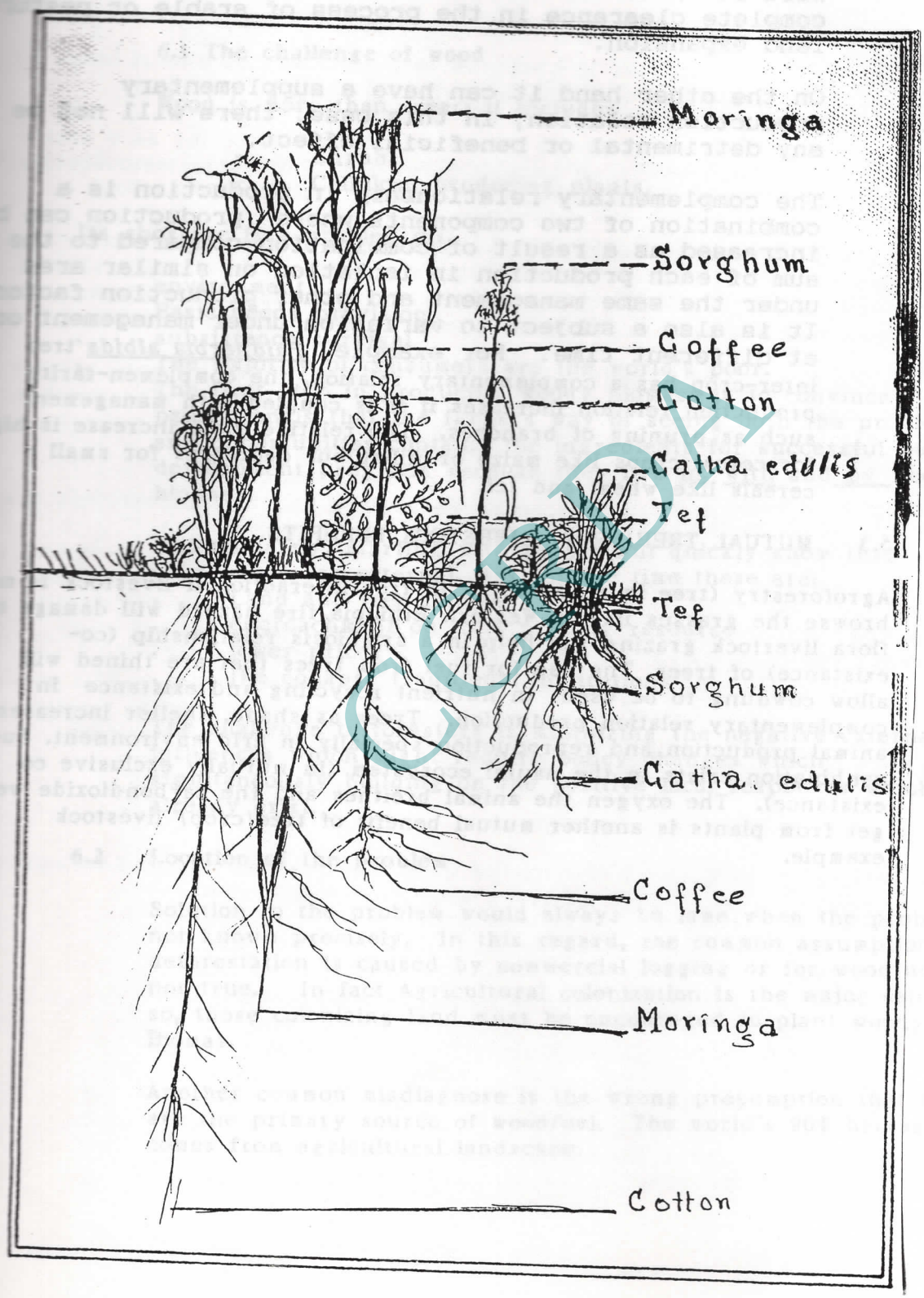
5.1 ZONE OF INTERACTION

The tree crop interaction can be horizontal or vertical. Utilization of resources for production in a complementary interaction relationship can be optimized by selection of the appropriate species to be combined or management practices that boosts the production of these components.

The Konso people practice an integrated agroforestry and soil conservation on terraced land in multi-storey system. This is a practice of long history and one of the advanced technologies in Ethiopia. They use the limited environmental resources both above and below ground in an optimal way. As they are mixing several crops of different canopy and root reach level, farmers produce better yield by mixing than planting each crop in mono-cropping practices.

The use of mixed cropping in intensive farming system both in above ground resource trapping and under ground mining, for yield optimization is illustrated in the following diagram.

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Multi-storey formation of mixed cropping

5.4 TYPES OF INTERACTION

- The production relations of any two component can be competitive directly or indirectly. For example, trees might have a detrimental effect by shading or harboring wild animals. As a result the tree can be subjected to complete clearance in the process of arable or pasture land expansion.

  On the other hand it can have a supplementary production relation, in this case, there will not be any detrimental or beneficial effect.

  The complementary relationship in production is a combination of two components where production can be increased as a result of combination compared to the sum of each production in isolation on similar area under the same management and other production factors. It is also a subject to variation under management or at different time. For example, *Faidherbia albida* tree inter-crop has a complementary relation, the complemen-tarity production relation increases if it is coupled with management such as pruning of branches. The relative yield increase is high for cereal crops like maize or millet but decreases for small cereals like wheat and tef.

5.3 MUTUAL TREE/CROP/ LIVESTOCK BENEFITS.

Agroforestry (tree in an open) or in tree interaction if livestock is not browse the grasses like in Western Ethiopia fire hazard will damage the flora livestock grazing will help in a symbiosis relationship (co-existance) of trees. The use for fuel from trees that are thined will allow cowdung to be used in nutrient recycling and existance in complementary relation production. Trees as shade, shelter increases animal production and reproduction specially in arid environment. Such canbination exists in the nautal ecosystem (in mutually exclusive co existance). The oxygen the animal breithes and the carbondioxide we get from plants is another mutual benefit of tree/crop/ livestock example.

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CHAPTER VI

AGROFORESTRY FOR FUELWOOD

SETTING THE SCENE

6.1 The challenge of wood

. Wood is more than trees; it includes

- Shrubs
- Cellulose producing plants.

Its shortage is a problem of:

. environment
. Basic needs provision
. subsistence survival
. The majority of consumers are the world's poor.
. The first step in producing woody biomass is to convince professionals that the farmers way of seeing both the problems and opportunities contains the ingredients for successful biomass development programs because they live in, with and by woody biomass.

Unfortunately, starting with people will quickly show that constraints are external. Most of the time these are:

. Land and tree tenure
. encroachment on local priority resource
. lower prices
. the collapse traditional institutions

The challenge to foresters is minimizing the negative external influences which might require policy changes which simultaneously building on the positive local responses which already exist.

6.2 Location of the problem

Solution to the problem would always be lame when the problem is not known precisely. In this regard, the common assumption that deforestation is caused by commercial logging or for woodfuel is not true. In fact Agricultural colonization is the major cause. If so, those colonizing land must be encouraged to plant woody Biomas.

Another common misdiagnose is the wrong presumption that forests are the primary source of woodfuel. The world's 90% biomass fuel comes from agricultural landscape.

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The notion that rural people fell trees for domestic energy use in again wrong. Woodfuel is a residue of the other end uses of wood in the local economy. In the farming system surveys of the author in the southern regions, most of the trees planted by the backyards are felled for addressing construction issues and then fuelwood demands. From the above stated facts it is possible to generalize that:

i. As biomass is produced and consumed at a local level, its use can only be understand at a local level.

ii. For rural people there can no be such thing as a single purpose tree; though rural people prefer certain species for a particular end use

Again, the biggest hurdle is that many rural development professionals pay little attention to the potential supporting role of trees/shrubs towards Crops, livestock and sustained environmental practices. Even foresters overlook anything that does not like a "real forest".

Extracting and developing timber at the fastest possible rate became number one goal and objective of forestry institutions. The southern region is no different. Many of the sawmills are exploiting the forests beyond the forest stock growth. Due to these facts,

- Antagonism between rural people and foresters grew.
- Foresters in many parts of the country including the Southern regions, assumed the role of police men, tax collectors, raising revenue from fines and cutting permits.

During 1950 to 1960s, even external donors such as FAO viewed forest as "essentially a wood producing unit ---- its treatment must be conditioned by the technological properties of its products for their industrial utilization".

6.3. Redefining interventions

The turning point came in the mid ps when the need for forest development in the agricultural landscapes became a must.

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The basis were:

1. The oil price hike in 1973 compelled the rural people to find alternative energy sources. For the people outside the forests, encouraging them to grow trees integrated within their farming systems become a solid means of tackling the problem.

2. Draughts of during and after 1968 - 1973 necessitated the development of trees not only in the forests but also in the agricultural landscape. The need to exploit the role of trees for environmental amelioration was realized.

Due to these obvious environmental and energy constraints of the rural poor and the potential of trees/shrubs and other cellulose producing vegetation in harnessing the problems, the 8th world forestry congress in 1978 took a theme of **"Forests and people."**

In 1978, FAO published a paper in rural development and forestry in which community forestry was defined as:

"Any situation which intimately involves local people in forestry activity."

The development embraced woodlot, forest products for local needs, growing of trees at farm level, processing of forest products at the household, artisan or small industry level. It excluded large scale industrial forestry and any other form of forestry that contributes to community development thought employment and wedges.

The world bank in the "Forestry Sector Policy Paper (1978) acknowledge that past approach to forestry had been inadequate and too narrowly to be of any real assistance in meeting the needs of both urban and the rural poor.

Despite the change in thinking and investment the failure rate was still unacceptably high due to the following reasons.

a. most rural development projects are organized according to sectors where each sector ignore land use system while the rural people have never seen forestry or tree plantation as a separate activity from the rest of their production activities. To this effect, a new approach to rural development became necessary. This new approach was an approach that starts from the existing entire production system and builds on the knowledge and skills of local people. Agroforestry is one potential approach.

b. Despite such rehitoric to the country foresters on the ground remained bound by their conventional approaches and scientific methods. In many cases the planning model remained "top-down". An approach that starts from the farmers became necessary.

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6.4. The Changing role of foresters.

Foresters have to work for and together with rural people. They are now expected to work with, not against local land use systems.

- in short they have to change from being forest managers to rural tree planting advisors.
- see comparative roles of traditional foresters as contrasted to social foresters.

6.5 Agroforestry for fuelwood production

Fuelwood continues to be the major energy source of Ethiopia with an overall annual consumption estimated at m/caput (Karamachandani 1989). According to UNDP-World Bank energy assessment study (1984), the estimated configuration of the final energy balance indicated that 93 % of the totall energy consumption is derived from biomass fuels. Fuelwood was estimated to represent 37 %, followed by animal dung 32 %, crop residue 23 % and charcoal about 1.3 %.

A more recent study by the Ethiopian National Energy Committee (1986), states that although the 94.5 % of the nations total energy comes from biomass sources, 77 % is derived from fuelwood and tree residues, animal dung 8 %, agricultural residue 7.7 %, charcoal 1.1 % while petrol and electricity constitute the balance. No separate balance is available for urban and rural sectors.

Even though there is no region where the production surpasses the energy demand, there is also a problem of mismatch between the production and consumption areas. Three fourth of the country's total resource base is located on the 1/3 of the land surface. The remaining 2/3 contributing only a quarter of the total woody biomass. The same is true to the Southern regions. There are few areas of large resource base while the majority of the areas have acute shortages.

The need in the agricultural landscapes (rural areas) is estimated to be 2.5 times the availability. The following generalization has been made in various energy studies.

1. depletion of forests far exceeds their annual growth leading to total forest resource base depletion.

2. 160,000 - 200,000 ha is deforested annually for expansion of food crops and cash crops leading to biodiversity depletion and land degradation.

3. The annual soil loss due to devegetation and land degradation at 1 billion tons 10 % of which is carried away irritriveably by streams.

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The inter relationship between deforestation and land degradation in the agricultural landscapes compels that conservation-based forest development be initiated. This would be effective if planning and implementation are executed at a micro-level with full involvement of the local people.

The concepts of tree planting should change from plantation to fields and from forests to trees. Trees and shrubs for food fodder and fuel within the cropping system should flourish. A vegetative cover of crops, fodder and tree species combination shall be rapidly adopted in all agricultural production systems. Grater weight would have to be given to the integration of rural needs for fuelwood within a wider framework of multipurpose land use and farming system development.

CHAPTER VII

POTENTIAL OF AGROFORESTRY FOR SOIL CONSERVATION

Most agroforestry practices involve both multi-purpose plant species and multi-species plantations. The effectiveness of agroforestry systems in soil conservation emanates from the aggregations of species in a given land use. The aggregate of woody perennial in the mid to upper storey and none woody components in the lower storey provides un effective barrier to erosive forces.

There is substantial circumstantial evidence that supports the effectiveness of agroforestry systems for soil conservation. According to Raintree (1986), if multi-purpose species are properly selected, arranged and managed with respect to adjoining crops, they can offer micro-climatic benefits such as windbreak effects and reduced evaporation. Researchers such as Wiersum (1984), Nair (1986), Sheng (1982), have indicated that tree-crop culture has high potential for sustaining land by serving as a conservation tool.

Though specific researches need to be conducted to quantify the extent of the potential of a given agroforestry intervention for erosion control,, the role in general can be understood by examining its possible functions within each variable of the soil loss equation due to water erosion ad wind erosion.

A. The potential for Controlling Water Erosion

According to Wischmejer and Smith (1978), the Universal Soil Loss Equation can be explained in terms of six variables as indicated below.

$$A = RKLSCP \quad \text{---------- (1)}$$

Where:

A = Total soil eroded in metric tons/ha
R = Rainfall erosivity factor in MJ/ha mm
K = Soil erodibility

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L = Slope length
S = Slope percentage (gradient)
C = Cropping management
P = Conservation Practice

In all but, L and S, agroforestry plays a lessening role. The 'R' values depend on the kinetic energy of the raindrops and intensity of rainfall.

Kinetic energy of rainfall that can be expanded to detach the soil is again dependant on the velocity of the fall which in turn is dependant on the distance of the fall.

Land that is treated by agroforestry systems, in which grasses or food crops are overtopped by multistory trees, will be protected better due to the reduction in the height of fall. the multi-storied plant aggregates of the agroforestry system will dissipate the energy of the raindrop layer which otherwise could have reached the ground at a terminal velocity. If we grow non perennial food crops alone, the physical obstruction by canopy layer would not be possible as the crops will be harvested seasonally leaving the ground unprotected during most of the heavy rains.

The effect of agroforestry components in reducing the erosive force of rainfall can be better understood from the gravitational potential energy equation presented by Hillel.

$$Eg = mgz \quad \text{---------- (2)}$$

Where:

Eg = Potential energy
M = mass
g = acceleration due to gravity
z = height above reference level

When the distance of the fall 'z' gets shorter and shorter, the erosive energy of the raindrops is reduced. Due to this reduction of energy, the beating and churning force of the raindrops will be less strong to shatter the soil clods and soil crumbs and to compact them into an impervious layer. By then, the detachment will be reduced and the impediment of infiltration avoided.

Another factor that contributes to soil loss due to rainfall erosion is the vulnerability of the soil (k) when subjected to the erosive rainfall. Soil erodibility factor "k" is equated by Romkens (1985) as:

$$K = \frac{2.1 \times 10^{-4} (12-a) M^{1.14} + 3.25 (b-2) + 2.5 (c-3}{100} \ldots (2)$$

Where:

a = Present of organic matter
M = Particle size parameter = % new silt (100-% clay)
b = Soil structure code
c = Soil permeability class

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Resistance of the soil against the erosive force is highly dependent on the amount of soil organic matter. The higher the organic matter the better the flocculation and moisture absorption of the soil particles will be. In addition to absorbing the water which might have contributed to run off, the organic matter improves the soil structure thereby giving it better resistance against the erosive force.

As it can easily be understood from 'Equation 2' presented above erodibility decreases until profile permeability class becomes >3. When trees and shrubs are introduced to cultivated lands and grasslands that have only shallow-rooted plants, profile permeability of the soil will get improved by deeply penetrating roots of the woody perennial. This will keep the class low.

In almost all forestry-agriculture integrated land use systems traditionally adapted in Ethiopia, the weak branch and leafy components are either cut for feed or used for mulch and green manuring. Recently, such components are being used for preparing compost. All these usages add up to the increment of organic matter in the soil thereby lessening the Soil Erodibility 'k' value.

Another contributor to soil loss is the cover factor (c). As pointed out by Wischmeier and Smith (1978), the combined effect of cover and cropping management on soil erosion is inter-related. Ploughing intensity, type of management, the length of rotation period, the intensity of grazing allowed on a certain pasture, have profound effects on the extent of soil erosion.

Moreover, in countries such as Ethiopia, where the arable land is limited, and where irrigation and fertilization are not well adopted, there is no land to spare for fallow. Instead, lands will have to be cultivated repeatedly and grazed intensively. All these reduce the soil cover.

Frequently, mono cropping farms are exposed to heavy rainstorms and strong heat, before and after the growing season respectively. During these times, there is virtually no protective cover available. Even in areas where grazing lands prevail, soil erosion is caused by over grazing. It is one of the most important problems. With less nutritious forage available the total livestock population consuming the soil cover in Ethiopia number over 75 million (EIU, 1984)

To address these multi-needs, having different forms of agroforestry systems by which woody perennial can be introduced into the cultivated lands and produce more nutritious fodder grasses and browses on grazing lands will have two major purposes. It can maximize cover by maximizing vegetation cover and it can avoid over-grazing by facilitating more feed to livestock. This is why many soil conservation practitioners are advocating agroforestry as an effective tool in remedying the soil erosion problem from various angles.

The last but not least factor in the universal soil loss equation is the conservation practice (p). Even in this context, agroforestry may play a significant role. Whenever slopping land is to be cultivated, the protection

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offered by sod or close-growing crops need to be supported by contour tillage, strip cropping, mixed cropping, mulching and by having stabilized terraces, check-dams, as well as shelter-belts. All these support practices will be easily implemented through the adoption of agroforestry systems.

B. The Potential for Controlling Wind Erosion

The second major soil erosion agent, mainly in the low lands of Ethiopia, is wind. The severity of wind erosion in the lowlands stems from:

1. limited vegetation growth that would serve as a wind barrier
2. intensive livestock grazing by excess number of cattle, sheep, goats and equines
3. relatively wide and smooth topography
4. dry, loose and fine textured alluvial and colluvial deposit soils, and
5. arid climatic conditions that discourage vegetation growth, but facilitate soil wind blow.

Due to these specific characteristics of the lowlands of Ethiopia, a wind erosion soil loss equation that represents the Ethiopian condition may be the one adopted by Chepil (1959) and presented by Zachar (1982) as;

$$E = IRKFBWD \quad \text{---------- (4)}$$

Where:

I = Soil clodiness factor
R = crop residue factor
K = ridge roughness factor
F = Soil arability factor
B = Wind break factor
W = Field width factor and
D = The wind direction factor

When we express the wide erosion in terms of the above seven variables and evaluate the erosion control potential of agroforestry systems in the light of these same variables agroforestry indeed appears to be one of the best solutions to overcome the problem. As indicated earlier, through an efficient use of agroforestry system, it is easy to add the soil organic matter that helps the soil to flocculate better. This itself will have a significant role in the soil cloudiness factor 'I'. The addition of organic matter to the soil can be made possible by mulching, manuring and decay of roots of the various components of the system. Since the system also tries to maximize wood fuel and fodder, the crop residue produced on crop field will not be consumed for feed and fuelwood. This again affects the crop residue factor 'R' passively.

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Shrubs and trees

wind break.

any type of barrier for protection from winds. It is more commonly associated with mechanical or vegetative to arrivers for buildings, gardens, orchards, and feed lot

shelter belt

A longer barrier than a wind break, that usually consists of shrubs and trees with an intention of soil and moisture conservation and protection of field crops, shelter belts must be moderately dense from the ground to tree tops if they are to be effective in filtering the wind and lifting it from the surface.

Since the wind velocity at the end of the belt is as much as 20% greater than velocities in the open, it in evident that long shelter belts are more effective than short ones.

An opening or break in an otherwise continuous belt results in a similar increase in velocity and will reduce the area protected. Roads through shelter belts should voided, and when essential they should be curved.

In establishing the direction of shelter belts records of wind direction and velocity, particularly during vulnerable seasons, should be considered, and the barrier should be oriented as nearly as possible at right angle to the prevailing direction of wind.

The distance of full protection from wind/spacing of shelter belts/ could be calculated from

$$d = 17\, h(Vm/v) \cos 0$$

Where

d	=	distance of full protection
h	=	height of the barrier in the same unit as "d"
Vm	=	minimum wind velocity at a 15 m height required to move the most erodible soil fraction (distance/time)
V	=	actual wind velocity at 15 - m height
0	=	the angle of deviation of prevailing wind direction from the perpendicular to the wind break.

The basic rational for having agroforestry as a land use option is because there is a need for securing rural development efforts by a land use that combines short-term measures that may insure human survival with long-term measures that can conserve the resource base -- land, for sustained production.

Having woody perennial on all land use types when applying agroforestry systems is one of the techniques by which we can increase ridge roughness on flat lowlands of Ethiopia. This could be made possible when hedge row inter croppings are exercised or when wind breaks and shelter belts are built or scattered trees incorporated within the grazing or cultivated land. By creating such obstructions on flat lands we can also affect the ridge roughness factor 'K' positively.

By introducing nitrogen fixing, mulch rich, and easily decomposing trees or leguminous shrubs, we are maximizing the arability of the land which is again reflected by the soil loss equation due to wind by factor 'F'.

The same applies to wind break factor 'B' field width factor 'W' and the wind direction factor 'D' effects. When trees and shrubs are properly selected, arranged, and managed in the tree cop interface they serve the above stated purposes. Having wind breaks at a given interval will reduce the field width which is not protected from wind. To some extent, wind breaks and hedge rows as well as trees planted in alleys can change the wind direction and lessen its eroding force.

i. Controlling wind velocities

Vegetation is generally the most effective means of mind erosion control.

Cultivated Crops

Close-growing crops are more effective to erosion control than are intertilled crops. The effectiveness of crops is dependent upon.

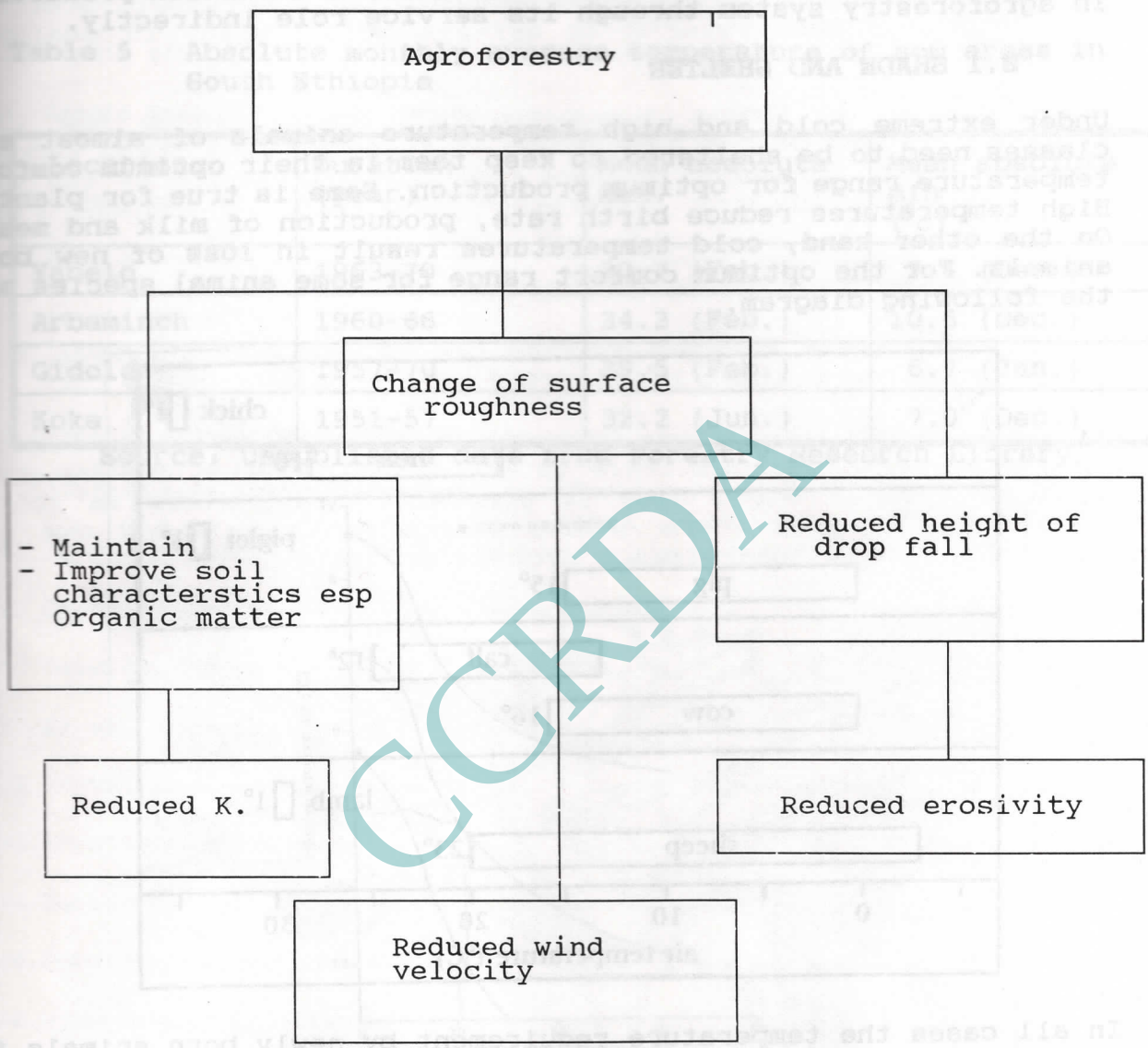
- Stage of growth
- Density of cover (mostly during critical periods)
- Raw direction
- Width of raws
- Kind of crop and
- Climatic conditions.

Vegetation used should have the ability to

- Grow on sandy soil
- Grow in the open

and firmness against the wind and long life. It should also provide a dense cover during critical seasons, provide as uniform and obstruction to the wind as possible, reduce the surface wind velocity, and form an abundance of crop residue.

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Agroforestry
Change of surface roughness
- Maintain
- Improve soil characterstics esp Organic matter
Reduced height of drop fall
Reduced K.
Reduced erosivity
Reduced wind velocity

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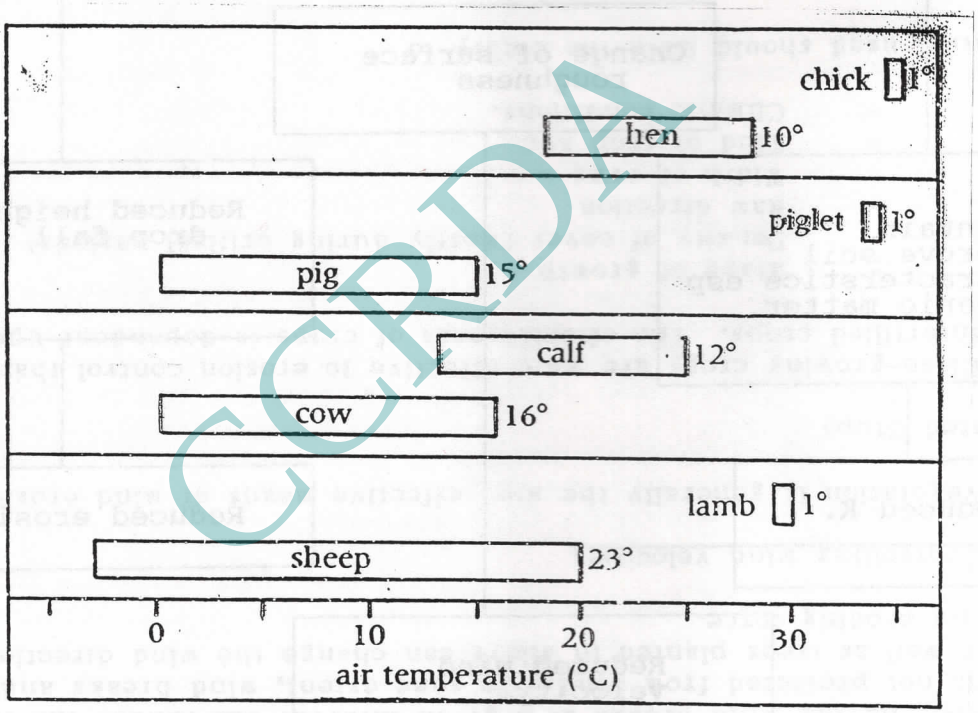
CHAPTER VIII

AGROFORESTRY FOR LIVESTOCK PRODUCTION

In agroforestry, combining perenial trees have an important role as feed directly and contribution in sustainable livestock production in agroforestry system through its service role indirectly.

8.1 SHADE AND SHELTER

Under extreme cold and high temperature animals of almost all classes need to be sheltered to keep them in their optimum comfort temperature range for optimum production. Same is true for plants. High temperatures reduce birth rate, production of milk and meat. On the other hand, cold temperatures result in loss of new born animals. For the optimum comfort range for some animal species see the following diagram.



In all cases the temperature requirement by newly born animals is elevated with a very narrow range. Therefore, their housing or shelter requirement need to be designed in such a way that it can keep them in the required temperature ranges. In order to provide good shelter for animals the right species selection for shade or manipulation of the canopy to obtain the right density of porosity level to control both direct sun light and controlling wind to avoid chilling are the most important.

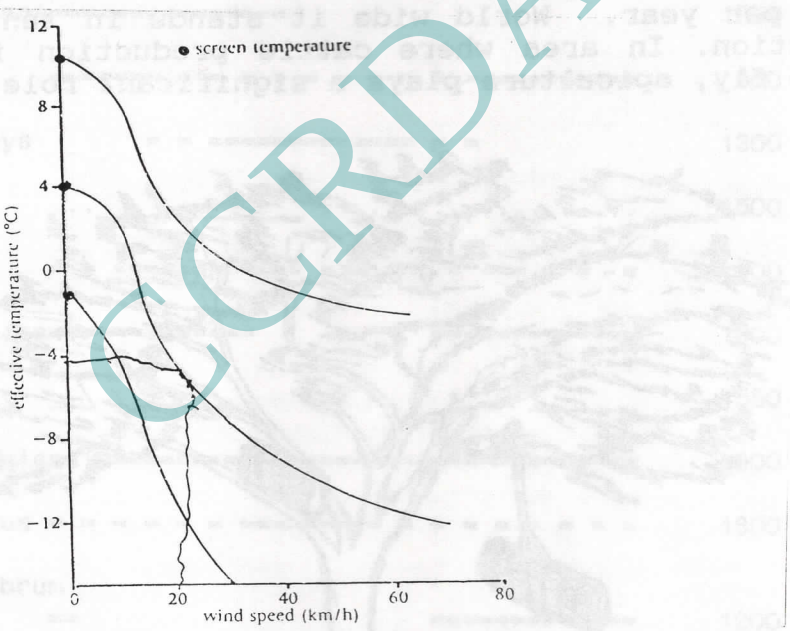
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Wind decreases effective temperature. A temperature of 4 dergee centigrade when the wind is still, corresponds to an effective temperature of minus 4 degree centrigradeas felt by the animal if wind blows at modest speed of 20 km per hour. To compensate the high energy loss resulting from this cold, the animal has to eat more.

Table 5 Absolute monthly average temperature of som areas in South Ethiopia

Location	Duration (year)	Mean absolute max.	Mean absolute min (^{0}c)
Yabelo	1963-70	30.7 (Feb.)	7.6 (Dec.)
Arbaminch	1960-66	34.3 (Feb.)	10.5 (Dec.)
Gidole	1957-70	29.5 (Feb.)	6.7 (Jan.)
Koka	1951-57	32.2 (Jun.)	7.0 (Dec.)

Source: Unpublished date from Forestry Research Library



In a mixed farming system, scattered trees have multiple uses both in pasture and arable land. Acacia species are the most popular shade trees in Ethiopia. The form of their canopy is predominantly an umberella-shaped.

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8.2 IMPORTANCE OF TREES AS FODDER, BROWSE AND THEIR ROLE IN GRAZING PATTERN

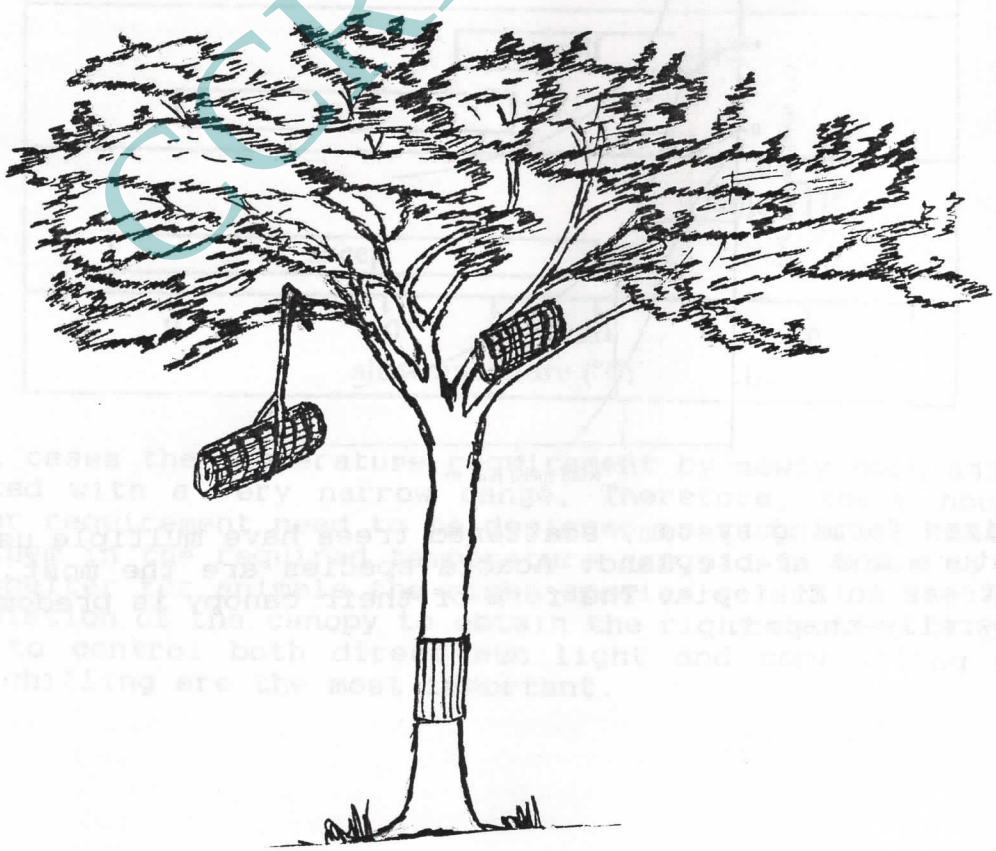
Trees are perenial and deep rooted compared to grasses and crops. Most trees retain their green leaves in dry seasons as they have access to resources like ground water in dry seasons. Incorporating trees into the farming system therefore complements grazing by providing fodder reserve to off-set deficiencies in pasture supply.

The inclusion of fodder trees in the farming system has the advantage throughout the year. Even if in some cases trees reduce pasture growth, it should be more than compensated for by the all year round availability of fresh green feed of protein rich sources.

8.3 HONEY PRODUCTION (APICULTURE)

Ethiopia has three to five million bee colonies which makes the country with the highest bee density in Africa.

It is the fourth largest wax producing country after China, Mexico and Turkey. The total estimate is about two thousand one hundred tones per year. World wide it stands in tenth place in honey production. In area where cattle production is limited due to tsetse fly, apiculture plays a significant role.



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Recommended species	Flowering period J F M A M J J A S O N D	Altit. in m.s.s.l Altitude in
1. Acacia abyssinica	==========	1500 - 2900
2. Acacia albida	==========	500 - 2600
3. Acacia tortilis (Subsp. sprocarpa)	==========	600 - 1900
4. Acacia persiciflora	=========	
5. Acacia seyal	=== ==========	500 - 2300
Acacia polyacanta Subsp. campy/acantha	======	
6. Albizia gummifera	==========	1550 - 2150
7. Albizia schimperiana	==========	1550 - 2800
8. Cordia africana	======= = = = = = = = = ==========	550 - 2600
9. Croton macrostachys	= = ========== = =	1300 - 2700
10. Dovyalis caffra	..._____	1500 - 2600
11. Ehretia cymosa	= = ========== = = = = = = = = = =	500 - 2700
12. Erythrina abyssinica	========== ==========	1000 - 2800
13. Erythrina brucei	___ _____	1550 - 2800
14. Eucalyptus camaldulensis	==========	900 - 2400
15. Eucalyptus globulus	= = = = = = ======= = = = = = = = = =	1800 - 3200
16. Euphorbia candelibrum	== ==========	1200 - 1900
17. Euphorbia tirucalli	= = = = = = = = = = = = = = = = = =	1300 - 2000

Note:-

========== Pollen and nectar are collected frequently

= = = = = = = = Pollen and nectar collected less frequently

_____ Either pollen or nectar

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Chapter IX

DIAGNOSTIC TECHNIQUES FOR AGROFORESTRY DEVELOPMENT

9.1 Pre-diagnosis

The success in agroforestry design and implementation is critically dependent on the diagnosis work. It is just like the analogy of a medical expert. If a sick individual is not properly diagnosed for the specific disease he or she has, the drug prescribed and the dose specified may not cure the patient or even it may worsen the case. According to Angles (1990),, if information is wrong to begin with,, no amount of statistical manipulation will enable it to help the project staff make good decisions. Hence, creating thrust between the one conducting the diagnosis and the information source very essential and would determine the truth of the information. This is why Pre-diagnostic works for effective involvement of development professionals successful diagnosis needs to be exercised as a step by itself.

In Pre-diagnosis works, various methods could one enable to be thrust worthy person. Approaching the community through selected and very few influential in the community showing relaxing and community-domain films and filmstrips would be helpful. Though it most often depends on individual's talent, associating oneself with the community members as much as possible need to considered.

9.2. Social diagnostic Techniques

PRA / RRA methodologies, Questionnaire Interview and On-farm Discussions are few of the social diagnostic measures in diagnosing social capabilities and constraints for agroforestry development

RRA refers to an intensive study and research approach which enables a multi-disciplinary team of 'outsiders' to rapidly collect and asses less comprehensive, but more appropriate data concerning rural areas and communities with degrees of participation by the community.

PRA refers to an intensive study and research approach which uses methods such as participatory mapping, transect walk and matrix ranking to enable rural people to present share and analyze their knowledge of life and conditions to plan locally and to implement projects which meet their own identified needs. The rise and growth of the participatory approach through time is presented by the following table.

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The Rise of Participatory Methods

Time -> Approach	1950 -> 1960s	1970s -> 1980s	mid 1980 -> 1990s
Paradigm	Modernization	Basic needs	Sustainability
Problem	rural Backwardness and farmer ignorance	farm level constraints and bottlenecks	technology does not fit
Prescription	formal extension	remove constraints for beneficiaries	participation of beneficiaries
Key activities "experts"	teaching and directing solutions	teaching and directing context-based solution	facilitating local solutions for local problems
Goal	adoption	adoption	community-directed learning
Frontier	modern often mechanized agriculture	appropriate agriculture	community-based planning and implementation
Methods	transfer of technology, green revolution and lead farmers	farming systems research and extension (FSR & E)	rapid rural appraisal (RRA) participatory rural appraisal (PRA)
from... rigid, formal and expert-client based to... participatory, relaxed, sharing and learning			

The Protocol SSI

- every team member can complete her questions on a sub-topic before moving on
- interruptions or corrections by other team member should minimal
- every team member should take notes to prevent bias - only one interpretation
- do not lead the discussion with questions that indicate preferred answers
- have the discussion on their territory
- ensure the diversity of the group or interview multiple groups
- don't look too official

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. probe - who ? what ? where ? when ? why ?
. don't go over time limit - max 2 hrs/group; 1hr/individual

Common Errors

. failure to listen closely
. failure to catch verbal clues
. repeating questions
. failing to problem - answers to yes/no questions are not answers!
. failure to judge the answers
. asking vague, insensitive or leading questions

Conclusion and Cautionary Notes

- find the right team (include women, multi disciplinary)
- going too quickly won't achieve the rapport needed for good RRA/PRA
- don not try to quantify everything
- false security of a rigid questionnaire
- not spending the time to identify the targets (poorest, women), information needs and right questions - appropriate imprecision
- leading questions
- not getting the full picture - optimal ignorance
- lecturing rather than listening
- imposing our categories and ideas
- right attitudes and behavior are the keys to success
- get out and try it!

How to do Participatory Mapping

1. with team and target group decide what sort of map to do (village area, watershed, Willag social map, grazing areas)

2. find people who know and who are willing to share their knowledge

3. choose a suitable place and medium (overlooking the village, valley, in the home of key informant)

4. use a medium that is appropriate (sticks, stones, leaves, flowers on ground, or paper mapping with markers or pencils for literate)

5. help people get started by letting them do it ! - be patient, it is their map.

6. sit back and watch or go away to let the process take over

7. keep a permanent paper record including villagers' names

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8. use the map to focus a semi-structured discussion or ranking activity.

How to do a Transect

1. find local people who are knowledgeable and willing to walk the transect

2. discuss with them aspects to be noted (soils, erosion, landslides, forests, crops, housing, health.....)

3. assign tasks in the team for observation and note taking
4. walk the transect, discuss critical issues, note contests and identify zones of land use

5. don't rush - a good transect may take all day

6. compile field notes and as a group draw the transect diagram, integrating the analysis of problems and opportunities

How to do a Matrix Ranking

1. with the village group decide what should be ranked
2. decide which types should be ranked (species, measures, practices)

3. develop criteria by asking group what is good or bad about each thing
4. determine which criteria are the most important

5. each member of the group is then asked to rank the usefulness or impact of each thing based on the criteria developed using local counters such as coffee beans, maize kernels, pebbles...
   1 = little use; 5 = high use

6. determine which things are wishes and which are realistic

7. keep detailed notes of how farmers arrive at their decisions/ allow no interference or goading

8. take a picture of the matrix or reproduce it for later analysis

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Good PRA/RRA requires ...

behavior and attitudes

- ask, listen, learn
- use your own best judgements at all times
- embrace error
- start, stumble, self-correct

Methods

- they map, model, rank
- we listen, learn support triangulate, disseminate

sharing

- villager and "expert" share knowledge and experience
- mutual goal setting & achievement

The "KEYS" Reviewed and Critically Assessed

The reversals of attitude and action that are needed

Closed	---------->	Open
Individual	---------->	group
Verbal	---------->	visual
Counting	---------->	comparing
Separation	---------->	rapore
Definition	---------->	description
Tedium	---------->	fun

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RRA vs. PRA

RRA -> people-based, outsider driven- planners continue to plan, but with more accurate, timely and reliable data.

PRA -> people-based, people driven - planners facilitate planning, people own and control their own information.

RRA and PRA Approaches

	RRA	PRA
dominant mode of operation	extractive	participatory
information owned by	study team	local people or community
role of study team	investigator	facilitator catalyst

Validity of Written questionnaire interview , PRA, RRA and On-farm discussion methods in diagnosing the intrinsic issues of socially stratified farmers of Ethiopia are would be presented on supplementary handouts.

9.3 SITE CONDITION ASSESSMENTS

Site diagnosis in agroforestry could be conducted by considering the factors that are used to rate the quality of the land by the farmers themselves. The most common factors are soil depth, fertility and slope of the land.

1. Identify the land capability class by noting *

   - slope range
   - soil depth
   - past erosion
   - rock out crop

- Class I - IV
  - Agri-silvi-culture
  - Agri-silvi-pasture
  - Homestead plastic

- Class V - VII
  - Silvi-pasture
  - Homestead Plastic
  - Agri-silvi-culture

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2. Identify the Agroclimatic Zone.

- Attitudinal range
- Precipitation amount
- major crops/forest and
- List possible species

. Agroclimatic zone identification

- farmer-level terrain classification and modeling techniques
- Farmer-level soil depth assessment and vegetation alignments
- Farmer-level soil fertility assessment and land appropriations
- Composite use of slope, fertility and soil depth ratings for relative land capability assessment
- Local technologies that could be used to overcome land limitations in soil depth, fertility and land terrain.
- Land capability analysis using the USDA-FAO hybrid method

IDEAL AF DEVELOPMENT APPROACH

Identify the farm owner's need

Identify site constraints and potentials

Work on species kind and completion

Avoid human hesitance

Minimize site constraint

.Prescribe the ideal establishment, mgt, and utilization techniques.

.monitor and improve

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SOILS/LANDFORMS DESCRIPTION FORM

Watershed:	Agroclimatic Zone	No of Observation	Aerial Photo. No.
Wereda	Present Land Use	Auger	Soil Un... ol
Awraja		Gully	L.E-W...
Zone	Parent Material	Road Cut	O.T.....
Altitude		Pit	
Rainfall	Major Landform	Observer	Land Class Unit
		Date	

INFORMATIONS NEED FOR LAND CLASSIFICATION

SLOPE (L)

0-2 %	L1 ☐
2-8 %	L2 ☐
8-15 %	L3 ☐
15-30 %	L4 ☐
30-50 %	L5 ☐
> 50 %	L6 ☐

PAST EROSION (E)

None	E0 ☐
Slight	E1 ☐
Moderate	E2 ☐
Severe	E3 ☐
Very Severe	E4 ☐

WATERLOGGING (W)

None	W0 ☐
Intermittently waterlog.	W1 ☐
Regularly waterlogged	W2 ☐
Swamps	W3 ☐

INFILTRATION (I)

Good	I0 ☐
Moderate	I1 ☐
Poor	I2 ☐

STONINESS OR ROCKINESS (S)

< 15 %	S0 ☐
15-30 %	S1 ☐
30-50 %	S2 ☐
50-90 %	S3 ☐
> 90 %	S4 ☐

Size ..... cm.

SOIL DEPTH (D)

> 150 cm	D1 ☐
100-150 cm	D2 ☐
50-100 cm	D3 ☐
25-50 cm	D4 ☐
< 25 cm	D5 ☐

TEXTURE (T)

Sand	T1 ☐
Sandy loam	T2 ☐
Loam	T3 ☐
Silt loam	T4 ☐
Clay loam	T5 ☐
Silt clay, clay	T6 ☐
Heavy clay	T7 ☐

ADDITIONAL INFORMATIONS (Optional)

pH	(R)	SALINITY (A) (Only for dry areas)	
< 5	R1 ☐	4 mmhos	A0 ☐
5-6.5	R2 ☐	4-8 "	A1 ☐
6.5-7.5	R0 ☐	8-15"	A2 ☐
7.5-8.5	R3 ☐	> 15"	A3 ☐
> 8.5	R4 ☐		

CARBONATES

Effervecence to HCL: Yes ☐ No ☐
if yes add * to R.

DOMINANT COLOUR

Black ☐ Brown ☐ Red ☐
Yellow ☐ Grey ☐ W...

LAND CLASSIFICATION TABLE

LIMITING FACTOR	RANGE OF CODES PERMITED IN THE COLUMN								
Slope (L)	1	2	3	4	1-4	5	6	1-6	1-6
Soil depth (D)	1	1-2	1-2	1-3	1-4	1-3	1-4	1-5	1-5
Past erosion (E)	0	0	0-1	0-2	0-2		0-3	0-4	0-4
Topsoil Texture(T)	3-5	3-6	3-7	2-7	2-7		2-7	1-7	1-7
Waterlogging (W)	0	0	0-1	0-2	0-2		0-2	0-3	0-3
Infiltration (I)	0	0	0-1	0-2	0-2		0-2	0-2	0-2
Surface stoniness or rockiness (S)	0	0-1	0-2	0-2	0-3		0-3	0-4	0-4
SOIL CONSERVATION REQUIREMENT CLASS	I	II	III	IV	VI		VII	VIII	V
	Land suitable for annual crops				Land suitable for grazing or perennial crops		Land suitable for forestry	Land not suitable for agriculture	Swampy areas, riverbeds

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9.4 SITE SELECTION

It is a matching of a given site to an appropriate agroforestry species. In matching species to a sites, a broad climatic zone should be identified. These are classified from subtropical humid to arid climate. Secondly matching of the local conditions like altitude, slope, soil types, local climate are important information of the site on which agroforestry trees are planted. The other step is identification of the detailed environmental requirements of the selected agroforestry tree. It is matching of species to site and site to species that determines the suitability of species to site or site to the species.

9.5 SPECIES SELECTION IN AGROFORESTRY

In agroforestry species are selected on the basis of their combined potential characteristics (genotiphic and phenotiphic) in fulfilling the required characteristics in its direct or indirect role in agroforestry farming system.

Characteristics of a tree important in agroforestry are the following.

a) Adaptability

Native trees in a site of its natural state can be assumed that the species can be perfectly adopted to that environment. Existing native trees are the best guide in selecting the adoptable tree species to the site. This does not, however, mean that the tree will meet the conditions required in farmers objectives.

Most of the trees can be shown to be relatively unproductive in their natural environment. However, manipulation of conditions can greatly increase production. Adaptability in terms of objectives refers to the ability of the species to satisfy these objectives over a wide range of environment; environment itself being the result of many factors, such as climate, altitude, soil status, management practices, existence of other plants and animals.

The above example can be illustrated by Eucalyptus globulus and Eucalyptus camaldulensis, where in the country of their origin in the southern hemisphere they show slow growth and low performance. On the other hand in the highlands and middle altitudes of Ethiopia (northern hemisphere) where soil fertility is by far better, they showed better performance and can have better local and commercial potential. The same relation applies to Pinus radiata in Australia. In its native environment it has very little commercial value due to its slow growth rate and poor form in California.
In general the greater the adaptability the more it is suitable for agroforestry which is further enhanced because of man made or nature of ecosystem.

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b) Growth rate

The major constraints that made tree farming as least accepted in relation to agricultural components is its long rotation. Rapid growth, especially in early years, short rotation (period between planting and harvesting) are considered desirable requirement in agroforestry trees. In its early growth, due to availability of space, production of grasses or crops can benefit farmers from agricultural returns.

Rotation length vary greatly with the species and intended objective of the end use of the agroforestry tree. The initial rotation of a coppicing species is longer compared to its subsequent rotations. Faiderbia albida and Eucalyptus globulus can be examples of native and exotic species respectively.

c) Palatability as fodder

Nutritious and palatable species due to severe foraging pressure will often be grown totally purely. Controlled provision in a form of cut and carry or pollarding trees beyond the reach of the tallest animal as it is traditional practiced in Faidherbia albida tree-intercrop is one alternative.

e) Ability to withstand adverse condition

Establishment of agroforestry is preferred on open pasture or crop land that is devoid of trees. As it is not a natural tree habitat, it is a site under highly adverse condition in most measures. The shock of planting, exposure to hot and cold wind, accidental grazing, drought and frosts stress, particularly in early years can kill many trees. Some species can overcome such conditions and exhibit an incredible performance.

Suitable species selection which is coupled with appropriate management will improve establishment and the subsequent productivity.

f) Growth habit

An agroforestry tree growth habit is depicted in its branching and rooting characteristics. Important points to be considered are:

-Shape of the crown
-Crown density with respect to light penetration
-Depth and spread of the root system and
-Variation with the environment in which the trees are growing

Forms of growth of trees in an open is often poor, with excessive branches development and reduced height growth. Thus need to be carried out to maintain both wood quality and high light level to agricultural crops. Even if eucalyptus shed large portion of their

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branches and Faidherbia albida almost all its leaves, there is a need for pruning as most of the cereal crops are light demanding (c4 crops). Among the exotic species, Eucalyptus camaldulensis can be integrated with pasture or arable while Eucalyptus grobulus is a vigorous competitor due to its shallow and laterally spreading root nature. Traditional windbreak management options like digging a trench between the tree and enset along the planting in the Guragie highlands seems to alleviate the problem.

g) Crop and livestock sheltering attributes

Trees that form not completely heavy crown density minimize competition with main crops and grasses. Persistence of living branches to the base of the tree with a uniform wind breakage on its entire height.

For shade requirement a clear bole either from an inherent self pruning nature or from pruning management, is important with its healthy growth of the entire tree. The shadow casted by such trees move with the sun leaving no area in permanent shade. The air space between the canopy and the animals allows unimpeded radiation of body heat and cooling by unrestricted air movement.

h) Trees' capability to withstand management practices

In general many of the agroforestry systems demand extensive pruning and lopping to maximize harvest of tree products. In such management practices trees must be able to withstand the subsequent adverse effect such as dramatic restriction in growth rate and induced decaying and loss of quality.

An ideal fodder tree that suits such purpose are often directly grazed. Example of such trees are tree lucerne or Tagasaste, Chamaecytisus palmensis, Luecaena spp. Ehretia sp. (Ulaga) Acacia spp. and Vernonia amygdalina. These species appear to thrive after grazing with increased potential production.

i) Vigor and productivity

Individual trees phenotype and its result of interaction between its genetic makeup (genotype) and environment in which it grows. Due to natural out breeding there are chances both outstanding and very poor genotype. Selection of the best genotype that is developed from cutting in its proper sites under appropriate management can increase productivity.

j. Nutrient cycling and nitrogen fixation

Nutrient leach down through soil profile and minerals released from weathering parent material such as rocks and sediments, can be recycled by agroforestry trees. Deciduous trees that shed their

leaves are more important in recycling. Eucalyptus camaldulensis that has been scattered on grazing land was found to recycle N, K, Ca and Mg from sub soil. Many species of eucalypt and hard wood have the ability to internally cycle nutrients from dying leaves and twigs. These trees do not fix nitrogen. There are several deciduous trees, like Ficus spp., Cordia africana and Croton macrostachyus that recycles nutrient, but do not fix nitrogen on farmers' field. These trees are intentionally left on farm for soil impoverishment under traditional practice.

The others which are the most important agroforestry trees have the ability of converting atmospheric nitrogen to organic nitrogen through a complex symbiotic relationship.

CHAPTER X

SPATIAL ARRANGEMENTS FOR TREES IN AGROFORESTRY

In terms of agroforestry, trees can naturally exist or be planted in farms. Natural trees are often scattered as a result of selective clearing of previous forests and are usually uneven aged. Planted trees can be indigenous or exotic and they are intentionally planted to meet a specific agroforestry objectives. They have generally some regular pattern in arrangement and are uneven aged.

Zonal arrangement in the form of patterns are naturally grown trees that are displaced in between farms. Structurally they are all thinned and as a result they allow enough light for under-growth of grasses or other crops in a mix. Planted trees are regular blocks and are in aligned arrangement such as boundaries, wind break fences etc. The following are the major tree arrangements in an agroforestry system;

Alley cropping (hedgerow)

Planting and managing of woody plants with annual crops. The trees are planted in an alley while the crops can be planted as an alley or broadcasted. Woody plants are regularly cut and leaves and twigs are mulched in between tree row to suppress weed, conserve moisture and add nutrient and organic matter to the soil.

The objectives is to increase crop production and sustainable short rotation wood supply in form of fuel wood, smaller poles fodder and other wood products. It was designed as a sustainable production alternatives to fallowing.

Problems - Design (systematic control treatment problem)
- competition
- protection

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Recommended species Tree lucerne, sesbania
Luecaena (Psyilid)

Improved fallow

A management practice of leaving cropped field without cropping. The process allows the soil to rest and recover some of its fertility. Traditionally, longer fallow periods can be possible if land availability is not a limiting factor. Shorter fallow periods practiced as a consequence of land shortage resulting from population increase, cannot sustain subsequent crop produc-tion as it fails to restore the soil sufficiently.

Thus fallow based-agroforestry is one of the options to minimize the problem. Potential species to be planted are short rotation bushes with the highest nitrogen fixing ability. e.g. Tree lucerne (alley cropping) Sesbania sesban, Sesbania grandflora etc. In rain forest areas where shifting cultivation is practices and large portion of forest are cleared, these system minimizes the rate of forest destruction.

Boundary planting

It is a tree planting arrangement on a property or land. It could be along boundaries of farm, home compound, pasture, crop land etc. Any line planting specially in a single row can be planted in much closer spacing than block planting. Since there is a free space on both sides of the line, tree competition is limited to two sides only. It can also be planted in several lines.

Eucalyptus globulus, Eucalyptus camaldulensis, Erythrina sp. Gravillea robusta, Casuarina sp. Albezin lebbek and Euphorbia sp. are some of the common boundary planted tree species.

Line planting along the property affects more than one owner. No owner can benefit in terms of shade and shelter if the tree has other advantages like nitrogen fixing. In such cases it could be an advantage to get a benefit without encoutering labour or other input. In most parts of Ethiopia where Eucalyptus globulus is planted, there is an effect of yield depression in such plantings thus, the owner need to agree in advance with his neighbour.

Live fence

Live fences are usually developed from bigger cutting or seeds. It is a living wall of vegetation for livestock enclosures and also cattle track to protect croplands and pasture from moving animals (both domestic and wild).

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In west Africa for example, (Cameroon) living fence is used to protect a community against aggressive neighbours and foreign invaders.

Free grazing is common in any region specially in dry season. Most of the perennial vegetation, fruit or other crops like coffee can easily be browsed or can be damaged for no apparent reason by animals. In a controlled rotational grazing padlocking is an essential management component in livestock raring. In the highlands - Erythrina spp., Euphorbia sp. and in lowlands Adhatoda shemperiana, Comiphora species, Agave spp., Euphorbia tirucalli are grown traditionally. Most of the above species develop from cutting.

Woodlot

Nearly 90% of the wood utilized is for fuel in rural area. As forestry is the most ignored sector compared to livestock and crops due to it long term gestation period, marginal areas are allotted to planting in many cases. There are some wood lot planting in non competitive and in between places.

The species for fuel wood, should be

1. fast growing
2. having a character of prolonged burning and must not emit spark while burning etc.
3. having a required form etc. e.g. Eucalyptus globulus, Acacia spp.

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CHAPTER XI

MANAGEMENT OF TREES IN AGROFORESTRY

11.1 Alternative agroforestry interventions for implementation.

* vertically arranged agroforestry interventions as valid to site conditions, farming systems and production targets

* Horizontally arranged agroforestry interventions that are appropriate for species characteristics, production targets and farming systems chosen.

A. Silvi-pastoral system

1. Dry A. C. Zones.

   . Have areas closed
   . Compartmentalize it with live fence
   . Prepare water harvesting structures.

- Refine the existing stock gradually
- Apply reach good-potential micro site technique.
- Always use seedling or sods, no direct seeding.
- Use cut and feed system (No on-site grazing)
- Use selective - cut technique
- Preferably use indigenous stock.

2. Moist A.C Zones

- Exclude human and livestock on-site use
- Have cut-of-drains or diversion channels with safe gradient
- Have water harvesting structures except on vertisols.
- Refine the stock gradually.
- Use seedlings or cuttings. Seeding may be possible on high moisture accumulation spots.
- Use strip, spot or single tree/ clump tending practice
- Use cut-and feed system, short time on-site grazing may be possible after full recovery of vegetation.
- Selective cut or shelter wood-cut-method may be more appropriate.

3. Wet A. C. Zones

- Exclude any human and livestock use interference
- Have cut-off-drains. Make sure the water ways are read earlier.
- Prepare water draining physical structures. All the structures should be graded and connected to the water way.
- Refine the stock in a strip, Coup, or spot.
- Seeding could be possible for special finalizing for the purpose; else use seedlings.
- Depending on the slope and denudation reaching those sports, cops etc. with potentials is preferred.
- Cut-and feed is advised, but could be joined with controlled on-site grazing. Compartmentalization is very essential.
- For woody materials, shelter wood cutting system selective cut system or even seed-tree-cut system may be possible.

4. Wurch A.C Zones

- Have live fencing.
- use graded structures with safe disposal structures.
- direct seeding and propagation by cutting may be possible; else use seedlings or sods.
- Controlled grazing is possible.
- use all types of cuttings except clear-feeling.

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Agroclimatic Zones of Ethiopia

	Legend: A: Main crops C: Traditional Conservation S: Soils on slopes T: Natural trees		HIGH WURCH A: None (forst limit) C: None S: Black soils, little disturbed T: Quarantinianum Hypercum roeperianum
		MOIST WURCH A: Only barley, 1 cropping season per year C: Drainage rare S: Black soils, degraded T: Erica arborea Hypericm	WET WURCH A: Only barley,2 cropping seasons per year C: Wildepread drainage ditches S: Black soils, highly degraded T: Erica, Hypericum
		MOIST DEGA A: Barley, Wheat end Pulses, 1 cropping season per year C: Some trad. terracing S: Brown clay soils T: Juniperus, Hagens, Poducarpus	WET DEGA A: Barley, Wheat, nug, Pulses, 2 cropping seasons per year C: Drainage diches widespread S: Dark brown clay soils T: Juniperus, Hagenia, Podocarpus, Bambo
	DRY WEYNA DEGA A: Wheat tef, rarely maize C: Terracing widespread S: Light brown to yellow soils T: Acacia trees	MOIST WEYNA DEGA A: Maize, sorghum tef inset rare, wheat,nug, dagussa, barley C: Trad. terracing S: Red-brown soils T: Acacia, Cordia, Ficus	WET WEYNA DEGA A: Tef, maize inset in W parts,nmug,barley C: Drainage widespread S: Red clay soils, deeply weathered,gullies frequent T: Many varieties, Ficus, Cordia, Acacia, Bamboo
	DRY KOLLA A: Sorghum rare, tef C: Water retention terraces S: Yellow sandy soils T: Acacia bushes and trees	MOIST KOLLA A: Sorgum, rarely tef nug, dagussa, groundnut C: Terracing widespread S: Yellow sillty soils T: Acacia, Erythrina, Cordia, Ficus	WET KOLLA A: Mangoo, Taro,sugarcane Maize,coffee, orange. C: ditches frequent S: Red clay soils oxidized T: Albizia grandi bractiata Milica excelsa Cyathea maniana
	BERHA A: None except irrigated areas C: None S: Yellow sandy soils T: Acacia bussei Parkinsonia aculata, Commiphora erythraea		
	Less than 900 mm	900 to 1400 mm	more than 1400
		Annual Rainfall	

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5. **Bereha A.C Zones**

- Prepare water harvesting structures
- Refine the stock gradually
- Use highly drought resistant
- Propagate from seedlings
- Apply cut-and-feed system have un even aged mix
- Use selective cut system.

11.2 TENDING OPERATION IN AGROFORESTRY

The major role of tending operation in agroforestry is restoratio of healthy co-existence among integrated crops of a given land us system. Because woody perennial usually have well structured an strengthened rooting and branching systems as compared to othe adjoining systems, the negative influence comes from tree an shrubs.

1. Pollarding

- It is removal of the crown total.
- Pollarding occurs when the adjoining crop is in it pick growing period.
- It helps the adjoining crop by removing the shadin effect.
- It is usually practiced in Agri silvi-culture an agri silvi-pasture systems.
- Pollarding can be exercised after the woody cro develops copping stem.

2. Pruning - It is an act of removing the branches and roots o woody perennial close to the stem.
   - Pruning is practiced in all AF systems.
   - Its function is to maximize term growth facilitate access to a passer by, and reduc competition for light and moisture agains adjoining crops.
   - It is better practiced when the branch base diameter is not exceeding 1 inch.
   - Pruning cuts are close to the stem and it worth doing for quality tree species.

3. Thinning It is reduction of stock density to an optim level.
   - Low Thinning (German Method)
   - High Thinning (French Method)

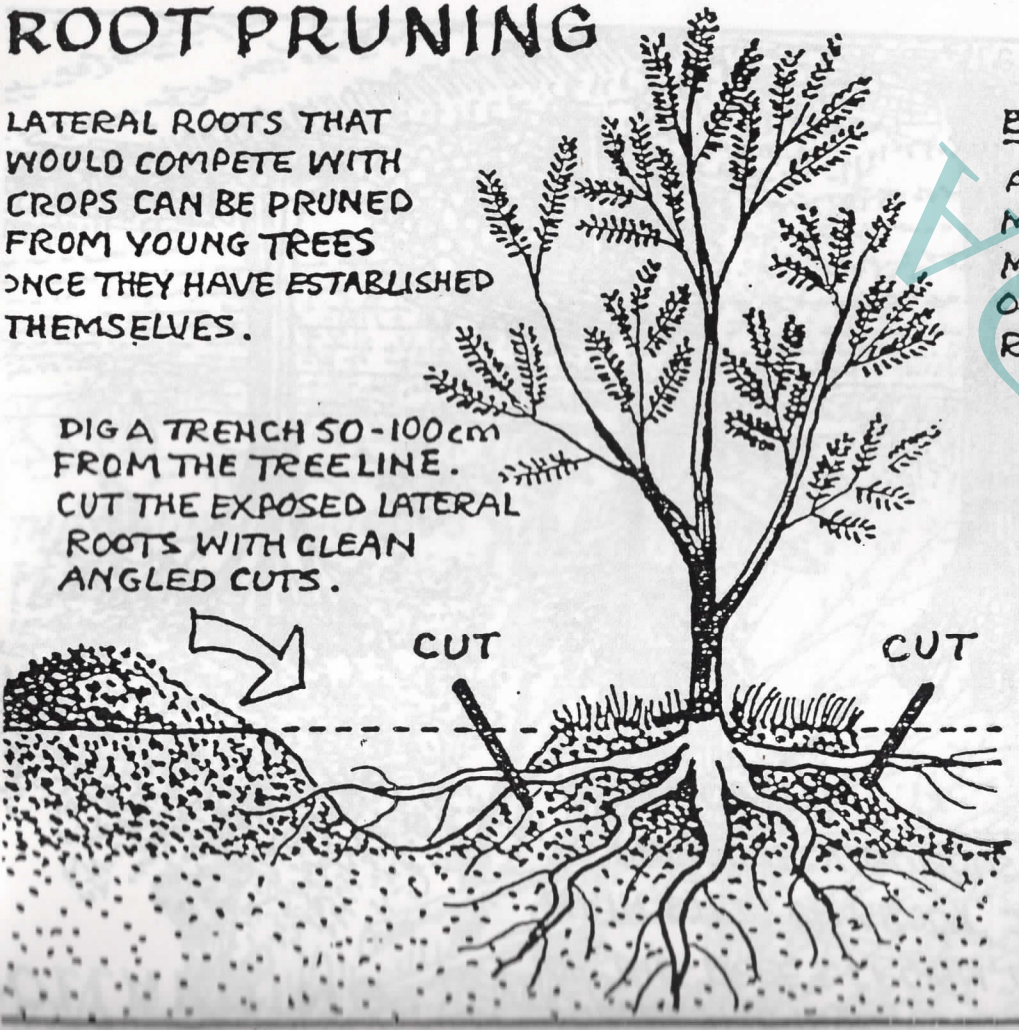
4. Lopping - It is removal of portion of branches of woo perennial.
   - It may be practiced in AF systems.

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ROOT PRUNING

LATERAL ROOTS THAT WOULD COMPETE WITH CROPS CAN BE PRUNED FROM YOUNG TREES ONCE THEY HAVE ESTABLISHED THEMSELVES.

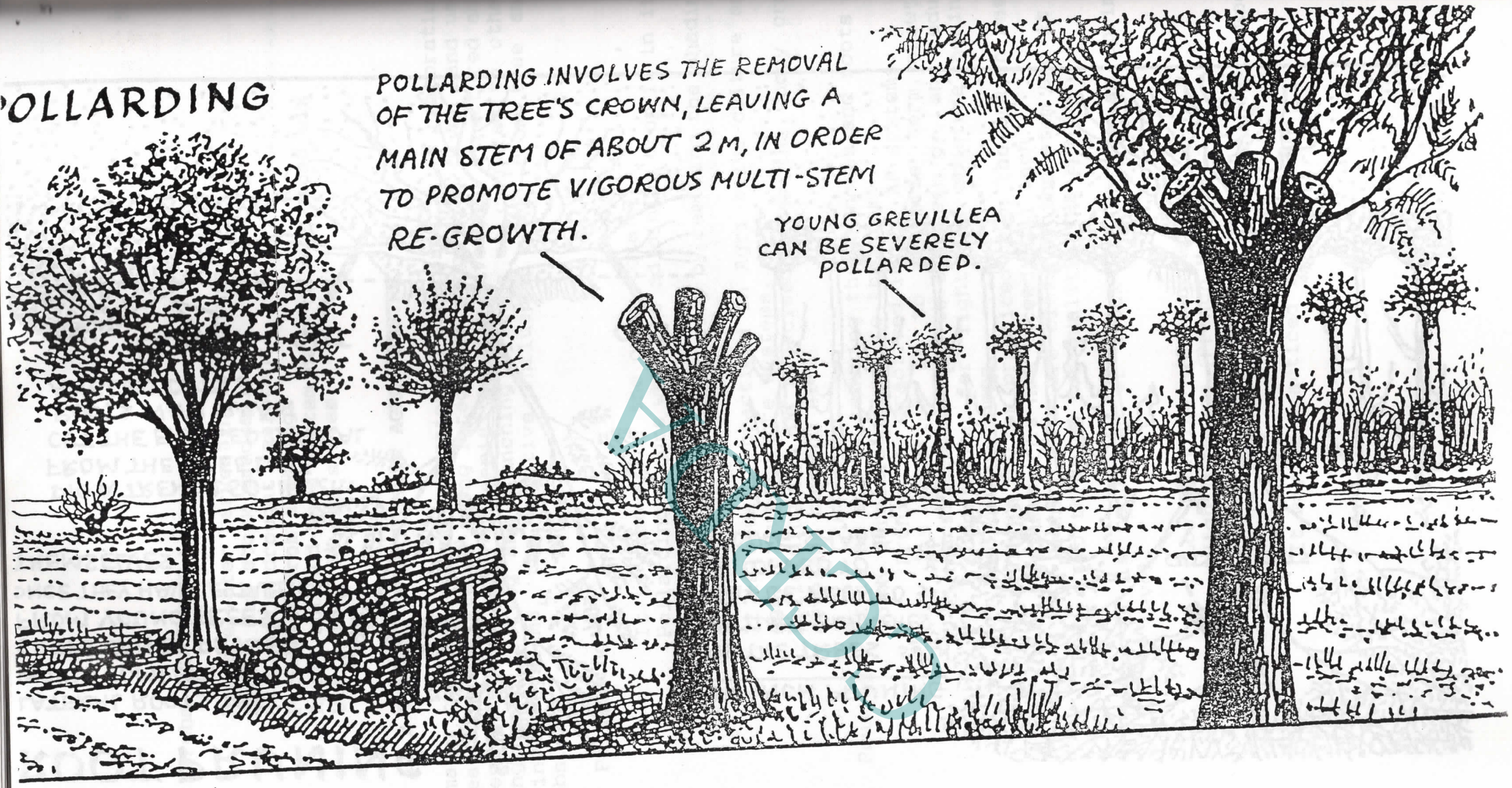
DIG A TRENCH 50-100cm FROM THE TREELINE. CUT THE EXPOSED LATERAL ROOTS WITH CLEAN ANGLED CUTS.



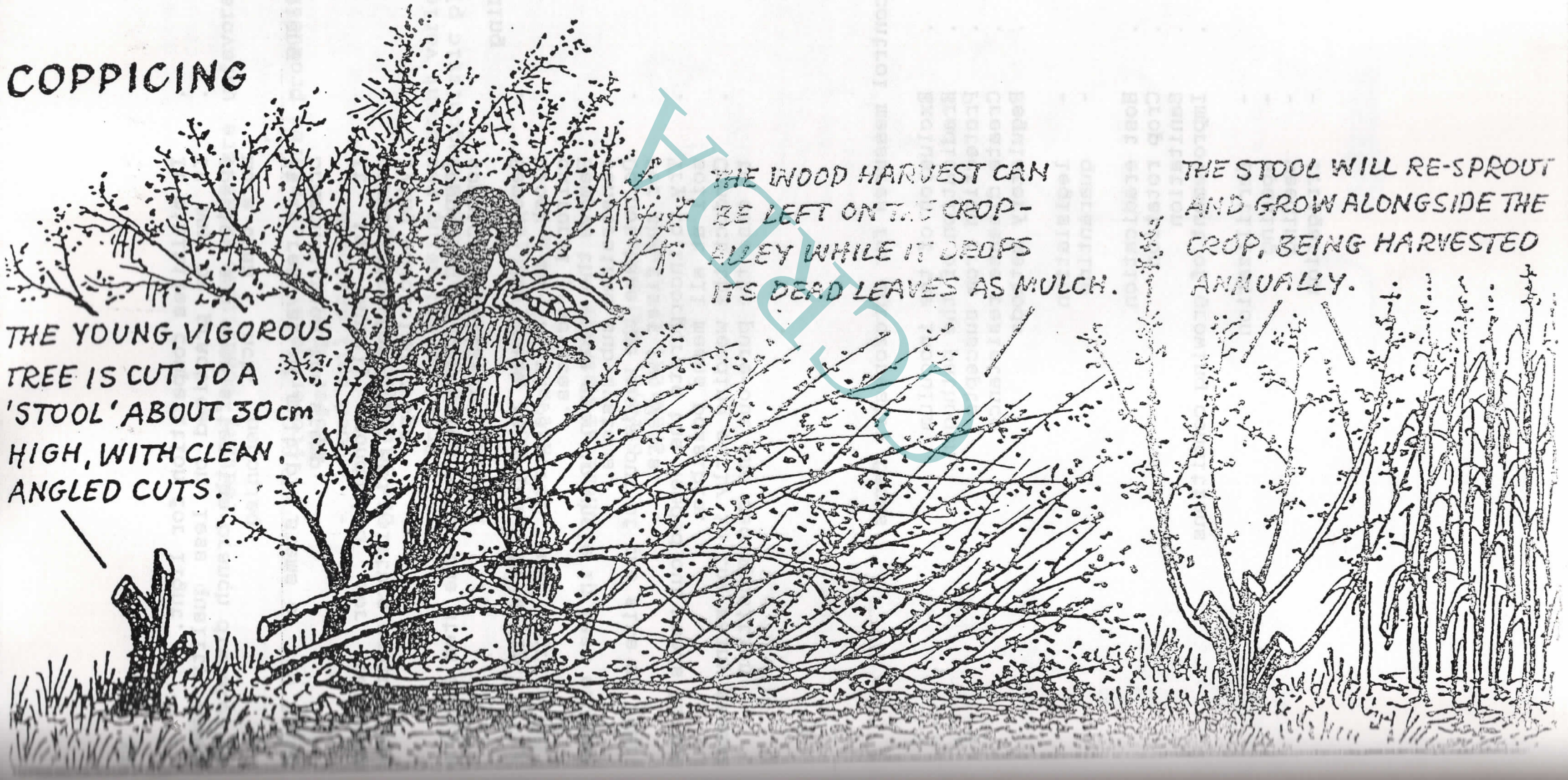
BRANCH PRUNING

AS THE TREES MATURE, BRANCHES MAY BE PRUNED OR LOPPED TO REDUCE SHADE.




POLLARDING
POLLARDING INVOLVES THE REMOVAL OF THE TREE'S CROWN, LEAVING A MAIN STEM OF ABOUT 2 M, IN ORDER TO PROMOTE VIGOROUS MULTI-STEM RE-GROWTH.
YOUNG GREVILLEA CAN BE SEVERELY POLLARDED.

COPPICING



ICRAF

- It minimizes competition for light.
- It may be practiced on less quality woody species and even after the branch diameter is more than 1 inch.

5. Coppicng - It is removal of multiple stems or low lying branches from the stamp.

It is usually conducted for reducing competition for light and moisture against low lying adjoining crops.

Coppicing is conducted after the stem attains coppicing ability

6. Weeding

- Remove the weeds in sopor, in strip, or in block in silvi-pastoral and agri-silvi-cultural practices.
- Remove the weeds even in whole in less erosion constrained sub systems.
- Do not take the weeds out of the site at least for the first two years.
- Try to incorporate the weeded out weeds to the soil at all means possible.
- Conduct the weeding early in the rainy season to ease the pure-out and decomposition.

Disease control measures for agroforestry farms

- Exclusion of the inoculum
- Eradication of the pathogen
- Protection from suscepts
- Create disease resistance
- Regulatory methods

  - legislation
  - quarantine

- Host eradication
- Crop rotation
- Sanitation
- Improvement of growing conditions

  - fertilization
  - spacing
  - weeding
  - irrigation

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. Creating conditions that are unfavorable to the pathogen

- Proper aeration of stored products.
- Proper spacing
- Good soil drainage

. Use biological Methods

- Breeding and using resistant varieties
- Use trap crops and antagonistic plants

. Physical Methods

- Soil sterilization
- Hot water treatment

. Chemical Methods

- Sprays, and other
- chemical treatment.

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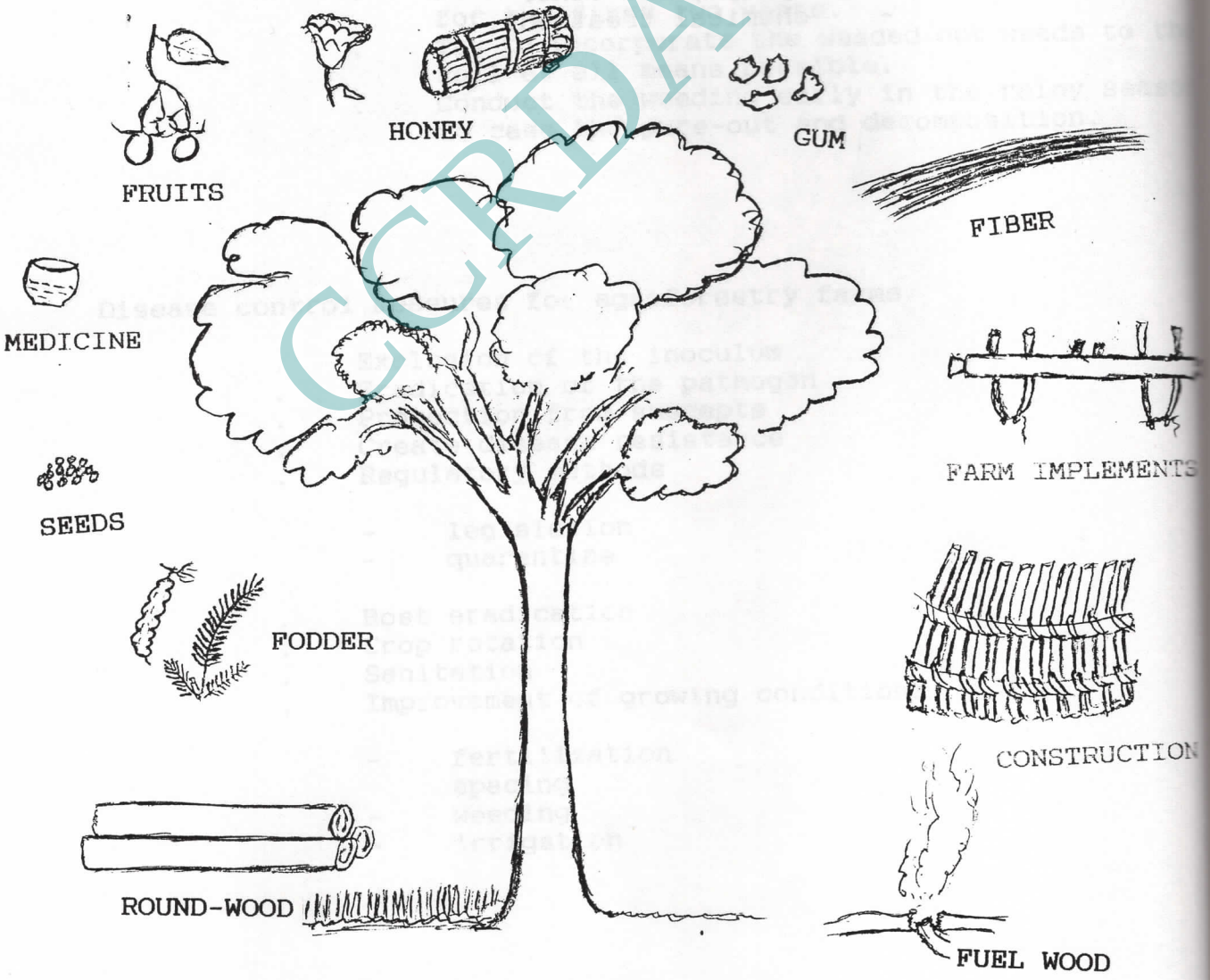
CHAPTER XII

CRITERIA FOR SELECTION OF AGROFORESTRY TREE SPECIES

Agroforestry trees are selected on the basis of farmers needS. It is on the potential of the species to complement with pasture and crop. Short gestation period, good quality of the product, sustanability of the supply and other criteria that has been determined by the farmer to fulfil primary and secondary objectives on his farming.

Multiple farmers need:

Having identified the growth habit of a tree and basic nature of his farm management objectives, a farmer plants or retains trees to fulfil his diverse basic needs. Generally a multi-purpose tree with several direct and indirect uses will be opted. The following diagram illustrates some of the basic tree products the farmer obtain directly from the agroforestry tree.



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Specific tree products:- A multipurpose tree cannot combine all the best characters in one. Some trees are best forage trees for honey production and flower throughout the year e.g. Eucalyptus camaldulensis. Some are best fuel wood others are high yielding. In production of specific commodity selection should be made. Fuel wood is a pressing need thus fast growing Eucalyptus species is preferred to fulfil such objectives.

Cash income:- As gestation period is long in tree production, short rotation tree crops both for wood and fodder are selected. In all species coppicing ability is a prerequisite to assure a subsequent sustainable production of short rotation spun. E.g. poles of Eucalyptus for construction from coppices require some two or 3 years. Fodder from pollarding and browses of acacia can be harvested every year. For timber, poles of bigger size timely pruning and thinning will improve the quality of the product for marketing.

Trees with a deep rooted nature and fixes nitrogen can generally be selected to integrate with pasture or crop to increase production and diversify farm products.

CHAPTER XIII

SEED COLLECTION STORAGE AND TREATMENT

In collecting seeds the basic information is knowing a good-quality seed, and understanding of the reproductive cycle of the target species. In Ethiopia the best trees for all sorts of purposes have been cleared and lost. Whatever remains pockets are inferior types of trees in general. Selection of trees with better performance phenotypically is the only option when we consider the remaining raiment trees.

13.1 Criteria in selecting the right parent tree

- Straight stem
- Fast growth
- Dense foliage for leaf production (fodder) and coppicing ability
- Healthy individual tree
- Avoid isolated tree, as self pollination yields low quality seeds
- collect similar quantity of seed from several trees to capture genetic diversity

Phenological knowledge of flowering time is important both for honey production research and planning and also indicates time at which fruiting starts.

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Fruiting time and patterns of fruiting of each species help to set a program of seed collection time accordingly. There are some good and bad seed years in tree species. Generally a good seed year is followed by bad seed year.

13.2 Seed collection

Ones the right species for the proposed objective is identified and trees seeds are ripe use ladder to climb the tree or spread canvas sheets on the ground and shake the trees so that the seed shed on the cannas or clean ground depending on seed or pod sizes.

13.3 Drying, cleaning, and storage of seeds

a) Drying seeds

Mature fruit must dry. To release seeds spread the fruit thinly on sheet or clean ground and expose to the sun; or place in a well ventilated shade or drying room. Turn the fruit regularly and protect from an pest. In cases of flesh fruit the outer pulp will be removed earlier.

b) Extraction

Seed at the bottom of the fruit is the most fertile for species like eucalyptus and casuarinas, sesbania and some acacias vigorous shaping of the dried fruit will release all seeds. For fruit that retain the seed, a stick may be used to beat the fruit and dislodge the seed. Seed like prosopis juliflora etc need local grinding means.

c) Cleaning

To separate seeds from unwanted parts of the fruit wire mesh of different size for different seed sizes are used. Winnowing or using of air stream (or manual blowing) is applied to separate impurities from seeds.

d) Storage

Make sure that the seed in dry to the required moisture level (both the external moisture level and surface should be dry)
The shelf life of different seed vary. For example seeds of leguminous species (those having pods like bean) can be stored for many years even at normal temperature.

Orthodox seeds like (eucalyptus and acacias) keep temperature and humidity low with minimum fluctuation (air tight). Recalutrant seeds will not tolerate drying, storage is often impossible. E.g angerin sp. sowing fresh is an option.

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Main tree species grown in the area are listed in Appendix. Common scattered trees on farms are Moringa stenopetala, Acacia albida (Faidherbia albida), Terminalia sp. Croton mycrostachys, cordia abyssinica. These are mainly pollared to minimize shade in light demanding tree inter crop and left unpollarded in range land. The agroforestry trees in linear arrangements and their management is also given in the boundary and wind break planting sections.

Chapter XIV

NURSERY PRACTICES, MAINTENANCE AND POLICIES

14.1 Yearly need of seeds

The amount of seed depends of the number of seedling required for planting, capacity of seed to germinate and grow into a healthy seedling. Information like germination percentage, number of seeds in one kilogram etc. can be supplied by a seed supplier.

The amount of seed in one kg is calculated as:

$$\text{Amount} = 125 \frac{N}{PW} \left(1 + \frac{E}{100}\right)$$

Where N = No. of seedling required for planting
P = germination rate of plant percent
W = no. of seeds per kg.
125 = a factor that adds a 25 percent reserve
E = an extra quantity if some of the seeds are not good. (See the calculation appendix).

14.2 Setting up nursery

Site selection shall consider

- Proximity to planting sites or social gathering areas (if demonstration nursery)
- Close to good water supply
- Good road network
- Optimal topographic location ie not at hill tops or valley bottoms, gentle in slope preferably sloping north to south or vise versa.
- possibility for compost preparation
- good site for raw material that could be used as substitutes to polytene pots

Size:- size depend on number of seedling produced each year
- the time it takes to produce seedling (e.g. if seedling requires more than one year time as much size is needed)
- size of the container

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14.3 Basic facilities

A nursery must have;

a) access road and paths;
b) fencing;
c) a shelter for tools, material and workers;
d) a soil dump;
e) seedbeds;
f) potbeds;
g) shading and shelter for plants (from frost, hail and heavy rain)
h) windbreak;
i) a compost area;
j) a working shed;
k) seed extraction area

14. 4 Nursery management

- pricking out
- watering
- weeding (after watering)
- shade (direction of shade)
- root pruning
- hardening
- transporting

14.5 Planting concerns

- seed or plant only after optimal moisture is built up.
- use viable seed or a healthy and quality seedling for the purpose
- cover the seeding with soil up to the collar point
- In moister deficit sites, plant the seedling at the lowest spot of the moisture retaining spot.
- Focus on native species
- mix the species to address the concerns of children, women, and adult men as well as the site.
- press it firm and leave loose soil at the top of the pit after planting.
- make sure that the top soil is put back to the pit first and the sub soil last during planting.

The maintenance of nurseries is to be done repeatedly so that the health of the seedlings would not be at risk. Due to this and other reasons, agroforestry nurseries would have to be small in size and managed by few individuals in groups. The policy of the future nurseries is in line with this notion.

CCRDA

CHAPTER XVI

THE SOCIAL AND ECONOMIC SIGNIFICANCE OF AGROFORESTRY

The agroforestry approach is different from pure forestry approach on that it emphasizes using trees for many purposes, both economic social & ecological. The success of an agroforestry programme depends on how the people perceive its costs and benefits.

16.1 The economics of agroforestry

In assessing the profitability of agorforestry, a cost benefit analysis should be performed.

Costs	Benefits
- Temporary loss of agricultural production due to land conception	- Diversity of product. - Erosion control
- Establishment costs	- Commercial production
- Maintenance costs - labour requirement	- Shelter, shade, fuel
- Loss of flexibility or management more manageable tasks	- Out-of-season fodder - Aesthetics
- Harvesting costs	
- Agroforestry may be riskier than agriculture because of the long gestation period for forest product	

For a farmer, agroforestry may be profitable in a number of ways:

a. an increase in agricultural production due to an increase in soil fertility, shade, shelter, fodder, etc.
b. Control of land degradation (arresting future loss of production)
c. Reclaiming degraded land for productive purposes and capital gain.
d. provision of commercially valuable tree crops such as timber, fruit, nuts and oils.
e. increased aesthetic appeal which can, in turn, increases the capital value of the farm.
f. farmers are likely to prefer an enterprise involving some agriculture and some trees. Agroforestry is not a "tug of war" between agriculture and forestry.
g. Trees provide medicine for both humans and livestock, as well as, fuel & building materials.

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16.2 The cultural and symbolic importance of Agroforestry

The tree's significance as a link to culture and belief

Trees are perceived as linking between the sky and earth ofte
symbolize links between the spiritual world of ancestors an
people. Rituals and ceremonies which draw on forest symbols ofte
link people with their cultural heritage, as well as thei
ancestral past. Eg. Zigba among the Gurage is perceived as
sanctuary of Waq the God of Gurage traditional religion.

Trees as a location for social, cultural and religiou activities.

Trees provide the venue for many cultural events. Each communit
has its own traditions associated with sacred areas and, as
result, the species that are found in them vary greatly. Eg. Th
Ye Joka - assembly of Guraghe elders takes place under Zigba tre
as the Oromo symbolize the Oda tree for political unity.

The symbolic and sacred significance of particular fores resources

In the Ethiopia Orthodox faith Girar is a sacred tree that is use
for making the ark of the covenant.

The Judicial function of trees

Trees serve both practical and symbolic judicial roles. Symbo
lically, they can represent mediators or decision makers
Practically, they are physically boundary makers that defin
property and provide evidence of use rights in judicial disputes
In many counties some one who plants a tree in a field has rol
rights to its produce and role rights to the use of the land
stands on.

The use of forest products in social, cultural and healin ceremonies.

Forests provide a range of products for traditional ceremonie
form food and beverages to customers, musical instruments a
medicinal values. Among the Konso wooden carved handicraf
locally called Waga are used to decorated grave yards for t
memorial of the dead.

EGRDA

CHAPTER XV

Agroforestry Extension

* Common extension approaches used in the country and lessons to be learnt from past experiences

* Farmers attitudes towards extension which is related to:

  @ tree growing,

  @ utilization of their indigenous knowledge and agroforestry experiences

1. Be effective in your persuading effort:

   Know who your audiences of use audio-visuals.
   Show the tangible benefits.
   Demonstrate practices needed.
   Avoid technical jargons.
   Be what they are and shape them gradually.
   Start with active participants and beneficiaries of the AF system.

Identify the outstanding social problems.

In participatory analysis:

Identify the major benefits the want to derive from their land.

Identify the major constraints they face in search of those benefits.

Quantify the benefits they intend to ----

Formulate the AF system for addressing the issues.

Decide the subsystem and arrangement.
Decide the components and species to be used.

2. Tips for effective extension

- Involve the farm owner from the beginning to the end.
- Buy the farmer's will by understanding the farmer is
  . an ecological dominant in his environment.
    - on-farm discussion

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. a rational individual who is guided by hi
self interest and innate shrewdness.

- Use on-farm discussion

. a member of the society who also is guided t
the role models within his community.

- Use PRA methodology

. a member of culture bearing population

- Use PRA methodology

3. Effective communication in extension :

- Considers the level of audience
- adios technical jargon
- uses audiovisuals
- shares the same morn values and culture
- demonstrates in practice
- gives more time to listening then talking
- promises less

4. Ease of adoption is based on :

- Observability

advantageous outcome of the AF shall be eas
observable by the "layman" farmer.

- Triability

It shall be triable under the available input
LEISA.

- Cultural compatibility

The agroforestry deliberation shall be
modification of indigenous knowledge.

- Technical ease.

It needs to be technically simple.

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CHAPTER XVII

MONITORING & EVALUATION

Monitoring is a managerial tool by which one can diagnose if activities ar conducted as planned, instructions re followed as formulated and proper resource allocations and utilizations are made as suggested.

Prerequisites

- Specific time plan for each activity.
- Pre determined technical guide and administrative rules to be followed.
- Specific inputs.
- Quantitatively stated activities.

Monitor the

1. Performance of activities in accordance to pre-determined norms such as time, quantity and quality.
2. Actual flow and usage of budget.
3. Supervision quality and frequency.
4. Allocation of internal and external imputes.

EVALUATION

Evaluation, just like monitoring, is a managerial tool by which performance and outputs (results) are judged for compatibility in addressing the ecological and economic expectations (objectives).

Ecological

Performance in measured:
- minimizing soil removal from the system.

Economic - performance

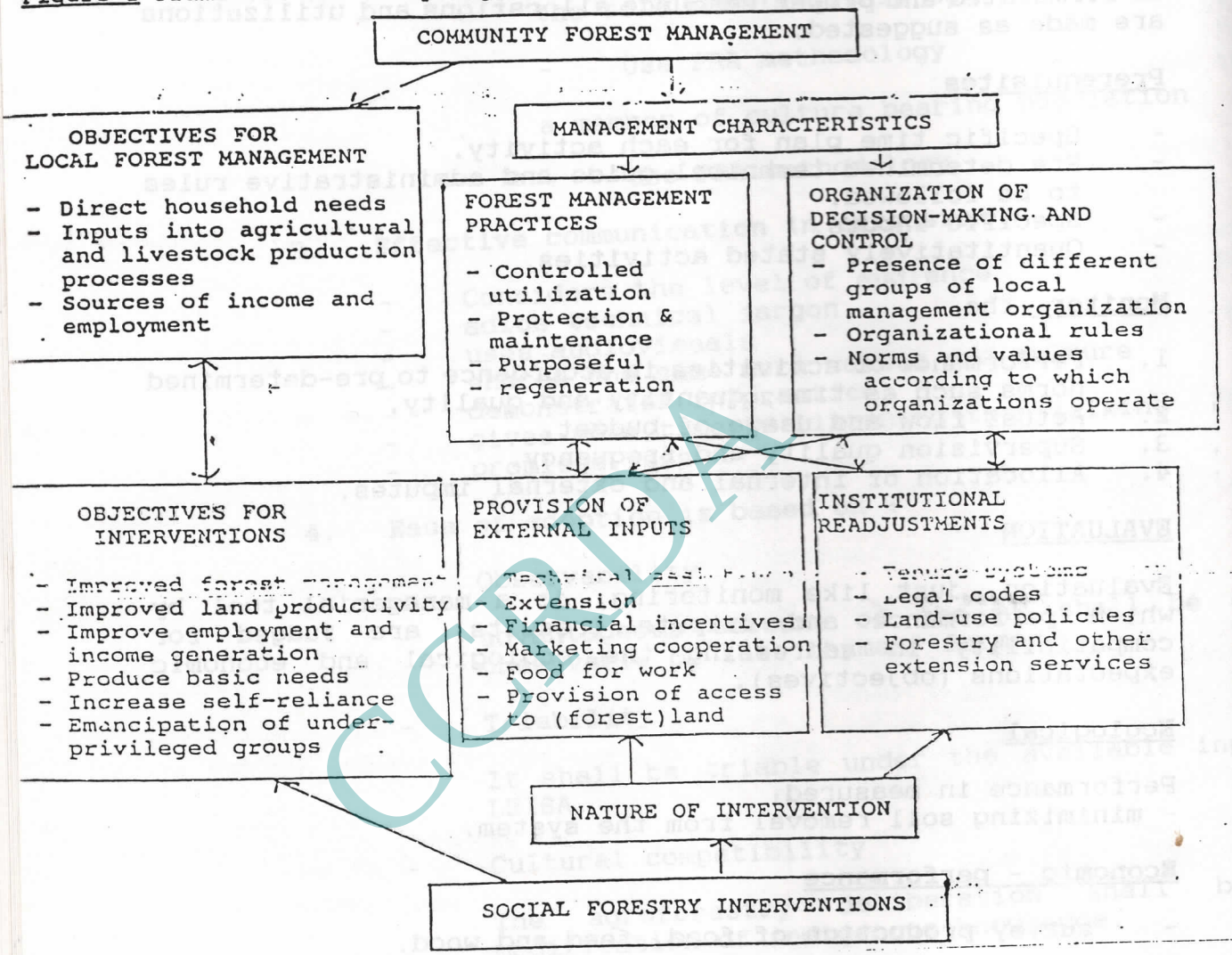
- survey production of food, feed and wood.

Ease of adoption

- Survey the no. of farmers who copied the intervention either in whole or in part. Request the reason for every modification if any.
  Enquire answers for quarries related to
  . technical complexity
  . economical viability
  . cultural compatibility
- Use the feedback from the evaluation for improving your

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Figure 1 Framework for analyzing social forestry strategies



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Appendix

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Acacia albida Del.

GERBI (Amh & Gur); QERETOR (gam); DEROT, GARBI (Or); [illegible] (Saho); AQBA (Tre); MOMONA, GARSHA (Tya); APPLE-RING ACACIA (Eng)

Family: Fabaceae (Leguminosae) subfamily Mimosoideae

Description: One of the tallest of the acacias growing to 30 m high, with a spreading or rounded crown and trunk reaching up to 2 m in diameter. Bark: rough, dark brown or dull grey, fissured and scaling; branchlet often hanging and with pale brown to white bark spines in pairs, straight, often pointing down. Leaves: bipinnate with 3 to 10 pairs of pinnae. Flowers: sweetly-scented, yellowish white, sessile, in slender spikes, 3.5 to 17 cm long. Pods: bright orange, curled round or sickle-shaped, resembling dried apple rings.



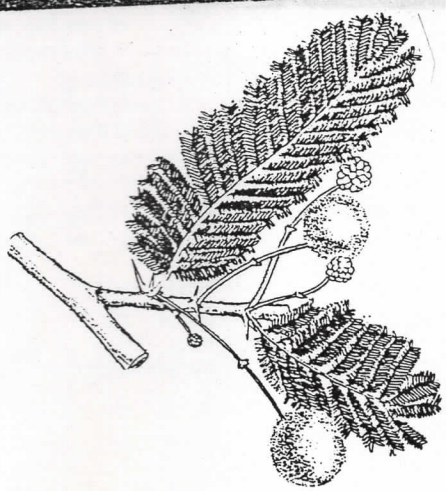


Acacia abyssinica *Hochst. ex Benth.*
QSLTO(Afar); BAZRA-GRAR (Amh); ODARA (kem); AMBO, DADECCA, DAGNISA, DEDECCA, GARBI, LAFTO, SONDI (Or); ALLA, CHE'A (Tya); ODORO, ODORWA (Wel)

Family: Fabacear (Leguminosae) subfamily Mimosoideae

Description: Large tree with branches ascending to form a very flat crown which can be up to 30 m wide. Bark: brown to almost black, rough and fissured; branchlet longitudinally ridged; spines, straight, in pairs, variable in length, up to 4 cm long. Leaves: bipinnate, pinnae in up to 30 pairs; leaflets up to 40 pairs in pinna. Flowers: sweet-scented, white, tinged red, in round heads. Pods: somewhat thick and woody, grey-brown or purplish-brown, straight or slightly curved; up to 12 cm long and splitting on the tree or on the ground to release elliptic, compressed seeds.





Acacia tortillis *(Forssk.) Hayne* **spirocarpa** *(Hochst. ex A.rich.) Brenan*

BEHBEY (Afar); SHERA (Gam); LOTTOBA, TEDDECCA (Or); TIMAD, ABAK, AKAB, ORA, GURHA-DARUYE, HARAH (Som); AQBA, TSA'DA-AQBA (Tre); ANQUIEBA, A'LLA (Tya); UMBRELLA THORN (Eng)

Family: Fabaceae (Leguminosae) subfamily Mimosoideae

Description: Spreading tree with a wide, flat or umbrella-shaped crown. The branching is not dense and the shade is light. Bark: grey to black, rough and fissured; branches armed with a mixture or spines, paired stipular spines are hooked and up to 5 mm long, others are straight and slender up to 10 cm long. Leaves: pinnae in 2 to 10 pairs; leaflets in 6 to 22 pairs. Flowers: very fragrant, dirty-white in small round heads. Pods: spirally twisted, pale brown with numerous dark red glands, containing small compressed seeds.





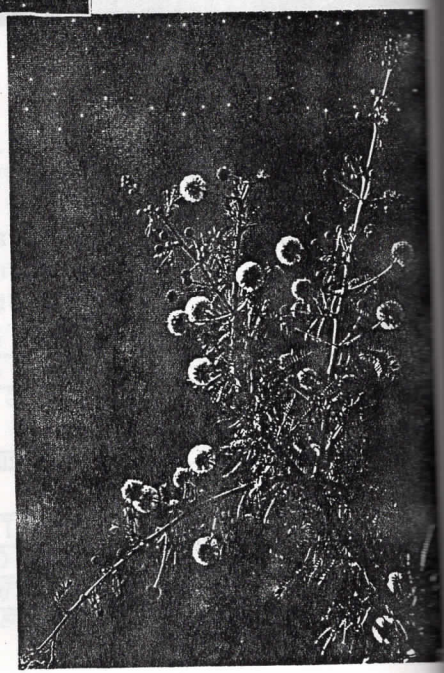
Acacia seyal Del.

MAKANI, ADIQENTO (Afar); CGINDA (Gam); WACU, WAJJI, WAKKO-DIMO, WASIYA (Or); AFLO (Saho); FULAAY, JIIQ (Som); CHE'A (Tr & Tya); QEYYH-CHE'A, SA'DA-CHE'A (Tya)

Family: Fabaceae (Leguminosae) subfamily Mimosoideae

Description: Small to medium-sized tree with a characteristicall umbrella-shaped crown. Bark: on trunk powdery, white to greenis yellow or even orange red; spines up to 8 cm long, straight sometimes fused into "ant-galls". Leaves: dark green, bipinnat with 3 to 10 pairs of leaflets. Flowers: fragrant, in shinin yellow globose heads, usually appearing before the leaves. Pods slightly curved, constricted between the seeds, light brown splitting on the tree; containing elliptic, flat seeds.





Albizia gummifera *(J.F.Gmel.) c.A.Sm. var.* **gummifera**

SESA (Amh); SASA (Amh & Or); CATTO (Kef & Or); AMBABESSA, CAWICCO, EMELA, GORBE, KARCOFFEE, MUKKA-ARBA, SANKILE, SHIMORO, SISA, YUNGO (Or)

Family: Fabaceae (Leguminosae) subfamily Mimosoideae

Description: Large tree, growing up to 30 m tal, with a markedly flat or umbrella-shaped crown of dark green, shiny foliage. Bark: grey, smooth, often tinged with red; large quantities of glutinous latex bleed when the tree is cut. Leaves: bipinnate, leaflets in 9 to 16 pairs; dark green and shiny. Flowers: white and numerous, arranged in clusters. Pods: oblong, flat, papery, pale brown to purplish.



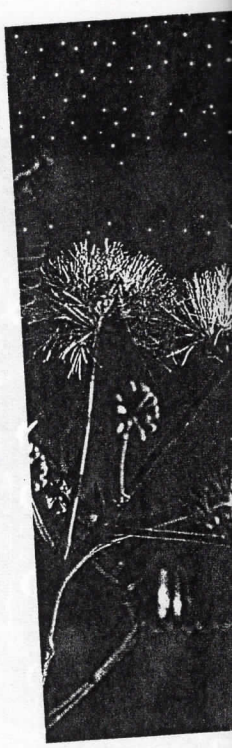
Albizia schimperiana *Oliv.*

SESA (Amh); SASA (Amh & Or); AMBABESSA, CATTO, CAWICCO, EMEL
GORBE, KARCOFFEE, MUKKA-ARBA, SANKILE, SHIMORO, SISA, YU
(Or)

Family: Fabaceae (Leguminosae) subfamily Mimosoideae

Description: Tree with umbrella-shaped crown. Bark: smooth, grey
brownish; the branchlet are velvety covered with brown hair
Leaves: bipinnate, pinnae in 2 to 7 pairs; leaflets in up to
pairs, obliquely oblong. Flowers: white or creamy-white or pa
yellow; borne in loose conspicuous heads; flower stalks hair
Pods: oblong, dull brown, containing many large seeds.





Cordia africana *Lam.*

WANZA (Amh); WADESSA, MOKOTO (Or); WADICHO (Sid); AWHII (Tya)

Family: Boraginaceae

Description: Tree growing up to 30 m, with a rounded crown and often a rather crooked trunk. The stems of trees that grow in open land branches at a height of 1 to 2 m from the ground. The bole of old trees reaches 1 m in diameter. Bark: dark-brown or even blackish and finely fissured; the slash is white. Leaves: leathery, simple, alternate, broadly ovate to egg-shaped, rough to feel, dull dark green above and paler beneath often with soft, light brown hairs. Flowers: funnel-shaped, pure white, sweetly scented, produced in quite large bunches. All the flowers on one tree open at the same time giving a very decorative effect. Fruit: circular, up to 1 cm in diameter, yellow when mature and single-seeded. The sweet stickily flesh is edible.



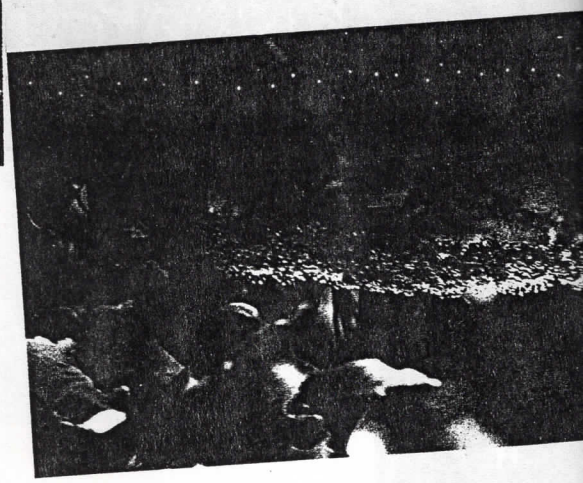


Croton macrostachys *Hoschs. ex Del.*
BSANNA (Amh); WAGO (Kef); MASSAGANTA (Konso); BEKANISS
BAKANICHA, MOKONISSA, BAKANISSA (Or); TAMBUCH (Tre); AMBU
(Tya)

Family: Euphorbiaceae

Description: Deciduous, medium-sized tree, growing up to 25 m hig
with spreading branches. Bark: grey, fairly smooth, fissured wit
age; slash has a strong spicy odour, as a pepper, and abundan
clear sap. Leaves: soft, green simple and heart-shaped, margin
wavy, crowded at the end of branches. Flowers: conspicuous yellow
white or creamy-white, swwt scented, in mostly hanging bu
sometimes erect spikes up to 25 cm long. Fruits: grayish wood
capsules, 3-lobed and 1 cm in diameter with 3 flattened seeds.





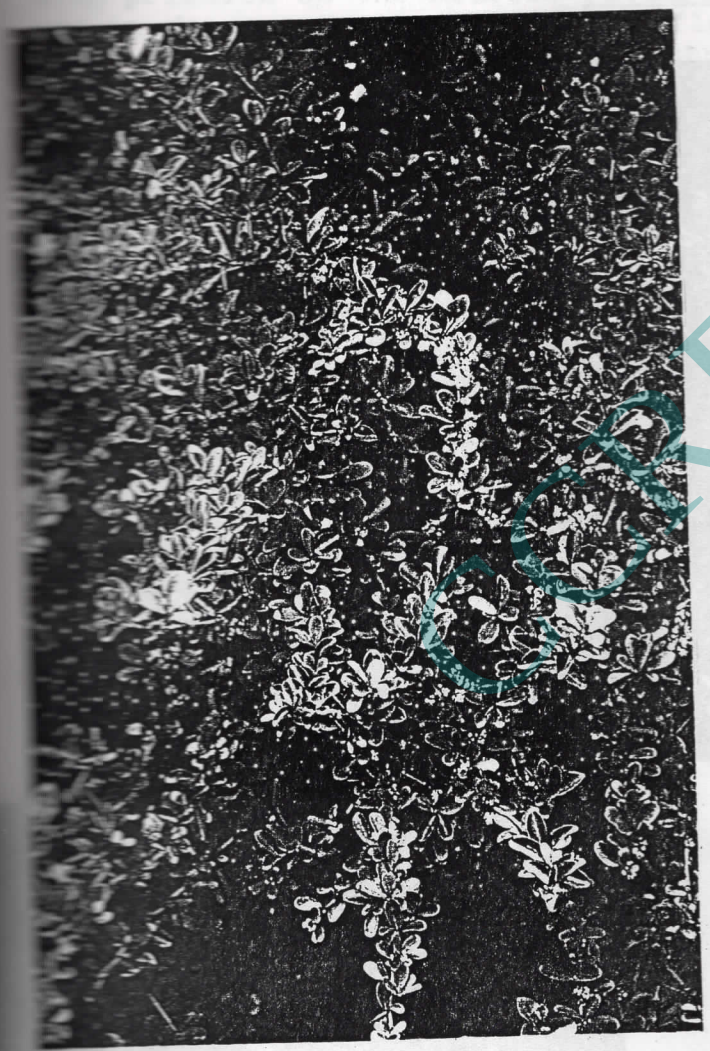
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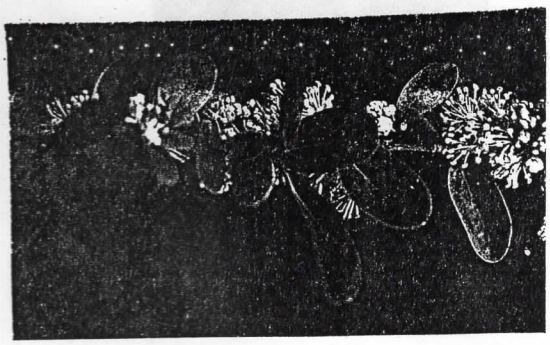
Dovyalis caffra *(Hook.f. & Harv.) Hook.f.*

KOSHM (Amh); ANKAKUTEH (Or); KAI APPLE (Eng).

Family: Flacourtiaceae

Description: Evergreen shrub, armed with robust spines up to 7 cm long. Leaves: leathery, shiny dark to bright green, simple, elliptic or obovate, with venetian raised on upper surface. Flowers: small creamy yellow, differentiated into male and female. The male flowers are arranged in 3 to 10-flowered clusters while female flowers are solitary. Fruits: flesh, round, yellow-orange, up to 3 to 4 cm across, on short stalks. The flesh has a pleasant sharp refreshing favour.





Ehretia cymosa *Thonn.*

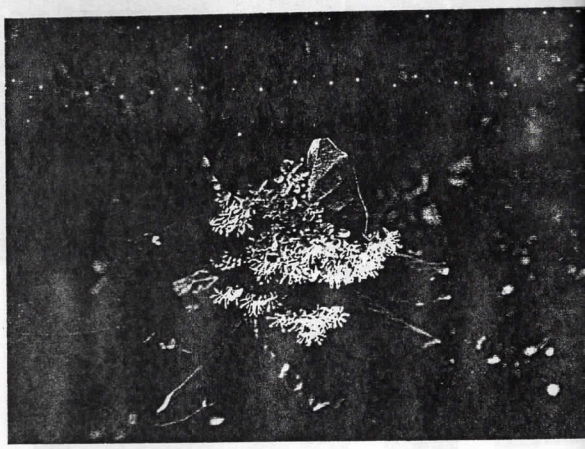
GAME, HULAGA, MUKERBA, GARMI (Amh); WAGAMO (Kef); BORBORI (Konso); WAGI, WURUGU, URAGA (Or); KARUAK (Tya)

Family: Boraginaceae

Description: Much-branched tree or shrub very variable in size fro a few metres in dry areas to a tree over 10 m tall in wette places. Bark: light to dark grey and rather rough; young branchle are covered in dense white hairs. Leaves: ovate to broadl elliptic, entire, glabrous to thinly hairy, mostly on the lowe surface, glossy green above Flowers: sweetly-scented, white, smal sessile and arranged in crowded terminal heads, often covering th tree in white bloom. Fruits: small, round, orange-red berries edible but acid.



CORDA



Erythrina abyssinica *Lam. ex DC.*

QWARA (Agew, Amh, Bil & Tya); 'GOFT, QURC (Amh); AMBILLSH (Gum); WERA (Had); BERU, KOLANCU, KALANICA (Kef); WELECCO (Kem); AFRARTU, ARFETU, BARTU, BORTO, DUS, MELAKO, WAZO, WELENA, WELENSU (Or); 'NQWI-ZBI, ZWAW' (Tya); BORTWA (Wel); RED HOT POKER TREE (Eng).

Family: Fabaceae (Leguminosae) subfamily Papilionoideae

Description: Deciduous tree with spreading, somewhat twisted branches and an open crown. The trunk is short and stout. Bark: yellow-brown, thick and corky, deeply fissured with woody spines; branchlet with black prickles, later turning woody. Leaves: trifoliate, petioles with or without prickles; leaflets broadly ovate with terminal leaflet larger than the lateral ones; usually with prickles on the midrib. Flowers: spectacular, red to orange-red in dense, erect, cone-like inflorescences, up to 15 cm long. Pods: up to 10 cm long, woody and strongly constricted between the seeds, which are red and shiny with a black hilum.



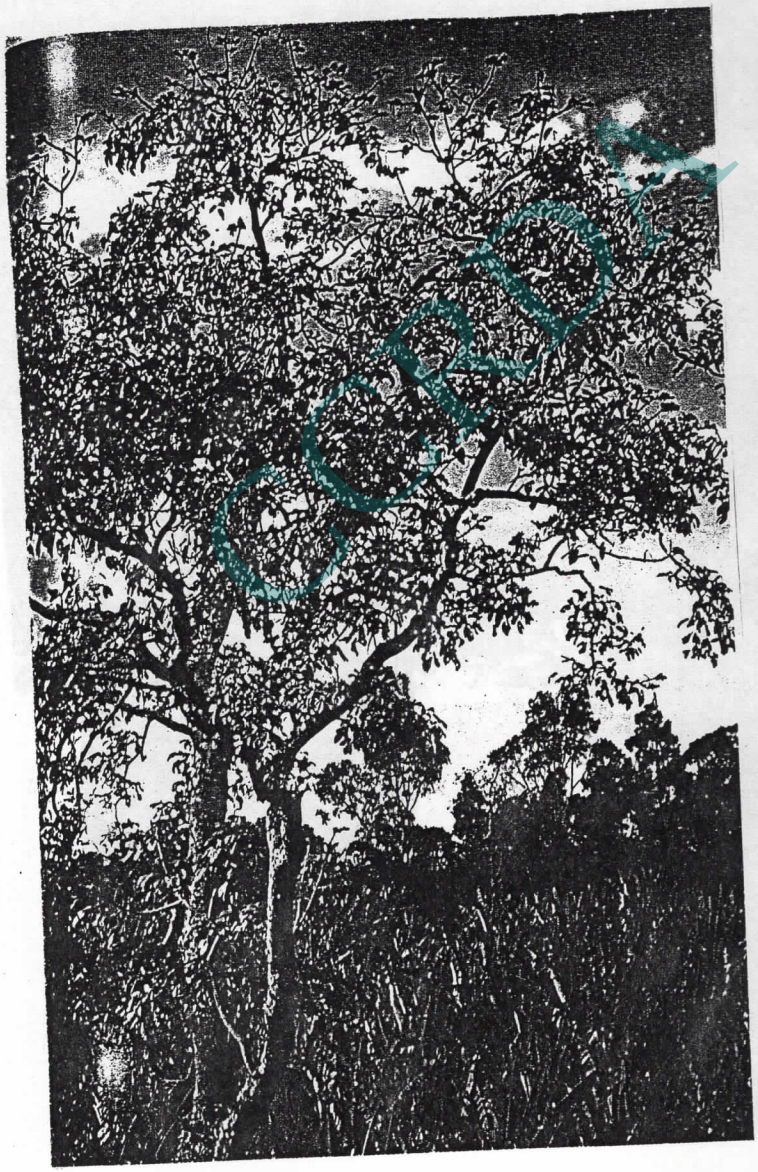


Erythrina brucei *Schweinf.*

QWARA (Ages & Amh); QORCH (Amh); BURTO (Dor); BORTO (Gam
BORTWA (Gof & Wel); WERA (Had); BERO, KOLANCU, KOLANICA (Kef
WELECO (Kem); AFRARTU, ARFETU, BARTU, MELAKO, WAZO, WELEN
(Or)

Family: Fabaceae (Leguminosae) subfamily Papilionoideae

Description: Endemic deciduous tree, up to 30 m tall, with a thic
trunk up to 1.2 m in diameter. Bark: dark brown, fissured; th
branches, leaf stalks and also young stems are armed with sto
prickles. Leaves: trifoliate; leaflets lanceolate to broadly ovate
sometimes with a few prickles on the midrib. Flowers: orange-re
occasionally light yellow, produced on long erect stalks, usuall
appearing when the tree is leafless. Fruits: linear-oblong pods, u
to 15 cm long; when mature they split open and expose a paper
lining, and bright-red seeds which are smooth and shining.



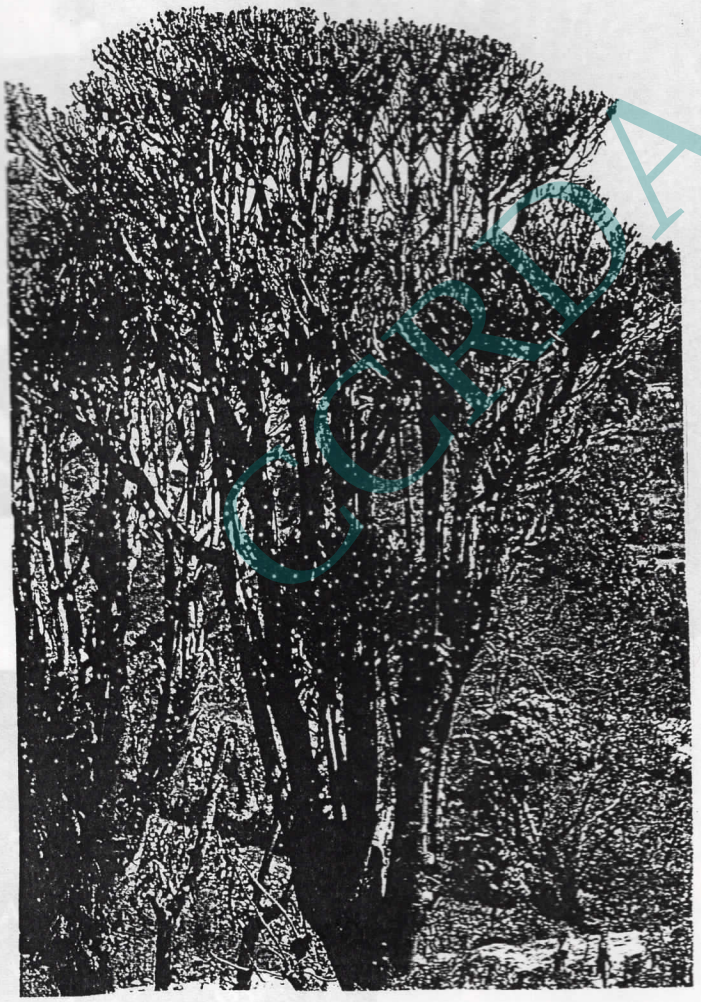


Euphorbia abyssinica *Gmel.*

Vernacular: KOLQUAL (Amh); HADAMI, TULU (Or)

Family: Euphorbiaceae

Description: Succulent leafless tree up to 10 m high with branches held almost parallel and forming an almost flat top. The thick trunk becomes woody with age. The green branches are succulent and have taken over the function of leaves. They are spiny, leafless, dark green, 3 to 8-angled and irregularly constricted with wing-like angles. The spines are in pairs and up to 1 cm long. Leaves: only found on seedlings and soon falling off. Flowers: crowded cymes at the tops of branchlet, bright yellow. Fruits: capsules, first green later on deep crimson; up to 2 cm across;



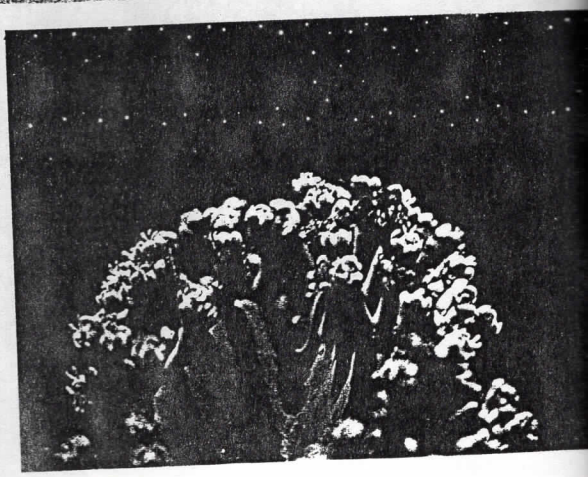
Euphorbium candelabrum *Trem. ex Kotschy*

KALKWOL, QOLQWAL, QULQUAL, QN'CHB (Amh & tya); ADAMI, HADAMI, AKIRSA (Or)

Family: Euphorbiaceae

Description: Scucculent tree that grows up to 12 m high with a short, thick trunk and a characteristic crown of massive ascending branches. The stem often produces numerous lateral branches but the lowermost branches fall off quickly as new ones are produced. Bark green with grey lines. Branches: succulent, leafless and dark green, 3 to 5 winged, with each wing bearing paired spines. branches are slightly constricted at irregular intervals. Flowers yellowish-cream, terminal, clustered on top of the branches. Fruits: reddish brown, pea-sized capsules, produced on tips of the branches. All parts of the tree produce a milky latex.





Euphorbia tirucalli L./
Euphorbiaceae
QʷCHB (Amh); KINCHIBA (Kef); DANNO (Som)

A shrub or tree with a straight cylindrical bole and a dense bushy crown, growing to 18m high, but more often an untidy shrub up to 5 m high. Stems are dark green and leafless, except when young. Flowers creamy white, arranged in terminal clusters.

Mostly grown as a hedge plant but also often escaping or at least persisting in long-abandoned areas at altitudes between 1300 and 2000 m.



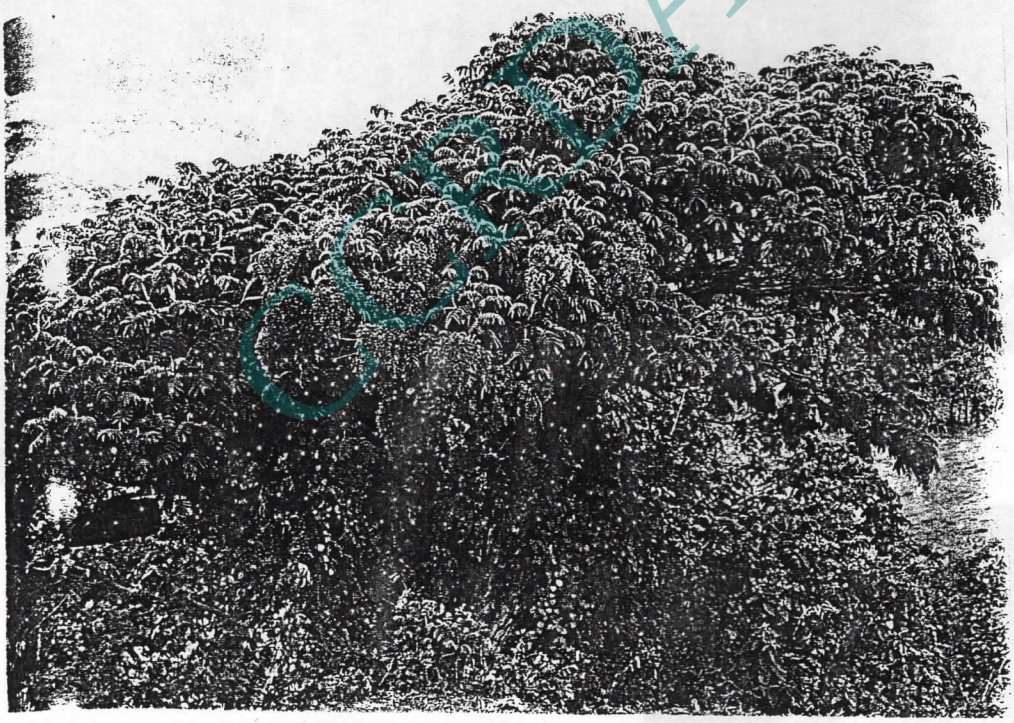
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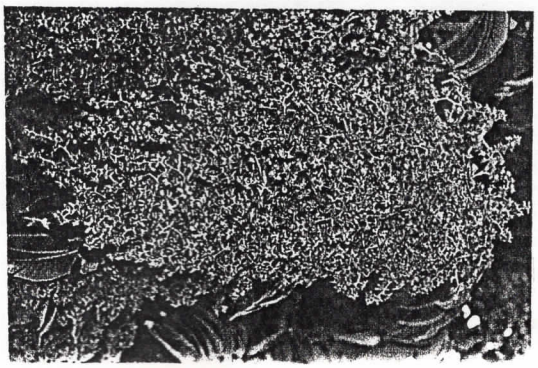
Hagenia abyssinica *(Bruce) J.F.Gmelin*

GORA-GORA (Agew); KOSO (Amh); SOBERT, SOSEN (Ge'ez); WENQQ
(Gam); KEBSE, TCHEMA (Gur); SUTO (Had); TIEMA (Kem); DUCC
ETO, FICO, HETO (Sid); H'ABBI, SONO (Tya); JOLIYA-MIT
KOSUWA, TALIYA (Wel); KOSSO, HAGENIA (Eng)

Family: Rosaceae

Description: Forest tree growing to 25 m tall with a rounded o
even umbrella-shaped crown. The short trunk or stem is sometim
very thick, up to 1 m in diameter, but rarely straight. Bark
reddish-brown, flaking irregularly; the gyoung branchlet ar
covered with golden hairs, ringed by the scars of the sheathi
leaf-bases. Leaves: compound, up to 40 cm long; divided into 11
13 pale to bright green leaflets which are arranged in a opposit
manner on the stalk; the margins of leaflets are toothed like
saw; the surfaces are often slivery on the underside. Flowers
small and numerous in large, attractive hanging bunches up to 60
in length; the female flowers are bulkier and more reddish than th
more feathery, orange-white male heads. Fruits: small a
asymmetric.





Millettia ferruginea *(Hochst.)* Bak.

BRABBRA (Amh, Gur & Tya); ZADYA, ZAGIE (Gof & Wel); BILEWU-HAQA (Had); BIBERO (Kef); YAGO (Kef & Or); RENGAZENA (Kem); SOTELLI; YAGOY (Mes); GDICCO, AKSIRA, ASRA, DEDATU, KARCECCE, KOTELLU, SARI, SOTALLO (Or); ZIYAG, ZIYAGU (Sha); 'NGEDICCO (Sid)

Family: Fabaceae (Leguminosae) subfamily Papilionoideae

Description: an endemic tree with a mainly straight trunk. Bark: smooth and grayish. Leaves: up to 40 cm long; leaflets up to 9 cm long, oblong-acuminate, hairy on both sides; usually the upper surface is green and the lower one ashy-green. Flowers: violet or lilac, produced in groups on stalks up to 30 cm long. Pods: flat, thick, brownish-hairy or almost without hairs and up to 27 cm long and 3 cm wide. The pods burst on the trees and the dark brown flat seeds are so scattered.





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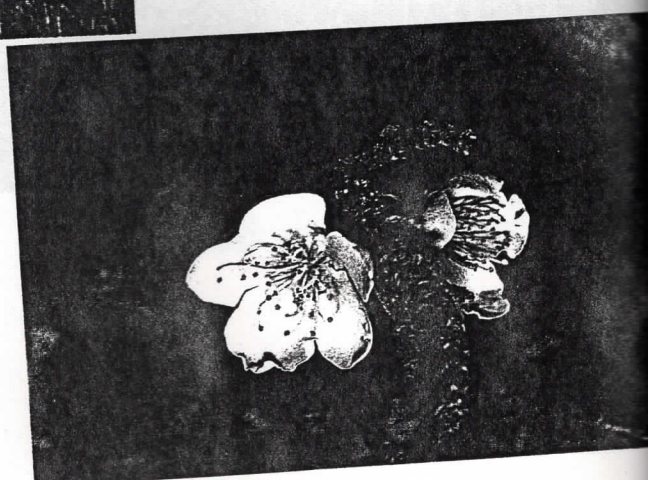
Prunus persica *(L.) Batsch*

KOK (Amh, Gur, Ge'ez & Tya); HOH, SEQUINON, SKINON, SQIN
(Ge'ez); KOKI (Or); KOH' (TYA); PEACH (Eng); PFIRSICH (Germa

Family: Rosaceae

Description: Small fruit tree with glabrous, reddish twigs. Bar
grey brown and splitting. Leaves: oblong-lanceolate with fine
toothed margins. Flowers: pale to deep pink, subsessile and mostl
solitary. Fruits: fleshy, round, 40 to 80 mm in diameter; sk
greenish and velvety, seed in a hard pitted stone.





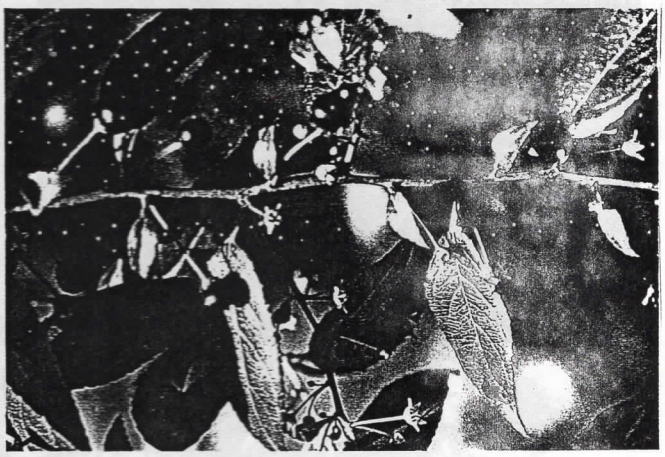
Rhamnus prinoides *L'Herit.*

GEGHO (Agew); GIESHO (Amh, Ade, Gam, Had, Or & Tya); SIEWA (Ge'ez); GISHE (Gur); GESHA (Kem & Saho); RAHA, TADO (Or); GIESO (Tya); TANDO, GESWA (Wel); DOGWOOD (Eng); KREUZDORN (German)

Family: Rhamnaceae

Description: Small tree or shrub, much-branched, growing up to 8 m high with slender stems and drooping branches. Bark: smooth, grey-brown, getting darker with age; it is clearly dotted with white breathing pores. Leaves: alternate and pinnately veined, ovate to elliptic or lanceolate, up to 12 cm long; shiny dark green above with a finely toothed margin. Flowers: yellowish green and small, solitary or in axillary clusters. Fruit: small berries, 8 mm across, turning from green through red to blackish purple.





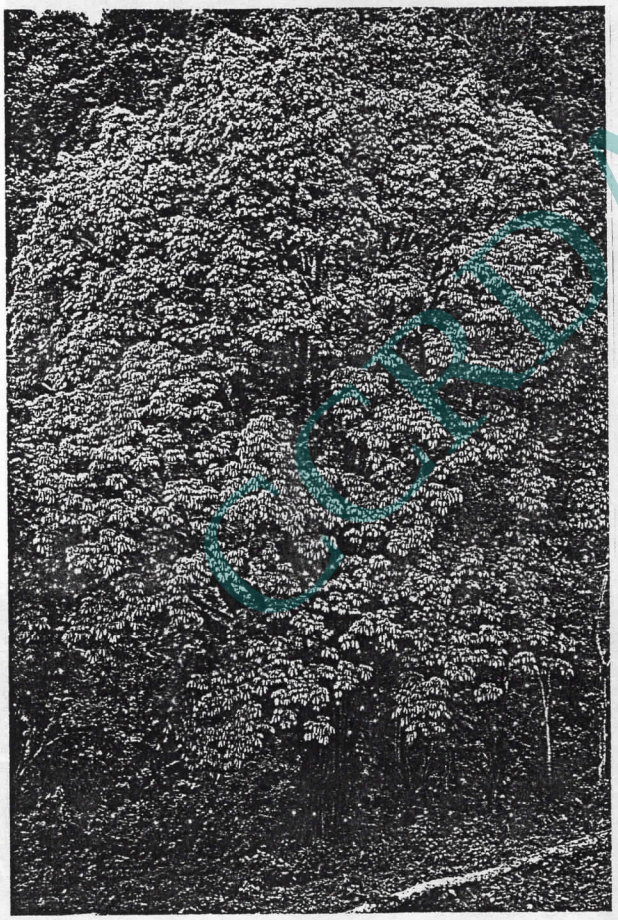
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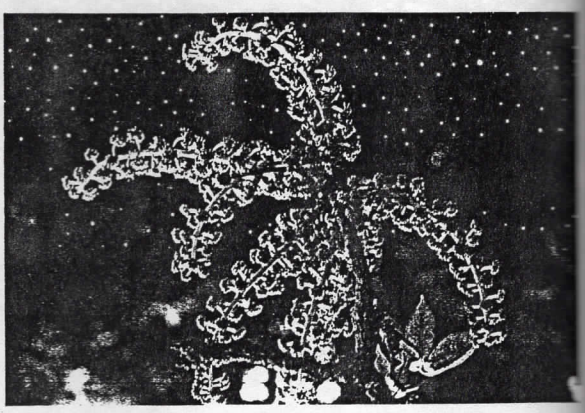
Schefflera abyssinica *(Hochst. ex A. Rich.) Harms*

KETEME, QUSTYA (Amh); GABTZE (Gam); GETEM (Had & Sid); WT
(Kef); ARFATTU, GATAMA, HARFATU, MARFATU (Or); ORONCE (Sid
BOBLUHU (Som); get'em (Tya)

Family: Araliaceae

Description: Tall tree, up to 30 m high, with a spreading crow
sometimes found growing as an epiphyte. Bark: grey-black and cork
Leaves: simple and palmately lobed, clustered at the ends of th
branches; leaflets ovate or elliptic, rarely obovate; papery o
somewhat leathery usually toothed margins. Flowers: cream-
yellowish or creamy-white in small umbels which are grouped into 3
to 40 cm long racemes. Fruits: red, 0.5 to 1 cm long.





Acacia mearnsii De Wild
Family Mimosaceae

Related species: *A. dealbata* has larger leaflets, usually silvery foliage and broader legumes which are only slightly moniliform.

Names: Botanical--honours E.A. Mearns (1856-1916), the collector of the type specimen; common--refers to the dark foliage and bark which many acacias have.

Bark: Somewhat variable on old trunks--usually brownish-black, hard and fissured. On younger stems and the upper parts of older trees it is thinner, smoother and lighter in colour.

Leaves: Seedling--sprawling, bipinnate, with 4-8 opposite pairs of pinnae, dark green; each pinna consists of 20-25 pairs of oblong leaflets. Adult--bipinnate with 8-21 pairs of pinnae and 15-70 pairs of leaflets; leaflets oblong, 1.5-4x0.5-0.75 mm, often minutely pubescent, olive green, concolorous; glands present between the pairs of pinnae on upper surface of leaf; overall length of compound leaf often 8-12 cm.

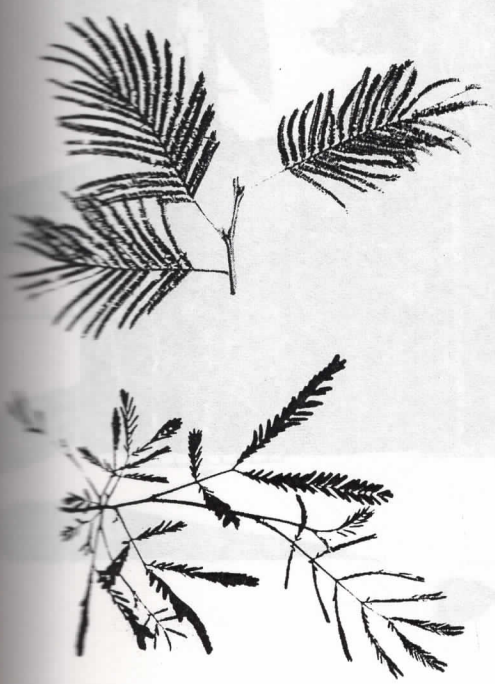
Inflorescences: Axillary or terminal panicles, about as long as the leaf. Heads with 20-30 flowers, pale creamy yellow.

Fruits: Legumes, more or less straight, tending to be moniliform, finely pubescent, 5-15x0.4-0.8 cm.

Wood: Sapwood very pale; heartwood light brown with reddish markings, very hard and tough, fine textured but cross or interlocked grain common, low to moderate durability, density about 810 kg m^{-3}.

Distinctive features: Dark green foliage; very small leaflets; leaves, more or less moniliform legumes; glands between the pairs of pinnae on the upper surface of the hairy leaf rhachis.

CCRDA





Acacia melanoxylon R.Br.
Family Mimosaceae

Related species: *A. implexa* is closely related to *A.melanoxylon* but the phyllodes of the former are normally more falcate and the veinlets are anastomosing; the flower heads are branched and, most importantly, the funicle is in a few folds at one end of the seed compared with the bright red funicle which encircles the seed in *A.melanoxylon*.

Names: Botanical--Greek *melas* (black), plus *xylon* (wood); common--from the wood colour.

Bark: Varies in thickness from less than 0.5 to 5 cm at the base of very large trees. Hard, longitudinally furrowed but only slightly transversely, brownish-grey to very dark grey. In moister environments the shady side of the stem often has a partial covering of light to mid-grey coloured lichens. Leaves: Seedling--bipinnate, mainly with 2-5 pairs of pinnae and 12-15 pairs of leaflets; leaflets almost sessile, oblong, about 0.8x0.2 cm, mid-green on the upper surface, slightly paler on the under surface; the mid-vein and lateral venation of leaflets are visible with a 10x times magnifying hand lens.

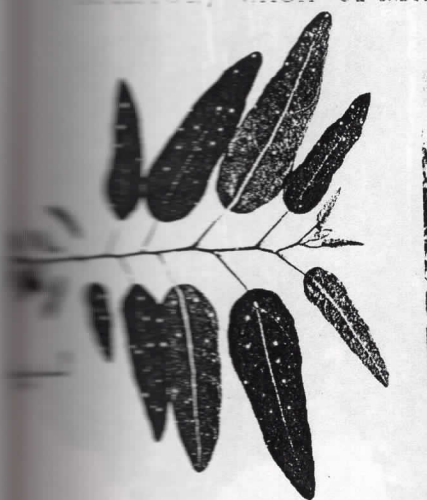


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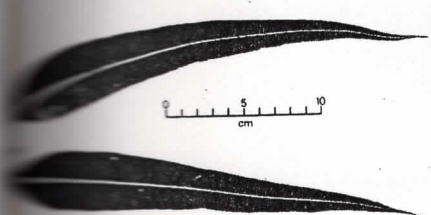
Eucalyptus citriodora Hook.
Family Myrtaceae

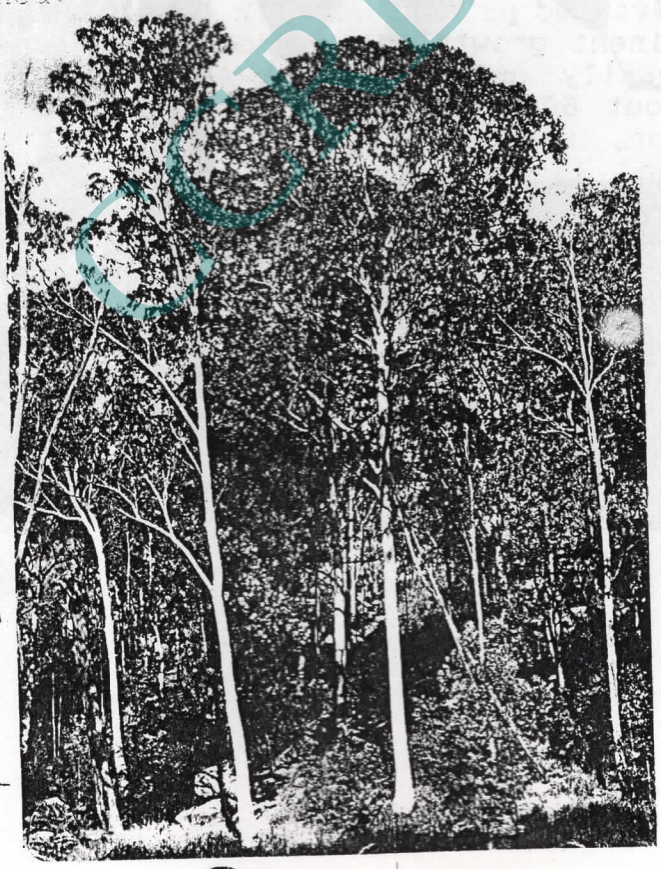
Names: Botanical--Latin *citron* (emon), plus *odorus* (having a smell); common--also from the strong lemon scent of the crushed leaves.

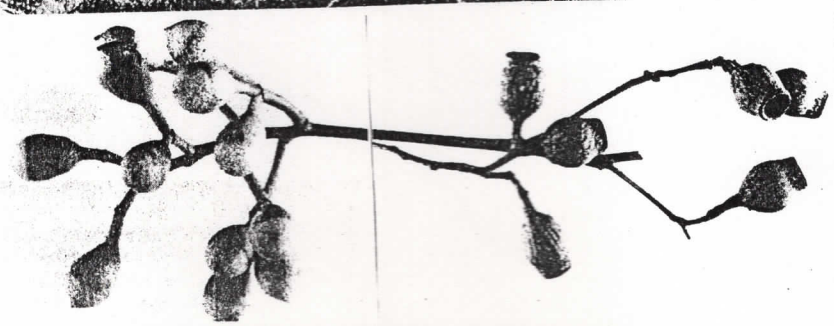
Bark: Usually smooth white throughout with a powdery surface; in north Queensland the bark is often pink to almost red for a large part of the year, only the recently exposed bark being whicht. In the southern area the trees are often indistinguishable from *E. maculata* on bark characteristics, due to the patches of bluish grey older bark adhering to the tree, giving the characteristic "spotted gum" appearance. Leaves: Seedling--opposite for 3-5 pairs then alternate, petiolate, peltate, ovate, 6.5-17x2.3-7.5 cm, pale green, slightly discolorous, setose. Juvenile--alternate, petiolate, ovate to broad-lanceolate, 14-21x4.5-8 cm, some remaining setose, pale green and peltate for many pairs, others becoming glabrous and glossy green soon after the seedling stage. Stems, petioles and leaves (particularly veins) are covered with simple hairs to 0.5 cm long, in both the seedling and juvenile leaf stages. Intermediate--alternate, petiolate, broad-lanceolate to lanceolate, 13-30x2-5 cm, green concolorous. Adult--alternate, petiolate, lanceolate to narrow-lanceolate, 8-16x0.5-1.8 cm green, concolorous. All leaves with strong smell of citronellal (lemon-scented) when crushed.











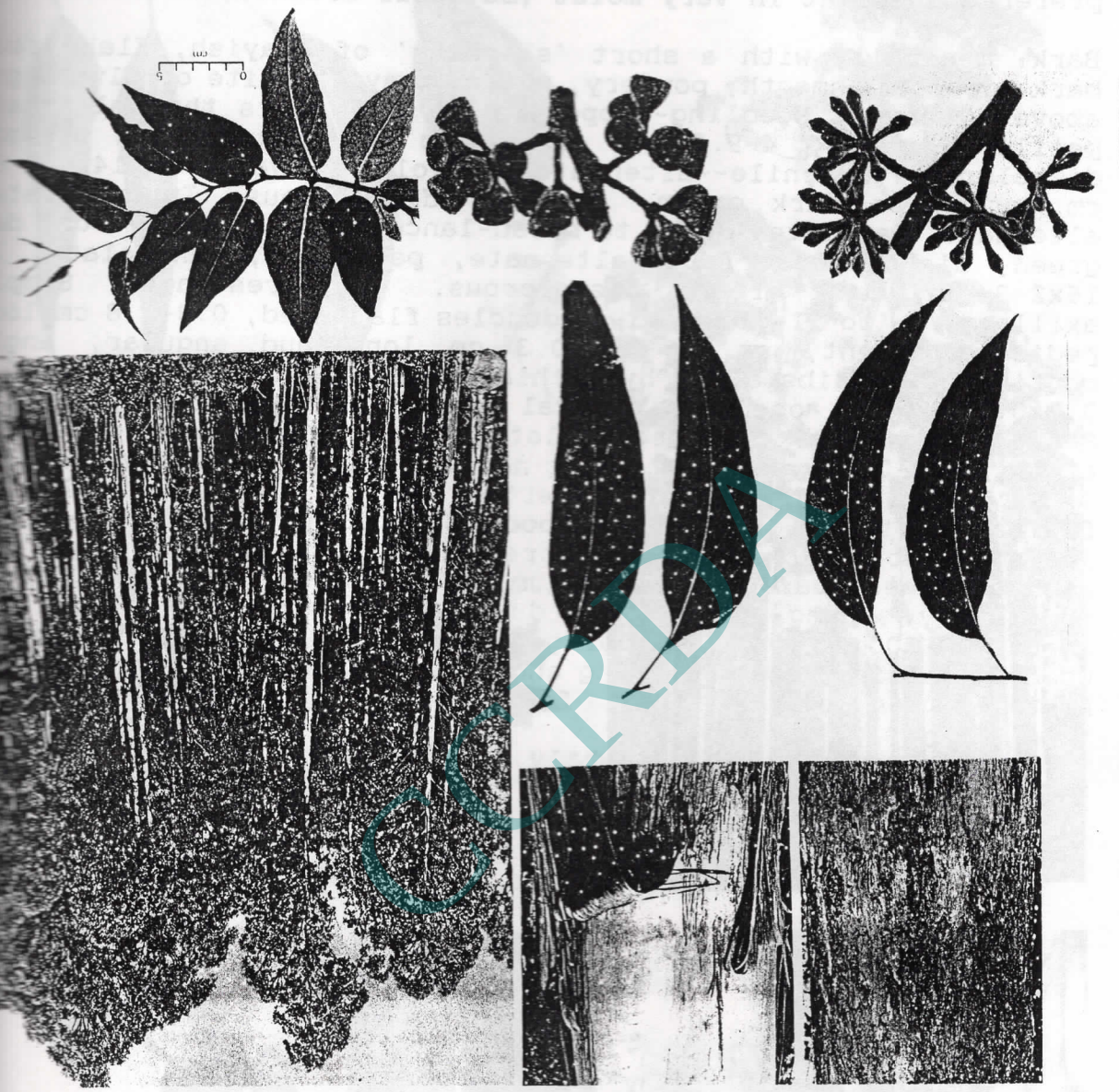
FORDA

Eucalyptus regnans F. Muell.
family Myrtaceae

Names: Botanical--Latin *regnare* (to rule), of its height and dominance; common--refers to habitat and the similarity of the timber to the ash *(Fraxinus)* of the norther hemisphere.

Bark: Rough and persistent, fibrous at the base for up to 15 m, the remainder smooth, white or greenish grey, thin, shed in long ribbons, often conspicuously hanging from the branches. Leaves: Seedling--opposite for 2-3 pairs then alternate, petiolate, ovate, 5-13x2.5-4.5 cm, green, discolorous. Juvenile--alternate, petiolate, ovate, oblique, tapering suddenly to a pointed tip, 7-17x4.5-8 cm, green, discolorous at first, soon becoming concolorous. Stems at seeding and juvenile stages have numerous raised oil glands. Intermediate--alternate, petiolate, broad-lanceolate, oblique, 13-21x3.5-6 cm, green, glossy, concolorous. Adult--alternate, petiolate, broad-lanceolate to lanceolate, 8-14x1.6-2.7 cm, green, concolorous. Inflorescences: Simple, axillary, usually paired, 9- to 15-flowered; peduncles angular, 0.5-1.3 cm long; buds clavate, 0.5-0.7x0.3-0.4 cm; operculum hemispherical-apiculate or conical. Fruits: Pedicellate, obconical or pyriform, 0.5-0.9x0.4-0.7 cm; disc relatively broad, more or less level to slightly ascending, valves 3, to rim level or slightly enclosed, occasionally very slightly exserted. Wood: Sapwood indistinct, to 2.5 cm wide, rarely attacked by Lyctus borers; heartwood pale brown with open texture, straight grain and often prominent growth rings, moderately strong and hard but not durable, easily split and worked, dresses and finishes well, density about 600-800 kg m^{-3}; used for engineering and building construction, marine craft, flooring, architraves, furniture, plywood, and is considered the best of the eucalypts for the Australian pulp and paper industry. Distinctive features: Usually a very tall tree, without lignotubers, with a stocking of fibrous bark then smooth, white or grey above, often ribbony below. Inflorescences axillary, 3+ pairs, a characteristic only regularly shared in subgenus *Monocalyptus* with *E fastigata*.

CCRDA



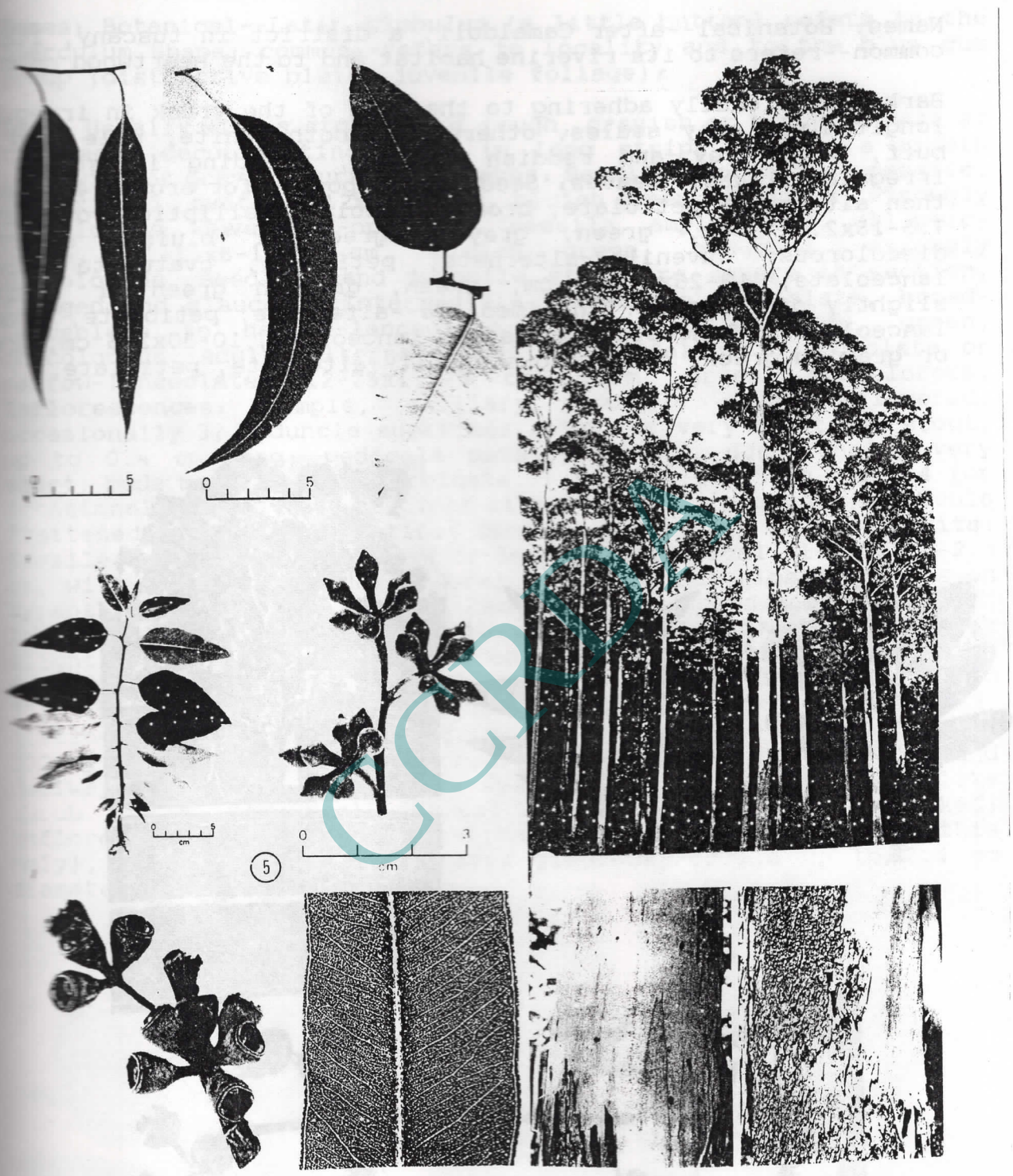
CRDA

Eucalyptus grandis W. Hill ex Maiden
family Myrataceae

Names: botanical--Latin *grandis* (large, big, tall), refers to the large size this species commonly attains; common--refers to preferred habitat in very moist (but well-drained) areas.

Bark: generally with a short 'stocking' of grayish, flaky rough bark for 1-4m, smooth, powdery, white, grayish white or bluish gray above. **Leaves:** Seedling--opposite for 4-5 pairs then alternate, petilate, ovate, 4-9.5x2-4 cm, green to dark green, strongly discolorous. Juvenile--alternate, petiolate, ovate, 10-14x5.5-8 cm, green to dark green, strongly discolorous. Intermediate--alternate, petilote, ovate to broad-lanceolate, 16-18x3-5 cm, dark green, discolorous. Adult-alternate, petiolate, lanceolate, 12-16x2-3 cm, dark green, discolorous. **Inflorescences:** Simple axillary, 7- to 11-flowered; peduncles flattened, 0.8-1.8 cm long, pedicels absent, or up to 0.3 cm long and angular, angles continuing as ribs along hypanthia; buds more or less ovoid, 0.8x0.3-0.4 cm; opercula conical or somewhat rostrate. **Fruits:** Sessile or very shortly pedicellate, pyriform, slightly contracted at rim, 0.5-0.8x0.4-0.7 cm; disc narrow, more or less level; valves 4 or 5, relatively broad, exserted and incurved. Branchlet and fruits sometimes glaucous. **Wood:** Sapwood pale pink, generally resistant to attack by *Lyctus* borers; heartwood pink to light red with a rather coarse texture, gum veins common, straight-grained, moderately strong, moderately durable; density rather variable, about 700-800 kg m^{-3}, used for general construction, joinery, plywood, panelling, boat building and flooring. Distinctive features: A tall tree of excellent form, without lignotubers, almost completely smooth-barked, leaves discolorous at all stages, fruits with relatively broad, slightly exserted, incurved valves, no lignotuber.

CCRDA


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cm
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5

Eucalyptus camaldulensis Dehnh.
family Myrtaceae

Names: Botanical--after Camalduli, a district in tuscany, Ital
common--refers to its riverine habitat and to the heartwood colou

Bark: Occasionally adhering to the base of the trunk in irregul
longitudinal grey scales, otherwise smooth, white, pale grey
buff, with grey and reddish patches, shedding in strips
irregular flakes. **Leaves:** Seedling--opposite for around 4-6 pa
then alternate, petiolate, broad-lanceolate, elliptical or ovat
7.5-15x2.5-7 cm, green, grayish green or bluish, slight
discolorous. Juvenile--alternate, petiolate, ovate to broa
lanceolate, 13-26x4.5-8 cm, green, grayish green or bluis
slightly discolorous. Intermediate--alternate, petiolate, broa
lanceolate to lanceolate or narrow-lanceolate, 10-30x2-6 cm, gre
or grayish green, concolorous. Adult--alternate, petiolate,



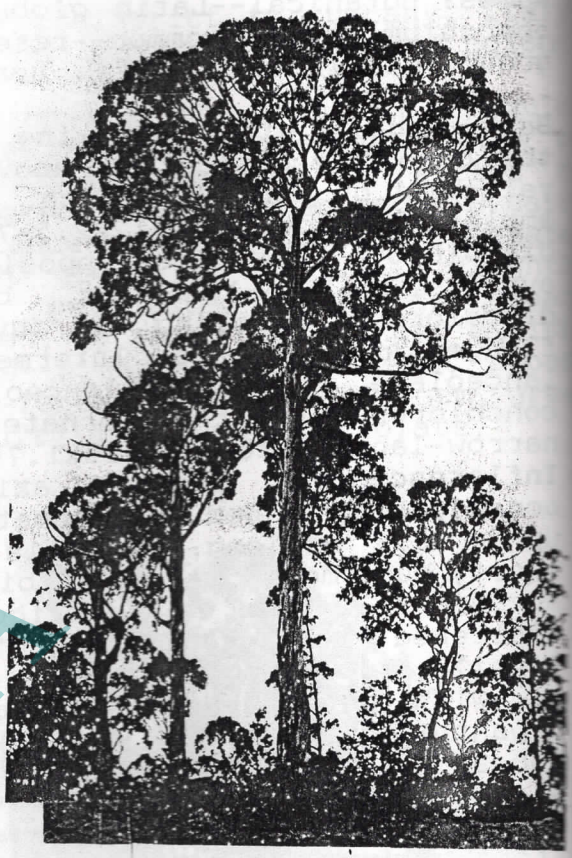
CORDA

Eucalyptus globulus Lbill. subsp. *globulus*
family Myrtaceae

Names: Botanical--Latin *globulus* (a little button) refers to the operculum shape; common--refers to locality and to the blue gum group (distinctive bluish juvenile foliage).

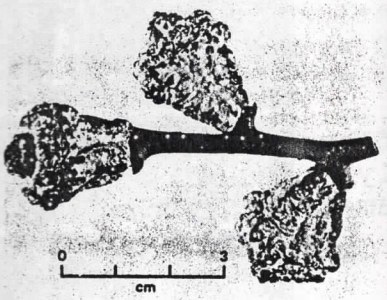
Bark: Usually with a stocking of rough, grayish or brownish bark at the base, decorticating above in long strips leaving a smooth yellowish or grayish surface. **Leaves:** Seedling--opposite, sessile, amplexicaul, ovate, 6-12x2.5-7 cm, bluish green, glaucous, strongly discolorous. Juvenile--opposite, sessile, amplexicaul, elliptic-ovate, 11-15x6-10.5 cm, bluish green, glaucous, strongly discolorous. Seedling and juvenile stems are square in section, winged and glaucous. Intermediate--alternate, petiolate, broad-lanceolate to narrow-lanceolate, 20-35 (-50)x3-8 cm, green, concolorous. Adult--alternate, petiolate, falcate, lanceolate or narrow-lanceolate, 12-25x1.7-3 cm, firm, green, concolorous. **Inflorescences:** Simple, axillary, usually only 1-flowered, occasionally 3; peduncle sometimes absent or very short and stout, up to 0.4 cm long; pedicels usually absent, occasionally very short; buds more or less turbinate, 1.5-2.3x1.4-1.8 cm, with 4 (or occasionally more) very distinct ribs, extremely glaucous; opercula flattened with a very distinct central knob, very warty. **Fruits:** Sessile, sub-globular to more or less hemispherical, 1-2.1x1.4-2.4 cm, with 4 (or occasionally more) very distinct ribs, glaucous on hypanthia; disc broad, more or less level or ascending, with slight lobes; valves 4 or 5, more or less horizontal and at rim level or slightly exserted, partly covered by the disc lobes. The fruits have a very distinct, concave calycine ring. **Wood:** Heartwood pale yellowish brown, open-textured, grain commonly interlocked, distinct growth rings, strong, moderately durable, density about 960 kg m^{-3}; used for light and heavy construction, poles, piles and railway sleepers. *Distinctive feature:* Varies from a mallee-like shrub to a very tall forest tree; largely smooth-barked; inflorescences usually with solitary buds; buds, fruits (hypathia only), juvenile stems and leaves glaucous; fruits up to 2.4 cm in diameter, 4-ribbed.

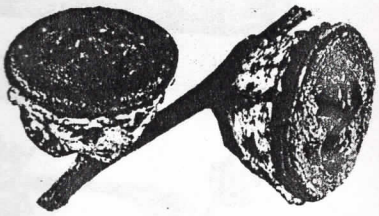
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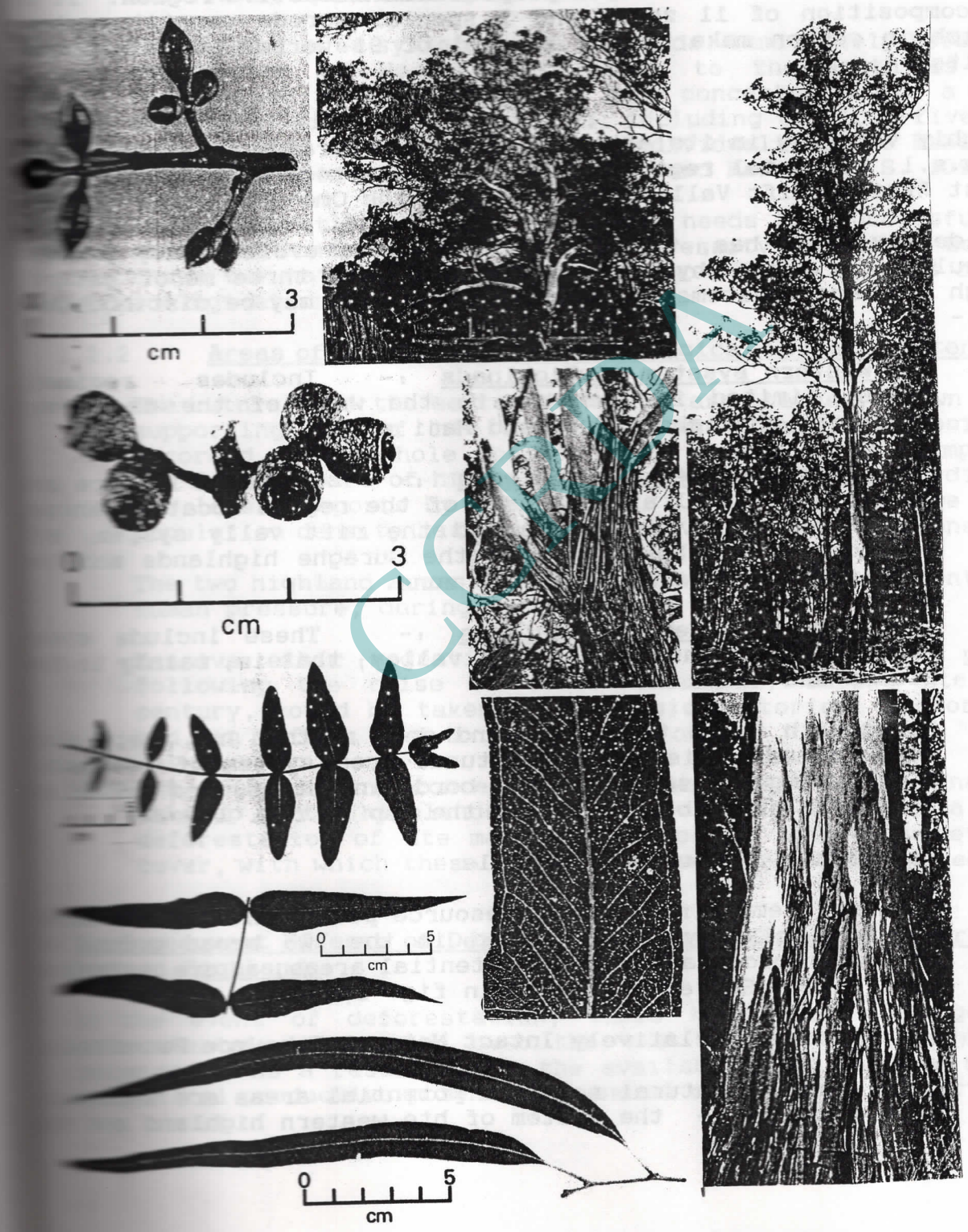






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Eucalyptus viminalis Labill. subsp. *viminalis*
family Myrtaceae



COPIA

AN OUERVIEW OF THE REGIONAL AGRO-FORESTRY TRADITIONS IN SEPAR

1. GENERAL BACKGROUND

1.1 The Regional Area

The total land area of some 117,000 km2 in the southern and sourt western most part of Ethiopia, comprises the territorial unity o SEPAR - the southern Ethiopia peoples administrotive region. It a composition of 11 zonal and 5 special woreda constituencie which in common make up for a total of 95 woreda administrativ units.

Highly varrying in its altitudes within the range of 400 and 35 m.a.s.l. the total regional area is tri-sected; once by the Gre East African Rift Valley, and again by the Omo-Gibe river gorge.

Evidently, this has, throuth its continuous evolutionary proces resulted in a geo-physical formation of hte three major natura high land area systems in this region. These may be distinguishe as:-

a. The Western sysstem of Highlnads :- Includes regiona areas, limited in locaiton to the west of the omo rive (kafidro, shakicho, Bench and Maji zones).

b. The central system of Highlands :- Included in here ar areas in the ceulral most part of the region located behvc the Omo-Gibe rivers gorges and the rift vally system, a extending Norht-South behveen the Guraghe highlands and t highlands of Bako in South Omo zone.

c. The Eastern System of Highlands :- These include are limited to hte east of hte rift valley; that is, mainly in t Sidama and Gedeo zones.

Along with these three highland area systmes has there al been formed a distinctive natural area system of lowland minly along the southern most bordering areas; and follwoi the major river basins. (See the map in fig. 1.)

1.2 The Natural Resource Potentials

The last remaining natural resource potentials in the SEP may best clearly be presented in the two broad groups natural biological resource potential areas, as are summari here under (See also the map in fig. 2).

1.2.1 Areas of Relatively Intact Natural Resource Potential

This group of natural resource potential areas are include such areas as :- the system of hte western highland and t

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ones that make up the general low lying area system, along the southern Gordering areas.

Both of these two natural areas are widely known ot be still accomodating one of the country's msot few, but last remaining thresholds of remnant bio-diversity resources. The western system of highlands is esp. considered highly significant due to the obvious fact that it still supports an exceptionally unique type of Tropical moist forest vegetation, along with a complex diversity of its naturally associated wildlife (fauna and flora) species composition.

The natural area system of the lowlands, immidiately bordering the system of Western Highlands, to the south is well reconginzed to be accomodating high concentration of a great variety of wildlife populations, including the "big-five", as well as, the last remaining few individuals of the Ethiopian black rhino (masteos, E; Fasil, T. and Kafialew, S. 1994).

In consideration with the coutnry's needs for successful and sustained conservation of its fio-diversity resoruces, both of these two natural area systems deserve to be treated as one ecological unit.

1.2.2 Areas of Naturally Altered Bilolgical Resource Potential:

The cetnral and the easter highlands are, rather, known to be supporting one of hte highest human population desities, recorded in the whole coutnry. The most notable example is the Kambata part of hte central highlands, where according to hte latest reports by sutcliff, p. (1992), the average human population density has amounted to as high as 600 persons/km2.

The two highland areas have presumably been under a continous human pressure, during the last 400-500 years.

Massive ethic migration that had reporedly taken place, following the raise of Gralju Mohammad, during hte 16th century, could be taken on the basic historical factor that had, in effect, led to this situation.

The contined and concentrated human impact on the natural make-up of the highlands has, thus, come to result in a total deforestation of hte montane type of he natural vegetation cover, with which these highland systems had been reputed for.

The Consequent Effects of Deforestation on the Areas of Central and Eastern Highlands:

In the event of deforestation, there had taken plce general environmental degradation over the vast areas of the highlands concerned. As a result, both the availabilty of land, with any agricutlral productive potentials, and of the fuel and construction

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wood resoruces, that had otherwise used to be naturally availa
have accordingly declined in their physical quantities a
qualities.

Thus, the question whether the minimum availabitly of
agricutlrally productive land and energy resources (Wood) can
sustained at any desirable level became cruially improtant.

It is, apporently, this that had come to trigger the development
some agro-forestry traditions in these parts of hte SEPAR. Some
hte major Typical traditional components of agro-fores
practices, existing in the region is briefly presented in
following section.

2.0 Description of the Existing Agro-Forestry Traditon and
Components:

Major components of hte (regional) agro-forestry traditio
that have developed in the parts of SEPAR and their relat
significance to the different areas are summarised as ti
given in table 1. The summary is especially based on
results of a recnet survey, extensively conducted along
kms. long road systems in the parts of Kambata, Hadiy
Wolaita, Sidama and Gedeo.

The Components included in the summary are further discuss
as in the fore-going details.

2.1 Individual Woodlot Planting Traditions

Here are included varieties of woodlots that are plan
and/or managed, mostly for wood prodction (fuel wood a
construction materials) purposes. The great majority of th
are composed of Eucalyptus spp. ; i.e :

E. globulus :- on the higher altitudes (Dega);
E. Camaldulensis :- on the lower lying areas (woinedega).

Individual varieties of this component are more intesiv
practiced in the parts of Kambata, Hadiya, Wolaita and Sida
while they are very insignificant in the Gedeo area, where th
may be found only as strip plantations of a few trees, along w
front yard enclosures.

Traditions of managing individual bamboo and reed stands, and t
of hte relict trees and/or Tree stands (As adfar trees, grave y
trees) are almost equally well developed throught out the surve
areas, except it is little known in the parts of Gedeo.

A summary of Major Traditional Agro-Forestry components practi
in the parts of SEPAR.

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Traditional Components (Break-down)	Relative Frequency (Significance)				
	Kembata	Hadiya	Wolaita	Sidama	Gedeo
1. INDIVIDUAL WOODLOT PLANTATIONS					
1.1. Road side (strip) plantations	HF HF HF	HF HF HF	HF HF HF	HF HF HF	LF MF LF
1.2. Corner area (Far-field) plantations	HF HF	HF HF	HF MF	LF HF	LF -
1.3. Front yard corner plantation	HF	HF	HF	HF	-
1.4. Bamboo and Reed stands					
1.5. Relief trees and tree stands					
2. LIVE FENCING TRADITIONS					
2.1. Front yard enclosures	HF	MF	MF	LF	LF
2.2. In field enclosures:	HF	MF	MF	MF	LF
- Front Yard - in field boundary	HF	HF	HF	HE	-
- In-field-out field boundary	HF HF	LF MF	LF MF	-	-
- Individual land holding boundary					
3. Shade Tree Growing Traditions					
3.1 Front yard shading Trees	HF	HF	HF	HF	HF
3.2 Crop land shading Trees	HF MF	HF MF	HF MF	HF HF	- EHF
4. PERENNIAL FOOD CROP C PAR. AG-F. ROLE					
4.1 Fruit tree/shrub spp. diversity	HF LF MF HF	HF MF MF HF	HF MF HF HF	HF HF HF HF	HF HF HF HF
4.2 Root-Tuber producing spp. "					
4.3 Enset Cultivation					
5. COMMERCIAL CROPS (VARIETY)	HF	MF	HF	HF	HF

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Encalyptus woodlots are almost always located on peripherial com
parts of individual land holdings, so that they connot adver
affect cultivated (crop) aldns.

The agro-forestry signifcance of individual woodlots is interms
wood production, mainly for domestic consumption, though it may
improtant commercially, as a soruce of additional income, as we

2.2 Live Fencing Traditions

Traditions of live fencing are found widely distribu
through out all surveyed areas. But, there have been recor
some remarkable variations in their intensities, diversity
species composition. The highest diversity and intensity
live fencing varieties were recorded from the areas in
central highland system; i.e. in its Kambata, Hadiya
Wolita parts.

For example, in the Kambata part, where the existing li
fence varieties may be considered the highest, the follow
component (elements) were represented on the majority
individual land holdings. These are:

a. **Homestead (Front Yard) Enclosures**:- This type
live fencing is used to enclose the front quale
of the total homestead, and is almost alw
associated with an strip of Eucalyptus trees.
is made up of two conopy layers, where the fi
one is formed by the Eucalyptuses and the second
a variety of shrub species which may inclu
sensel, grawa, and the like.

b. **In-field enclosing live fences** :- These
usually of two types:-

- short and/or mono-canopy type of live fenc
that are usually used to separate the
fields and/or backyard homesteads from
front yard compounds. They may be composed
a shrubs spp. varieties, esp. suited for li
fencing.
- Live fence type that is commonly used
separate the in-fields from the main (o
fields is particularly widely used on fa
lands that occupy slopping terrains (pla
along contour lines) though they may not
vary uncommon on flat land holdings.

This type is probably the most diverse one
its species composition. (This is where
high variety of indigenous tree specie
shrubs, as well as, the bamboo and/or re

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stand, may be found concentrated.

The specific purpose of main training this type of live fencing, apart from physically protecting the mostly "a perennial crop supporting" in-fields from the main fields - mainly used for a plough seed types of farming and/or from any of the surrounding environs; is also to create a biological means of protecting agricultural productivity of the land holdings, as well as, to maintain a permanent source of timber, wood for making various types of farm tools (handles), wood for house construction and dry-tending, fuel wood, as well as, forage leaves - especially used as a dry season subsistence for domestic livestock. (see sketch on slide no.).

2.3 Inter-Farm land and/or Outer Boundary Live Fencing :- This type of live-fencing could, normally, the largest extent (coverage among the families of the traditional live fencing agro-forestry component. It may be very similar in its composition with the fore-going type of live fencing, especially when it is meant to serve as an inter-farm land boundary between two individual farms. It otherwise and when it is made to follow the farm land boundary along high-ways, internal system of the public rights of way (foot paths), and/or other communal lands, it may then include, additionally, wood lots and/or strips of Eucalyptus plantations. (See slide no.).

The primary purpose of an inter-farm land or outer boundary live fencing is physical protection of individual land holdings a supplementary source of multi purpose wood resources.

Due to this kind of traditional live fence complexity (diversity), the areas included in the general system of the central highland,s particularly when viewed form the air, may give an impression of some artful structural designing, that is some what comparable with a modern urban area planning. (See the sketch on slide no. _____ and picture on slide no. _____).

The eastern highland areas, unlike the central parts, possess much less developed (simple indiversity and species composition) live fencing type of agro-forestry tradition. In this aspect, the majority of the Sidama part has got relatively better developed live fences, though these too are still found limited in their component variety, to the homestead enclosure type, only. Whatever the case may be in this connections, the Sidama could be considered as a transition between the two major regional area systems.

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Overall, therefore, a hypothetical top-view of the eastern areas, would produce a pitcher of a flank continuity, with clear boundaries between any individual land holding unit (See sketch picture on slide no. _____).

2.4 Shade Tree Growing Traditions

The two major varieties of regional traditional shade tree growing type of an agro-forestry component are : the Front Yard (homestead) tree shading; and on-the farm land-tree shading traditions.

2.4.1 Front-Yard Tree shading Tradition :-

This traditions agroforestry element is almost equally developed, through out all central highland areas as well as, in the Sidama part of the Eastern highland areas; and Gedeo has been found the only exception in this respect.

The front-yard tree shading practice in many parts of among many nationalities of the SEPAR part of Ethiopia is strictly associated traditionally, with the complimentary practice of maintaining large front-yard spaces. Both, the size of the front yard space maintained and the quality of the shade trees, it is meant to support have long since been, and still are being used as a major factor for measuring (ranking) the social status of individuals in their societies.

In the sidama, Kambata, Hadiya and Wolaita parts of the region, where the front-yard tree shading tradition has been well developed, the tradition of maintaining spacious front-yard areas, has also been complimentarily and equally well developed.

Contrary to this it looks as if, only the Gedeo part among the whole group of areas concerned, lack the traditional standards, necessary for either, maintaining the front yards or developing its shade tree growing traditions.

The most commonly prepared tree species in all areas with well developed tradition of front yard tree shading practices, are:- Prodocarpus graciliro (Zigba), Cordia africana (Woira), Jumiperus procera (Habesha Tid), Albizia gumibera (Sesa), accacia abysimica (Gra), Syziqium Spp, and the like. However, there are some recent tendencies of increasing the use of exotic fast growing tree species for this very purpose. The most notable species are: Eucalyptus saligna, E.grandis, Cupressus lusitaniea grevilia robusta, casuarina equistifolia; and a few more

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2.4.2 The on-the farm-land shade tree growing:- This traditional element is found to have been exceptionally most highly developed on the eastern highland areas than any where else. the Gedeo part may be ranked "the best developed" in this regards, only to be followed by its adjacent sidama part, as the second best.

The farm land tree shading element of the traditional agro-forestry practices, is found far less developed on the central highland parts. among the group of areas, belonging to the central high lands, only the Kamabta part may be considered slightly better in this respect with wolaita and Hadiya parts still remaining far insignificant yet.

This biologically invaluable traditional element most probably, possess the highest possible ecological diversity of species, that could rarely be expected of any of the agriculturally developed land use systems, one could possibly think of. In this case all possible combinations of species (forest trees and shrubs, cultivated food crops such as enset, bananas and the like, together with the coffee and various other multipurpose species associations may be recorded on every piece of land in almost every part of the Gedeo. Hence, the Gedeo part of the eastern highlands would give to its uninformed strange visitors, a wrong impression that it still supports its original natural forest cover.

2.5 Perennial crops and Inter-cropping traditions

Many of the major types of food crops and commercial crops invariably grown in the areas under consideration are perennial in nature. The most noteworthy, in this regards are:-

The Enset - Major common staple food crop, with remarkable high multi-purpose values - as food and as a source of various raw materials, as well as an important plant species with an invaluable agro-forestry significance.

Root-tuber producing food plants: such as cassava, yam, godare potatoes ....etc.

Fruit trees and/shrubs : Avocado, Papaya, Zeitun, Mango, Banana....etc.

Commercial crop species : Coffee, Chat, Gesho, Sugar cane, ananas and the like

All or most of these perennial crops are widely cultivated in all of the areas under consideration.

The existing traditional agro-forestry practices in these

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areas is further diversified and biologically more enriched by the tradition of inter-cropping all most all sorts of perennial crop species, with the annual crops; such as: Maize, Beans, Pigeon peas, Cucumbers, Pepper, and others(see film No. ____ and _____) It is not uncommon to count up to 20 different food and/or commercial crop species just on the same plot in the homesteads and in-fields.

3.0 Conclusion

No matter how, just one or another type of the traditional elements described could be variable among the areas concerned, agro-forestry practices; and that it is this tradition that has helped the successful sustenance of the otherwise, highly limited agricultural land and its productivity in these areas, known to have long been effectively altered naturally, and yet still supporting one of the country's highest human population densities, remains a fascinating reality.

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AN OVERVIEW OF THE REGIONAL AGRO-FORESTRY TRADITIONS IN SEPAR

1. GENERAL BACKGROUND

1.1 The Regional Area

The total land area of some 117,000 square km in the Southern and South western most part of Ethiopia, comprises the territorial unity of SEPAR - the Southern Ethiopia Peoples Administrative Region. It is a composition of 11 Zonal and 5 Special Woreda constituencies, which in common make up for a total of 95 Woreda administrative units.

Highly varying in its altitudes within the range of 400 and 3600 m.a.s.l. the total regional area is tri-sected; once by the Great East African Rift Valley, and again by the Omo-Gibe river basin.

Evidently, this has, through its continuous evolutionary process, resulted in a geo-physical formation of the three major natural high land area systems in this region. These may be distinguished as:-

a. **The Western system of Highlands** :- Includes regional areas, limited in location to the west of the Omo River (Kaficho, Shakicho, Bench and Maji zones).

b. **The Central system of Highlands** :- Included in here are areas in the central most part of the region located between the Omo-Gibe rivers gorges and the Rift Valley system, and extending North-South between the Guraghe highlands and the highlands of Bako in South Omo zone.

c. **The Eastern System of Highlands** :- These include areas limited to the east of the Rift Valley; that is, mainly in the Sidama and Gedeo zones.

Along with these three highland area systems has there also been formed a distinctive natural area system of lowlands; mainly along the southern most bordering areas; and following the major river basins. (See the map in fig. 1.)

1.2 The Natural Resource Potentials

The last remaining natural resource potentials in the SEPAR may best clearly be presented in the two broad groups of natural biological resource potential areas, as are summarizesd here under (See also the map in fig. 2).

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1.2.1 Areas of Relatively Intact Natural Resource Potentials:

This group of natural resource potential areas are included; such areas as :- the system of the Western highland and the ones that make up the general low lying area system along the southern bordering areas.

Both of these two natural areas are widely known to be still accommodating one of the country's few, but last remaining thresholds of remnant bio-diversity resources. The Western system of highlands is especially considered highly signi-ficant due to the obvious fact that it still supports an exceptionally unique type of tropical moist forest vegetation, along with a complex diversity of its naturally associated wildlife (fauna and flora) species composition.

The natural area system of the lowlands, immediately bordering the system of Western Highlands, to the south is well recognized to be accommodating high concentration of a great variety of wildlife populations, including the "big-five", as well as, the last remaining few individuals of the Ethiopian black rhino (Mates, E; Fasil, T. and Kefialew, S. 1994).

In consideration with the country's needs for successful and sustained conservation of its bio-diversity resources, both of these two natural area systems deserve to be treated as one ecological unit.

1.2.2 Areas of Naturally altered Biological Resource Potential:

The Central and the Easter Highlands are, known to be supporting one of the highest human population densities, recorded in the whole country. The most notable example is the Kambata part of the central highlands, where according to the latest reports by Sutcliff, p. (1992), the average human population density has amounted to as high as 600 persons/km square.

The two highland areas have presumably been under a continuous human pressure during the last 400-500 years.

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Massive ethnic migration that had reportedly taken place following the rise of Gragn Mohammed during the 16th century, could be taken on the basic historical factor that had, in effect, led to this situation.

The continued and concentrated human impact on the natural make-up of the highlands has, thus, come to result in a total deforestation of the montane type of he natural vegetation cover, with which these highland systems had been reputed for.

The Consequent Effects of Deforestation on the Areas of Central and Eastern Highlands:

In the event of deforestation, there had taken place general environmental degradation over the vast areas of the highlands concerned. As a result, both the availability of land, with any agricultural productive potentials, and of the fuel and construc-tion wood resources, that had otherwise used to be naturally available have accordingly declined in their physical quantities and qualities.

Thus, the question whether the minimum availability of an agricul-turally productive land and energy resources (Wood) can be sustained at any desirable level became crucially important.

It is, apparently, this that had come to trigger the development of some agroforestry traditions in these parts of the SEPAR. Some of the major and typical traditional components of agroforestry prac-tices, existing in the region is briefly presented in the following section.

2.0 Description of existing Agroforestry tradition and their Components:

Major components of the (regional) agro-forestry traditions, that have developed in the parts of SEPAR and their relative significance to the different areas are summarized in Table 1. The summary is especially based on the results of a recent survey, extensively conducted along 466 kms. long road tran-sect in parts of Kambata, Hadiya, Wolaita, Sidama and Gedeo.

2.1 Individual Woodlot Planting Traditions

Here are included varieties of woodlots that are planted and/or managed, mostly for wood production (fuel wood and construction materials) purposes. The great majority of them are composed of Eucalyptus spp. ; i.e :

E. globulus :- on the higher altitudes (Dega);
E. Camaldulensis :- on the lower lying areas (Woinedega).

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Individual varieties of this component are more intensively practiced in the parts of Kambata, Hadiya, Wolaita and Sidama; while they are very insignificant in the Gedeo area, where they may be found only as strip plantations of a few trees, along with front yard enclosures.

Traditions of managing individual bamboo and reed stands, and that of the relict trees and Tree stands (as **Adbar** trees, grave yard trees) are almost equally well developed throughout the surveyed areas, except it is little known in the parts of Gedeo.

A summary of major traditional Agroforestry components practiced in the parts of SEPAR

Eucalyptus woodlots are almost always located on peripheral corner parts of individual land holdings, so that they cannot adversely affect cultivated (crop) lands.

The agro-forestry significance of individual woodlots is in terms of wood production, mainly for domestic consumption, though it may be important commercially, as a source of additional income, as well.

2.2 Live Fencing Traditions

Traditions of live fencing are found widely distributed throughout all surveyed areas. But, there have been recorded some remarkable variations in their intensities, diversity and species composition. The highest diversity and intensity of live fencing varieties were recorded from the areas in the central highland system; i.e. in its Kambata, Hadiya and Wolaita parts.

For example, in the Kambata part, where the existing live fence varieties may be considered the highest, the following component (elements) were represented on the majority of individual land holdings. These are:

a. **Homestead (Front Yard) Enclosures**:- This type of live fencing is used to enclose the front qualers of the total homestead, and is almost always associated with an strip of Eucalyptus trees. It is made up of two canopy layers, where the first one is formed by the Eucalyptus and the second by a variety of shrub species which may include: sensel, grawa, and the like.

b. **In-field enclosing live fences** :- These are usually of two types:-

- short and/or mono-canopy type of live fences, that are usually used to separate the in-fields and/or backyard homesteads from the front yard compounds. They may be composed of a shrubs species varieties, esp. suited for live fencing.

- live fence type that is commonly used to separate the in-fields from the main (out) fields, is particularly widely used on farm lands that occupy slopping terrains (planted along contour lines) though they may not be very uncommon on flat land holdings.

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This type is probably the most diverse one in its species composition. This is where the high variety of indigenous tree species, shrubs, as well as, the bamboo and/or reed stand, may be found concentrated.

The specific purpose of maintaining this type of live fencing, apart from physically protecting the mostly "perennial crop supporting" in-fields from the main fields - mainly used for a plough seed types of farming and/or from any of the surrounding environs- is also to create a biological means of protecting agricultural productivity of the land, as well as, to maintain a permanent source of timber, wood for making various types of farm tools (handles), wood for house construction and dry-tending, fuel wood, as well as, forage leaves - especially used as a dry season subsistence for domestic livestock. (see sketch on slide no. ...).

2.3 **Inter-farmland and/or outer boundary Live fencing** :-

This type of live fencing has the largest extent (coverage among the families) of the traditional live fencing agro-forestry component. It may be very similar in its composition with the fore-going type of live fencing, especially when it is meant to serve as an inter-farm land boundary between two individual farms. It otherwise and when it is made to follow the farmland boundary along highways, internal system of the public rights of way (foot paths), and/or other communal lands, it may then include, additionally, wood lots and/or strips of Eucalyptus plantations. (See slide no.).

The primary purpose of an inter-farm land or outer boundary live fencing is physical protection of individual land holdings and supplementary source of multi purpose wood resources.

Due to this kind of traditional live fence complexity (diversity), the areas included in the general system of the central highlands particularly when viewed form the air, may give an impression of some artful structural designing, that is some what comparable with a modern urban area planning. (See the sketch on slide no. ... and picture on slide no...).

The Eastern Highland areas, unlike the central parts, possess much less developed (simple in diversity and species composi-tion) live fencing type of agroforestry tradition. In this aspect, the majority of the Sidama part has got relatively better developed live fences, though these too are still found limited in their component variety, to the homestead enclosure type, only. Whatever the case may be in this connections, the Sidama could be considered as a transition between the two major regional area systems.

Overall, therefore, a hypothetical top-view of the eastern areas, would produce a pitcher of a flank continuity, with no clear boundaries between any individual land holding units. (See sketch picture on slide no. _____).

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2.4 Shade Tree Growing Traditions

The two major varieties of regional traditional shade tree growing type of an agrofo component are : the Front-Yard (homestead) tree shading; and on-the farmland- shading traditions.

2.4.1 Front-Yard Tree shading Tradition :- This traditional agroforestry ele is almost equally developed throughout all Central highland areas, as well a the Sidama part of the Eastern highland areas; and Gedeo has been found the exception in this respect.

The front-yard tree shading practice in many parts and among many nation of the SEPAR part of Ethiopia, is strictly associated traditionally, with complimentary practice of maintaining large front-yard spaces. Both, the si the front yard space maintained and the quality of the shade trees, it is mad support have long since been, and still are being used as a major factor measuring (ranking) the social status of individuals in their societies.

In the Sidama, Kambata, Hadiya and Wolaita parts of the region, where the fr yard tree shading tradition has been well developed, the tradition of maintai spacious front-yard areas, has also been complimentarily and equally w developed.

Contrary to this it looks as if, only the Gedeo part, among the whole grou areas concerned, lack the traditional standards, necessary for either, maintai the front yards or developing its shade tree growing traditions.

The most commonly prepared tree species in all areas, with well devel tradition of front yard tree shading practices, are:- Prodocarpus graciliro (Zig Olea africana (Woira), Juniperus procera (Habesha Tid); Albizia gumifera (Se Acacia abysinica (Grar) Syziqium Spp. and the like. However, there are so recent tendencies of increasing the use of exotic fast growing tree species for this very purpose. The most notable species are: Eucaly saligna, E.grandis, Cupressus lusitanica Grevillea robusta, Casuarina equisti and a few more

2.4.2 The on-the farm-land shade tree growing:- This traditional element is found to have b exceptionally most highly developed on the Eastern highland areas than any where e the Gedeo part may be ranked "the best developed" in this regards, only to be follo by its adjacent sidama part, as the second best.

The farm land tree shading element of the traditional agro-forestry practices, is found less developed on the Central highland parts. among the group of areas, belongi the Central highlands, only the Kamabta part may be considered slightly better in respect with Wolaita and Hadiya parts still remaining far insignificant yet.

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This biologically invaluable traditional element most probably, possess the highest possible ecological diversity of species, that could rarely be expected of any of the agriculturally developed land use systems, one could possibly think of. In this case all possible combinations of species forest trees and shrubs, cultivated food crops such as enset, bananas and the like, together with the coffee and various other multipurpose species associations may be recorded on every piece of land in almost every part of the Gedeo. Hence, the Gedeo part of the eastern highlands would give to its uninformed strange visitors, a wrong impression that it still supports its original natural forest cover.

Perennial crops and Inter-cropping traditions

Many of the major types of food crops and commercial crops invariably grown in the areas under consideration are perennial in nature. The most noteworthy, in this regards are:-

The Enset - Major common staple food crop, with remarkable high multi-purpose values - as food and as a source of various raw materials, as well as an important plant species with an invaluable agro-forestry significance.

Root-tuber producing food plants: such as cassava, yam, godare potatoes ....etc.

Fruit trees and/shrubs : Avocado, Papaya, Zeitun, Mango, Banana....etc.

Commercial crop species : Coffee, Chat, Gesho, Sugar cane, ananas and the like

All or most of these perennial crops are widely cultivated in all of the areas under consideration.

The existing traditional agro-forestry practices in these areas are further diversified and biologically more enriched by the tradition of inter-cropping almost all sorts of perennial crop species, with the annual crops; such as: Maize, Beans, Pigeon peas, Cucumbers, Pepper, and others(see film No.____ and ____) It is not uncommon to count up to 15 different food and/or commercial crop species just on the same plot in the homesteads and in-fields.

Conclusion

No matter how, just one or another type of the traditional elements described could be variable among the areas concerned, agro-forestry practices; and that it is this tradition that has helped the successful sustenance of the otherwise, highly limited agricultural land and its productivity in these areas, known to have long been, effectively altered naturally, and yet still supporting one of the country's highest human population densities, remains a fascinating reality.

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Traditional Components (Break-down)	Relative Frequency (Significance)				
	Kembata	Hadiya	Wolaita	Sidama	Gedeo
1. INDIVIDUAL WOODLOT PLANTATIONS					
1.1. Road side (strip) plantations	HF	HF	HF	HF	LF
1.2. Corner area (Far-field) plantations	HF	HF	HF	HF	MF
1.3. Front yard corner plantation	HF	HF	HF	HF	LF
1.4. Bamboo and Reed stands	HF	HF	HF	LF	LF
1.5. Relief trees and tree stands	HF	HF	MF	HF	-
2. LIVE FENCING TRADITIONS					
2.1. Front yard enclosures	HF	MF	MF	LF	LF
2.2. In field enclosures:	HF	MF	MF	MF	LF
- Front Yard - in field boundary	HF	HF	HF	HE	LF
- In-field-out field boundary	HF	LF	LF	-	-
- Individual land holding boundary	HF	MF	MF	-	-
3. Shade Tree Growing Traditions	HF	HF	HF	HF	HF
3.1 Front yard shading Trees	HF	HF	HF	HF	-
3.2 Crop land shading Trees	MF	MF	MF	HF	EHF
4. PERENNIAL FOOD CROP C PAR. AF. ROLE	HF	HF	HF	HF	HF
4.1 Fruit tree/shrub spp. diversity					HF
4.2 Root-Tuber producing spp. "	LF	MF	MF	HF	HF
4.3 Enset Cultivation	MF	MF	HF	HF	
	HF	HF	HF	HF	
5. COMMERCIAL CROPS (VARIETY)	HF	MF	HF	HF	HF
6. GRASS FIELDS (CUT AND EARLY)	HF	MF	HF	MF	

CCRDA