Training Manual

AWARENESS CREATION, NURSERY ESTABLISHMENT, PLANTATION DEVELOPMENT and AGROFORESTRY MANAGEMENT PRACTICES

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"Community-based Climate Adaptation and Biodiversity Conservation in the model area of Lake Tana Biosphere Reserve, Ethiopia"

Content

i. Table of Contents

1. Introduction

Ethiopia Natural forests once covered 40% of the total land area. These natural resources are vanishing at an alarming rate, as deforestation amounts to 150,000 to 200,000 ha per year. Today the natural forest cover of the country is less than 7 %. The main reasons of forest degradation are: deforestation, agriculture land expansion, increase demand for fuel woods, increase in human population and livestock, poor land use systems and change in resource management structure. Besides, forest fire and mining of natural resources for construction are further factors of resource degradation in the country that result in high rate of soil erosion, reduction in soil fertility and change in climate patterns and ultimately chronic food insecurity.

Similarly, the ecosystems of Lake Tana have been significantly changed. Most of the forests have been converted to farm land and grazing areas. The natural forest cover has been reduced from an estimated 40% in 1990 to 0.39% at present (Lutz et al, 2015). These remnant forests are situated in the remaining church forests, on islands in the Lake Tana and in a few state forests.

Reducing poverty by increased agriculture productivity is one of the pillars of the Millendium Development Goals (MDG). However, growth in the agriculture sector needs to be closely associated with conservation of natural ecosystem and environmental parameters. The issue of food security will only be achieved if there is an integration of tree components into farming system and agricultural land management that incorporates trees as a component. This appears to be a practical solution of meeting the demand for tree products and environmentally sound practice. This is only possible if farmers and all stakeholders are educated and trained towards keeping their eco-system sustainable.

This training manual has been developed to serve Development Agents and the Woreda Office of Agriculture as reference material to train the local community and families on how to establish and develop home gardens with Agroforestry components and all necessary steps to achieve this, such as seedling preparation, management and improved nature management.

2. UNESCO Biospheres Reserves

2.1 The UNESCO definition

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located.

Biosphere reserves serve often as 'living laboratories' or model areas for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network: the World Network of Biosphere Reserves (WNBR). Within this network, exchanges of information, experience and personnel are facilitated. There are 669 biosphere reserves in over 120 countries.

The Man and the Biosphere (MAB) Program launched in 1970 promotes UNESCO's mission to foster peace and security through interdisciplinary and cross-sectoral collaboration, research and capacity building to stimulate local responses to global problems. The MAB Programme provides a platform for partnerships at the interface between science, policy and management for sustainable development. The Man and Biosphere (MAB) programme is supervised by UNESCO´s National Commission or mandated to the MAB National Committee of each respective country. MAB main tasks are: to promote research and education programmes, support information exchange and networking.

MAB interdisciplinary research, while rooted in ecological sciences, integrates knowledge from new and emerging disciplines, like ecological economics, socio-ecology and other areas of natural and social sciences including humanities as well as traditional knowledge of indigenous and local communities. It serves to attain the Millennium Development Goals and promotes sustainable development and human well-being through conservation of biological diversity, economic and social improvements and respect for cultural values (MAB Programme for Sustainable development, 2009).

Learn more about UNESCO and the MAB Programme at:

http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/

2.2 The Statutory Framework of the World Network of Biosphere Reserves

The Man and Biosphere (MAB) programme was established to promote and demonstrate a balanced relationship between humans and the biosphere. Biosphere reserves are designated by the International Co-coordinating Council of the MAB Programme, at the request of the State concerned. Each biosphere reserve remains under the sole sovereignty of the State where it is situated and thereby is subjected to state legislation only. All biosphere reserves form a World Network in which participation by the State is voluntary and differs greatly from country to country.

The Statutory Framework of the World Network of Biosphere Reserves has been formulated with the objective of enhancing the effectiveness of individual biosphere reserves and strengthening common understanding, communication and co-operation at regional and international level.

The Statutory Framework comprises ten articles:

- Article-1 The definition of biosphere reserves,
- Article-2 World Network of Biosphere Reserves,
- Article 3- Functions of biosphere reserves,
- Article 4- Criteria of biosphere reserves,
- Article 5- Designation procedure of biosphere reserves,
- Article 6- Publicity,
- Article 7- Participation in the Network, Article 8- Regional and thematic sub networks,

- Article 9- Periodic review and Article 10- Secretariat of biosphere for promotion by UNESCO.

2.3 The Seville Strategy

In 1995 UNESCO general assembly approved the Seville strategy in Spain. The Seville Strategy depicts the seven goals that widen conservation of biodiversity, sustainable development research and education that provide a vision for biosphere reserves in the 21st century. The strategy provides recommendations for developing effective biosphere reserves and for setting out the conditions for the appropriate functioning of the World Network of Biosphere Reserves.

2.4 Madrid Action Plan

In February 2008 during the 3rd World Congress of Biosphere Reserves the *Madrid Action Plan* was enacted. It builds on the Seville Strategy and aims to capitalize on the strategic advantages of the Seville instruments and raise biosphere reserves to be the principal internationally-designated area dedicated to sustainable development in the 21st century. The Madrid Action Plan articulates actions, targets, success indicators, partnership and other implementation strategies that avert accelerated climate change, loss of biodiversity, socio-cultural value and economic status of local community from 2008- 2013.

2.5 Local Regulation in Ethiopia

Each country has regulations to protect biodiversity and sustainable development. In Ethiopia the following national and regional policies have supported the establishment and management of biosphere reserves. These major policies and strategies are:

- National policy on Biodiversity Conservation and research policy (1998)
- National Biodiversity strategy and action plan (NBSAP) to the CBD (2005)
- National food security strategy (2003)
- Water resource management policy and proclamation (2001)
- Forest policy and proclamation (2007)
- Tourism development policy (2009)
- Rural development strategy (2002)
- Water resource management policy and proclamation (2001)
- National livestock development Programme (1997)
- Land use and land administration proclamation
- Climate-resilient Green Economy (CRGE)
- Growth and Transformation Plan (GTP)

3. Lake Tana Biosphere Reserve (LTBR)

3.1 Introduction

The LTBR is located in the Amhara National Regional State in the North West of the Ethiopian highlands (between 10°58`-12°47` northern latitude and 36°45`-38°14`eastern longitude). The UNESCO site comprises Lake Tana itself, all immediate

surroundings and parts of the higher catchment area of the Blue Nile. The total area of LTBR is 695,885.056 hectares, of which the core zones constitute an area of 22,841.584 hectares, buffer zones 187,566.666 and transition zones 485,476.806 hectares.

The LTBR is part of the *Eastern Afromontane Hotspot of Biodiversity*; it contains seven *Key Biodiversity Areas* and is the centre of origin of crop plants such as Noug (*Guizotia abyssinica*) and Teff (*Eragrostis tef*). This fertile region, with its centuries-old cultural history is of national and international importance for biodiversity and cultural landscapes' heritage. LTBR is naturally endowed with diverse arrays of ecosystems (wetlands surrounding the lake, forest ecosystem, fresh water, islands etc.) and different agro ecology which resulted in diverse flora and fauna. This can explain among other things the more than 270 bird species which include globally threatened bird species including palaearctic and inner-African migrants, more than 29 fish species (more than 15 endemic species) and plant species.

Lake Tana, the biggest and highest fresh water lake in Ethiopia and the source of the Blue Nile, represents the water tower of Africa. Its water resource is the fundament for agriculture and fishing and feeds the surrounding wetlands. Those wetlands are considered the most important hibernation sites for middle and north European water fowls (e.g. gray crane), ducks, shorebirds and singing birds (e.g. European barn swallow, yellow wagtail).

The Lake Tana basin supports the livelihoods of more than 2.5 millions inhabitant. The most important economic sectors of the local community are: smallholder agriculture (50% field, 30% grassland), which employs about 80% of the local population, tourism, fishing, livestock breeding and small scale producing industry.

Despite the huge local and international significance of LTBR, human induced problems are strongly affecting the biodiversity status. Among the land use change, extensive agriculture expansion, deforestation, siltation of the lake and pollution are the major human induced challenges.

3.2 Zonation

Biosphere reserves are sites recognized under UNESCO's Man and the Biosphere (MAB) programme to promote sustainable development, integrated science and conservation of biological and cultural diversity through partnerships between people and nature.

In order to fulfil UNESCO's requirements Lake Tana BR has different zones: core zones, buffer zones and the transition/development zone.

3.3 Core Area:

The core area of **22,841.589 ha** comprises entire ecosystems and sites of immense ecological importance in terms of biodiversity, unique habitats, species and populations. In particular the plain water areas, reed belts and wetlands that will contribute to the preservation of feeding and roosting grounds for highly threatened fish and bird species. The core area covers namely major parts of Lake Tana's water body, its primary wetlands, flood plains, grasslands and supporting rivers, islands like Aba

Germia Island, parts of Dek Island and Zege Peninsula, forest remnants including dry and high forests, river mouths as seasonal closures, Important Bird Areas and Bahir Dar Blue Nile Millennium Park. Totally there are 78 core zone areas identified in the lake Tana BR.

3.4 Buffer area

The buffer Area **of 188,212.768 ha** also comprises entire ecosystems and sites of scientific importance and embeds ecological sensitive core zones. These sites and ecosystems fall within communal and publicly owned land and aquatic sites where non-consumptive and partly consumptive uses are practiced. The buffer area includes in particular church forests, lake shores with traditional fishery and traditionally used wetlands as well as islands, ecological corridors, and irrigation dam areas.

3.5 Transition area

The Transition Area of **486,146.640 ha**: comprises man-made (cultural) environments where consumptive land-uses are practiced with specific reference to crop cultivation, water transportation routes, harbour areas, and where the highest settlement densities occur are generally considered development areas. Still, the aim for sustainable and ecofriendly development should also be practiced in the transition area. The portions of transition area of the BR includes ***354,297.400*** ha of terrestrial/land surface and ***131,179.406*** **ha** aquatic parts.

Therefore, the UNESCO LTBR covers a total area of 6,885 km² or 695,885 hectares. The proportion of core, buffer and transition zones are summarized in the Table below.

Table 3: Zones and total area in the LTBR

	Terrestrial area (ha)	**Aquatic Area (ha)**	**Total Area (ha)**
Core Areas	7,699.619	15,141.965	22,841.584
Buffer Areas	30,968.976	156,597.689	187,566.666
Transition Areas	354,297.400	131,179.406	485,476.806
Total BR Areas			**695,885.056**

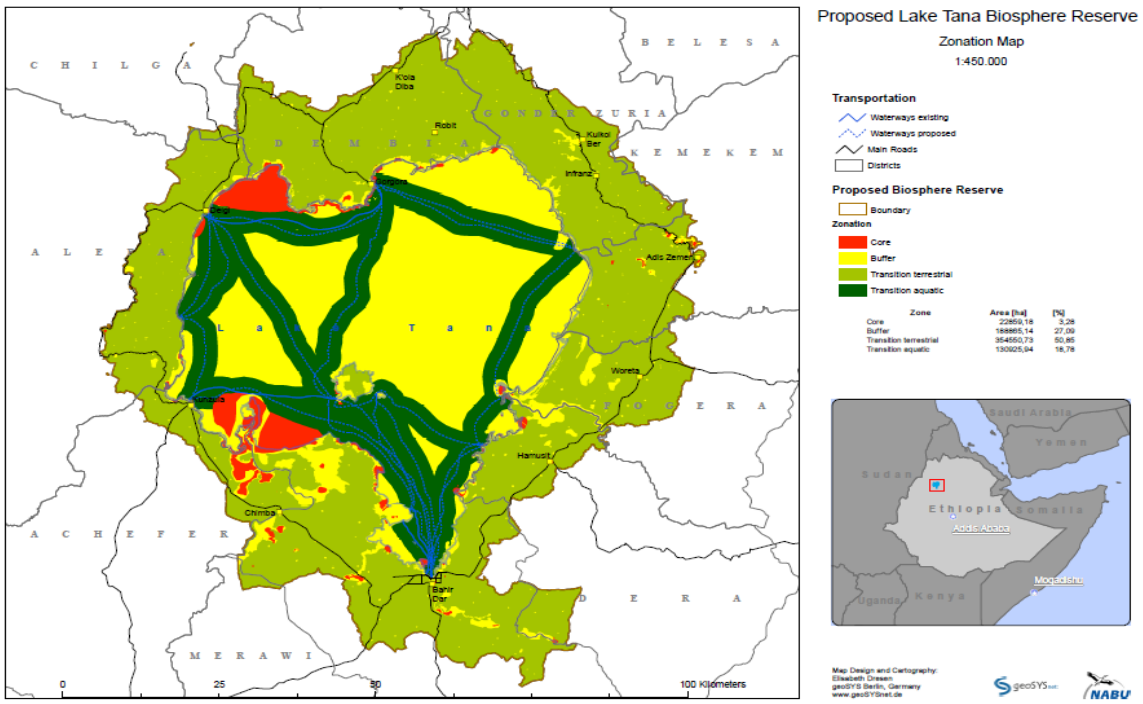

Figure 1: Map of Lake Tana Biosphere Reserve

4. Community awareness for Biodiversity Conservation and Climate Change

4.1 What is Community Mobilization?

Community is characterized by a body of persons having a common history, ethnicity, culture, geography, or interest and defined by distinct boundaries and bound by a common political, economic and social system with shared common interest & Goals.

Some common elements of community are (UNICEF,2013, Williams R B., et al, 2006); WHO, 2002)):

- Individuals or groups who share a common geographic location;
- Individuals or groups who have a common language, culture or values;
- How the groups or individuals interact or have relationships with each other;
- How members of the community use common resources and make decisions.
- Definition of Community Mobilization:

According to different sources community mobilization is defined as (UNICEF,2013): A capacity-building process through which community individuals, groups, or organizations plan, carry out, and evaluate activities on a participatory and sustained basis to improve their health and other needs, either on their own initiative or stimulated by others. Or Community mobilization is the process of engaging communities to identify community priorities, resources, needs, and solutions in such a way as to promote representative participation, good governance, accountability, and peaceful change. Sustained mobilization takes place when communities remain active and

empowered after the program ends. Fostering people to be their own agents of change is the underlying goal of 'community mobilization.'

Community mobilization engages all sectors of the population in a community wide effort to address health, social, or environmental issues. It brings together policy makers and opinion leaders, local, state, and federal governments, professional groups, religious groups, businesses, and individual community members. Community mobilization empowers individuals and groups to take some kind of action to facilitate change. Community mobilization is a means which can help the staff from CBOs, NGOs and INGOs to get people involved in humanitarian or development activities contributing their available resources. It can create an enabling environment for the community and result in more effective and committed work. Empowering people by building capacity, enabling them to have access to necessary resources and allowing them to get involved in decision making processes are vital in community mobilization. At the end of the day, the community itself needs to handle its own problems finding sustainable solutions with available resources. As much as CBO members and NGO workers may be committed to work for the people, no solution can be sustainable without creating ownership among the beneficiaries and working together with the people in the community.

To mobilize a community around any issue or problem, such as the biodiversity conservation and local livelihoods development, it is a priority to raise the community's consciousness about that issue through education, support the community to think about how the issue affects them, and to nurture the will and commitment of community members to develop constructive responses.

4.2 Phase of Community Mobilization

- Phase 1 Community Assessment: the beginning where information on attitudes and beliefs about biodiversity is gathered and where relationships with community members and professional sectors are established.
- Phase 2 Raising Awareness: the time to increase awareness about the *Green your Garden Campaign* and biodiversity conservation through workshops, meetings and information material.
- Phase 3 Building Networks: the time to start encouraging and supporting community members and various professional sector experts to consider acting and bringing about changes. Community members should come together to strengthen and intertwine individual and group efforts to improve biodiversity conservation and livelihood development.
- Phase 4 Integrating Action: the official start of the distribution of seedlings as part of the *Green your Garden Campaign*.
- Phase 5 Consolidating Efforts: the final phase where all actions are consolidated, actions and activities recapitulated and evaluated and if necessary additional measures introduced to ensure the overall sustainability, continued growth and progress.

4.3 Community Mobilizing Techniques

- Community meetings
- Political meetings
- Drama shows
- Music
- Posters
- Church gatherings
- Radio (Community radio)
- Demonstrations
- Face to face meetings (lobbying)
- Letters
- Posters/ leaflets
- Radio
- Door-to-door campaigns

4.4 What is Community Participation?

In simple terms, participation means taking part in an activity with others. This means participation involves doing things as a group. A group can range from two or more members of a community to the community as a whole. If you live in a community, it means you are part of a bigger society whether a village, town, a region/province, or a country. You may therefore participate at these different levels of society depending on opportunities that exist and your own abilities to do so (*https://en.oxforddictionaries.com/definition/participation)*.

Community members, leaders, and/or groups participate in one or more phases of an activity or project. Participation may involve contribution of ideas, priorities, resources, time or decision-making, implementation, and evaluation. The goal of participation is to give the communities ownership, the ability to express themselves, to learn from them, and ultimately to empower them through the transfer of skills, abilities, and knowledge. Participation is a process, often leading to some other end product. In simple terms, participation means taking part in an activity with others. This means participation involves doing things as a group. A group can range from two or more members of a community to the community as a whole. There are various ways in which people can participate in their social, economic and political life. These are aspects of life that affect many members of the community or the community as a whole.

Social Life

People are participating in social life in many different ways e.g. a community coming together to do maintenance work on a local road using their own resources. This is a case of self-help. Other examples of social participation are church, sports events, traditional ceremonies, cultural events, etc.

Economic Life

Individuals taking part in a market by selling various goods thereby making an income as well as providing goods for other members of the community. When people take part in communal weeding systems, it is a way of economic participation.

Political Life

Voting is the most obvious form of political participation, especially if it is *informed* voting, capable of improving the quality of political leadership. Participation in political life also occurs when people come together to engage the district authorities or when they campaign for services.

Community participation is very important to human life. Different cultures have proverbs or traditional sayings illustrating the importance of a member of a community taking part with others. Remember that in a democracy participation is free and not excessively controlled. In any society there are leaders and a government that have power to make decisions about how that society will function. This is not only true for countries, but also for local communities, traditional authority areas, and organizations like churches, mosques, trade unions, business clubs, and political parties. If the citizens in a society (or members of an organization) do not participate, then they have no say in decision making. Those in power can then impose their decisions without considering what the people really need or want.

4.5 The ladder of Community Participation

The guide proposes a five-rung ladder of **participation** which relates to the stance an organization promoting **participation** may take.

- **Information**: merely telling people what is planned.
- **Consultation**: offering some options, listening to feedback, but not allowing new ideas.
- **Deciding together**: encouraging additional options and ideas, and providing opportunities for joint decision-making.
- **Acting together**: not only do different interests decide together on what is best, they form a partnership to carry it out.
- **Supporting independent community interests**: local groups or organizations are offered funds, advice or other support to develop their own agendas within guidelines (David, W.1994)

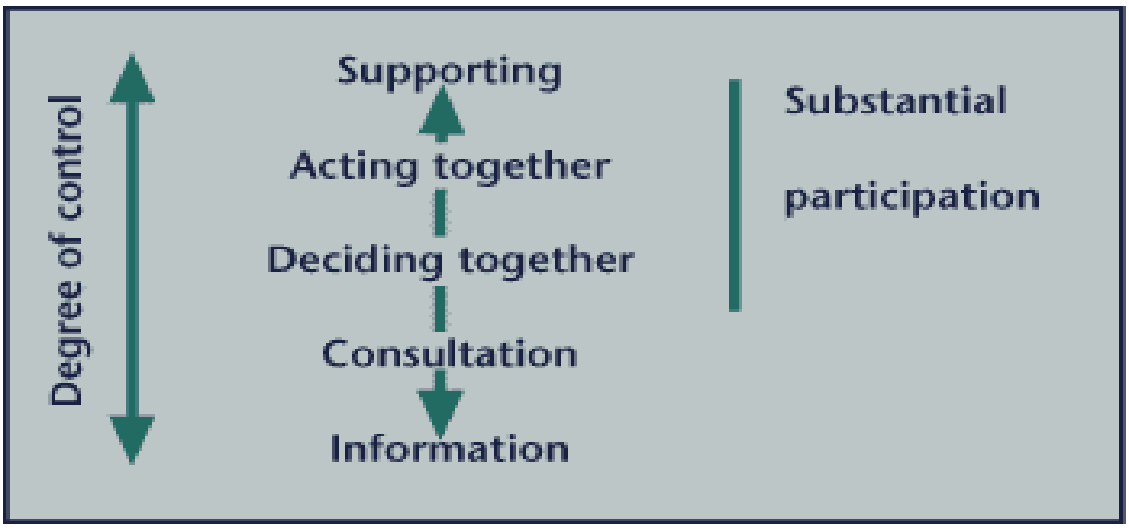

Figure 2: Graphical Representation for the level of participation (Source: David, W. 1994))

5. Seed Collection and Nursery Management

5.1 Seedling propagation

Seedlings can be collected from natural forests or from nursery sites that produced them artificially. Trees are propagated either vegetative or from seeds. Seedling production in nursery sites requires proper management and tending operations. In most cases in nursery sites those types of trees that can be propagated from coppices, root suckers etc. are the ones that can be reproduced naturally. The following major activities are necessary for raising seedlings:

5.1.1 Species and provenance selection

The type of trees to be produced depends on the site conditions, objective and other related factors. It is also important to know about the provenance of each species. Provenance means the place in which a stand of trees is growing. It refers to the area where seeds are collected or the physical address of the mother tree. Because of genetic variations associated with variations in geographic locations seeds must be collected from known provenances as this affects the quality of the trees.

5.1.2 Seed collection

Seed collection needs careful selection of mother trees. Because the nature of the trees affects germination, growth of seedlings, the quantity and quality of products obtained from the tree. Selecting strong and healthy parent trees indicates the quality of seeds to sow. Quality seed implies a seed that is highly viable, vigorous and genetically well suited to the site and the purpose intended. In general, good seeds produce good tree, which then produce more good seeds.

5.1.3 Period of seed collection

Seeds must be collected when they are ripe and ready for collection. Seed maturity can be detected easily for fruits and cones by their colour. Most fruits turn yellow, red, brownish etc. (depending on their nature) when they are ripe enough. Other methods like moisture content, specific gravity, etc. can also be used for detection. But in the field, change in the colour of the fruits and its readiness to fall are important methods for deciding the period of seed collection. Fully ripened trees are picked directly from the trees or collected as they fall. Seed bearing of trees/shrubs may not be regular every year. Therefore, it is wise to make advantage of good seed years by collecting as much seed as possible and use them during bad seed years. However, species like *Acacia nilotica, Jacaranda mimosaefolia, Delonix regia, and Eucalyptus* hybrid etc. seed every year.

5.1.4 Selection of trees for seed collection

The genetic quality of the parent tree is an important consideration in seed collection. In determining a seed tree, the objective of tree planting matters as well. Therefore, selection of mother trees for seed collection is very important and seeds should be collected from mature good mother trees.

The following points should be considered during seed collection.

- Collect seeds only from healthy and vigorous trees of reasonably good form that have more than the average growth (better form and height).
- Collect seeds from middle aged to mature trees. Young or over-mature trees should be avoided as the seeds from those trees have low viability.
- Avoid collecting seeds from trees that are crooked, deformed, abnormal growth, diseased and infested by insects.
- Do not collect seeds from isolated trees, which naturally have to cross-pollinate. If trees are isolated they tend to self-pollinate. Seedlings from those trees are either weak or malformed.
- Seeds should, if possible, be collected from dominant or co-dominant trees. These trees are better both in form and height than the existing trees. The seedlings from those trees will be strong and vigorous because of the genetic makeup.

5.1.5 Seed collection and handling

Seeds and fruits can be collected from a standing tree by hand from shrubs and trees that have low branches. The collector therefore, picks the seeds or fruits while standing on the ground. On the other hand, the branches that bear the seeds or fruits can be cut with the help of long pruning saw and the collection done on the ground. The third alternative is collection of seeds and fruits by climbing up the tree. Shaking trees to collect seeds by laying canvas on the ground is another means of cheap seed collection method.

5.1.6 Seed quantity

The quantity of seed required depends on the area to be planted, spacing, germination percentage etc. The number of seeds obtained from one kg differs from species to species (Refer annex 3).

5.1.7 Purity

All seeds supplied to the nursery are not pure seed. In order to know how many kilograms of seed are required, pure seed can be sorted out of a sample amount, and an estimation of the percentage of purity can be made by using the following formula:

$$\text{Purity \%} = \frac{\text{Weight of pure seed} \times 100}{\text{Total weight of original sample}}$$

5.1.8 Germination Percentage

In order to determine the number of seedlings to be germinated in the nursery it is necessary to know the germination percentage. Germination percentage is expressed as the total number of seeds that germinate from a given number of seeds. For example out of 100 seeds if 20 have germinated, the germination percentage would be 20%. The germination percentage can easily be obtained for many of the species in few weeks time.

$$\text{Germination \%} = \frac{\text{Number of germinated seeds} \times 100}{\text{Total number of seeds sown}}$$

Another aspect when estimating the amount of seed required is to determine the viability of the seeds. Viability is simple for how long the seed from different species can be stored before it losses the capability. Some tree species have stored for a long period of time without losing viability while other are not (Reference see table below).

Table 1: A few seed characteristics for some species

Species	**Seed/kg (000)**	**Germination**	**Storage time**
Acacia cynophylla	66-77	Good in 10 days	3 years
A. decurrens	50-70	Very good in 7 days	2 years
A. lebbeck	6.6-8.8	50-90% in 10-30days	4-5 years
Azadirachta indica	4-4.4	75% in 10 days	4-6 weeks

C.equstifolia	660-1,200	Fair in 1-2 weeks	4 months
Cuperssus lustanica	140-200	20% in 2-3 weeks	1 year
E.camaldulensis	200-1,000	Good in 7-10 days	3 years
E. globules	99-110	40% in 7-12 days	2 years
Grevillia robusta	65-100	Good in 2-3 weeks	3 months
Juniperus procera	40-45	20-40% in 2-8 weeks	1 year

5.1.9 Exercise

Calculate the seed requirement of *Acacia decurrens*, for producing 100,000 seedlings. The seed has 90% purity.

5.1.10 Seed processing

In handling and storing the collected seeds, drying it to the required moisture content prior to storage is crucial. Do not store wet or fleshy seeds and fruits since they easily rot and get spoiled. Therefore, the collected seeds must be spread over canvas or mats and turning over for drying in the sun and air. To separate some seeds from their fruits, threshing and winnowing may be required. After the seeds are well sorted, they should be packed in sacks or bags and stored in a dry place. Seed processing may require also extraction from the fruits or pods and drying them before sawing. If seeds are enclosed in a fleshy fruit, remove the flesh with knife, wash off the rest under water and sow the seeds immediately. For seeds in a seed pod, such as *Luceana leucocephala*, let the pods split open naturally by laying them in a semi-shade place. Similarly for other fruits with hard coat, drying them in semi-shade or gentle cracking could be applied.

5.1.11 Storage of seed

The storage of seeds needs a well ventilated and raised bed and free from pests. In order to keep the seed cool, storage along a wall facing a south-westerly direction should be avoided since this wall tends to be warmer than the other walls during the afternoon. Also seeds should not be stored too high in the building because hot air will concentrate under the roof. The sack, jars, or boxes with the seed must be placed in such way that air can circulate around each container. For this purpose shelves can be placed in the store. Some seeds can be dried to low moisture content of about 5% and be stored successfully at low temperatures. Others cannot survive drying below 20-50% moisture content. Therefore, seed storage requires the knowledge of the nature of the species. Several species of leguminous and others have high longevity (surviving for long years), For example, seeds of *Acacia, Albizia, Cassia, Leucaena, Prosopis, Hibscus* etc, can be successfully stored for more than 20 years

5.2 Nursery Operations

Raising seedlings in the nursery is an obligatory operation for producing dependable and vigorous seedlings. Because, if seeds are directly sowed into the field some seeds may not get enough contact with the soil and moisture and not grow well. The nursery

site is used as a multipurpose function. Nurseries are used for the preparation of plantation seedlings for industrial use, for preparation of agro forestry systems and native tree production or for fruit production. The general aspects of the establishment and management of a nursery are briefly discussed below**.**

5.2.1 Site selection

There are two types of Nurseries i.e. permanent and temporary nursery. Permanent nurseries are the nurseries used for preparation of seedlings for a long period of time while a temporary nursery as the name indicates is used for one time production of seedlings. The techniques for nursery site selections are:

- the site should be near to the planting site,
- accessibility to community for collecting seedlings,
- good and permanent supply of water and
- a gently sloping and well-drained place.

Avoid exposed windy hilltops, too cold high altitudes or swampy valley bottoms. Besides, road access for transporting seedlings in all season is prerequisite for establishing nursery sites. For potted plants, soil fertility of the nursery site is not important as the soil mixtures are brought from outside the nursery.

5.2.2 Design and layout of nurseries

After a suitable site for a nursery establishment is selected, planning, designing and layout of the nursery are follow up tasks which assure the management and optimal use of the area. When planning the overall nursery including design and layout, the following criteria are taken into consideration:

The walkways (distance between beds) should be a minimum of 50 cm wide to permit enough space for foot and wheelbarrow traffic. The beds should be no wider than 1.2m in order to make weeding easy. The length of beds should not be too long. The maximum length, as recommended in most cases, should not exceed 20m. If possible, arrange the beds so that their longer dimensions are placed in an east-west direction. This will give the seedlings a more even distribution for sunlight.

Developing activity plans for seedling production is to simplify the management of the nursery and helps to implement activities that require more labour or special equipment. Some labour-intensive work such as transplanting and lifting must be done during a limited period, and these periods are usually critical. Other labour intensive activities such as the filing of pots can be done over a long period. Activities such as watering must be carried out more or less continuously during production season. Generally, the plan should be made in the form of flow-chart depicted below.

Figure 1: Nursery activities schedule

Activities		Nursery activities schedule								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July
Preparation of germination Bed										
Preparation of pot										
Transplanting										
Root pruning										
Shading										
Watering										
Weeding										
Harden-off										

5.2.3 Area needed for nursery

The area needed for a nursery depends on the number of seedlings, nature of seedlings propagation (potted, bare-root seedlings and cuttings). In addition to that, the diameter of the pots or the spacing between bare-root seedlings or cuttings will affect the area needed. If, for example, the diameter of the pot is 5cm, the area needed to produce 1million seedlings will be approximately 4,500 m^2, assuming that all the pots will produce one seedling of acceptable quantity. If the spacing between bare-root seedlings is 5x20cm, the area needed to produce 1million seedlings will be 1ha.

Table 2: Estimation of nursery size for potted seedlings

No. of seedling to be produced	Pot size (cm)	Total area of beds (m^2)	Total area for production (m^2) a/	Area including fence & windbreak (m^2) b/	Area including roads (m^2) c/
100,000	5	250	450	500	750
	6	360	650	720	1,080
	7	490	880	980	1,470
	8	640	1,150	1,280	1,920
500,000	5	1,250	2,250	2,480	3,750
	6	1,800	3,240	3,560	5,400
	7	2,450	4,410	4,900	7,350
	8	3,200	5,760	6,340	9,600
1,000,000	5	2,500	4,500	4,950	7,500
	6	3,600	6,480	7,130	10,800
	7	4,900	8,820	9,800	14,700
	8	6,400	11,520	12,670	19,200

Note:

a/ Ratio b/n Total area for production (bed for plastic pots, germination beds, pathways, irrigation system, soil dump and store) and Total area of beds is approximately 1.8: 1

b/ Ratio b/n Total area including fence and windbreak and Total area of beds is approximately 2 : 1

c/ Ratio b/n Total area including roads (as well as fence and windbreaks) and Total area of beds is approximately 3 : 1

5.2.4 Exercise

What is the nursery area required to produce 800,000 seedlings/year? Plastic pots can be supplied only to the limited extent of approximately 400,000/yr. Due to a shortage of fencing materials, loading and unloading of vehicles will take place outside the nursery and consequently no inside roads are needed. The diameter of the pots is 5cm and the spacing for the bare-root seedling is 5 x 20 cm.

Table 3: Estimation of nursery size for bare-rooted seedlings

No. of seedling to be produced	Spacing b/n seedlings (cm)	Total area of beds (m^2)	Total area for production (m^2) a/	Area including fence & wind-break (m^2) b/	Area including roads (m^2) c/
100,000	5x20	1,000	1,600	1,800	2,600
500,000	5x20	5,000	8,000	9,000	13,000
1,000,000	5x20	10,000	16,000	18,000	26,000

Note:

a/ Ratio b/n total area for production (bed for bare-root seedlings, pathways, irrigation system, soil dump and store) and Total area of beds is approximately 1.6: 1

b/ Ratio b/n total area including fence and windbreak and total area of beds is approximately 1.8 : 1

c/ Ratio b/n total area including roads (as well as fence and windbreaks) and total area of beds is approximately 2.6 : 1

5.2.5 Soil mixture

The correct soil mixture for germination beds, bare-root beds and pots is characterized by good but not excessive drainage. The nutrient content is also an important aspect. Cattle manure, compost or forest soil rich in humus can be used; this not only increases the nutrient content, but also improves the physical structure of the soil. Up to 1-3 m^3/ha cattle manure, green manure, compost or forest soil can be added to the beds depending on the quality of the local nursery soil. The proper soil composition for the pots is something between 1/5-1/3 of well decomposed cattle manure, compost or forest soil mixed with the local nursery soil. If the soil is too heavy, sand can also be added to the mixture. Most seedlings establishment 3:2:1 ratio of organic soil, local soil and clay soil is used respectively. Clay soil is used for physical structure for water infiltration and organic soil used for nutrient.

5.2.6 Raising seedlings

There are many factors to consider when selecting the best system for raising seedlings. Some species are better suited for growth in pots and some are more conveniently grown as bare-root seedlings. But for the many species that can be raised by either system, the advantage and disadvantages of both systems must be considered. The most important factors are:

<u>Bare-rooted seedlings</u>

Advantages:

- They are less complicated to grow in the nursery

- Easy to transport

Disadvantages:

- They require more space in the nursery than potted seedlings
- They need a bit more time in the nursery
- The roots are sensitive to air exposure during lifting, transporting and planting
- They are more complicated to store at the planting site if, for some reasons , planting is not accomplished

Potted plants

Advantages:

- They require less space in the nursery than bare-root seedlings The time in the nursery can, to some extent, be reduced
- The main roots are not damaged up on lifting, transporting and planting
- They usually have a higher survival rate than bare-root when planted on difficult sites

Disadvantages:

- They are a bit more complicated to raise, especially if they are seeded in a germination bed first and later transplanted to pots
- They require regular root pruning in the nursery
- They are heavy to transport

5.3 Germination treatment

For some tree species to ensure uniform germination and stimulate growth the treatment of seeds by physical methods, biological methods and chemical methods is useful. To decide and use the most suitable type of treatment types of tree species and dormancy level is taken into consideration.

5.3.1 Physical Methods

Seeds with thick, hard seed coats might need abrasion against gravel in concrete mixer, rubbing on stones, filing, sand papering, etc. or hot wire scarification, drilling, nipping or split the seed coat by hammering, squeezing in a vice, centrifuging in a concrete cylinder in order to render it permeable. However, one must be particularly careful not to damage the embryo and endosperm.

5.3.2 Soaking in Water

Soaking in boiled, hot or cold water may be used for different lengths of time to soften the hard coat or leach out chemical inhibitors.

5.3.3 Biological Methods

Natural mechanisms such as feeding seed pods to sheep and goats would enhance germination process through the reaction of the natural acidity of the digestive tract. Termites are also helpful to remove exocarps or wings, as has been practiced with Tectona grandis and Pterocarpus angolensis. Fermentation, generally damaging seeds, can be used for some species to overcome dormancy.

5.3.4 Chemical Methods

Chemical methods are sometimes used to affect the seed coat (sulfuric acid) and/ or to overcome physiological dormancy by stimulating the release of food reserves or eliminating growth inhibitors.

Chemical methods contain a high risk for the person handling the chemicals - and the environment and are not to be encouraged.

5.3.5 Stratification

Stratification is used for species to overcome a dormancy that is caused by internal conditions (under development of the embryo, physiological inhibiting mechanisms). Several treatments can be summarized under stratification, which all have a cold moist treatment in common. Soaking in cold water (3-5^{0}C alternating with warm/moist storage, Stratification cool/moist storage(3-5^{0}C) in layers with a moisture retaining medium, storage in moist polythene bags (3-5^{0}C pre-chilling) after soaking in cold water (3-5^{0}C), alternating with warm moist storage.

5.4 Management of the nursery site

5.4.1 Sowing

Seeds can be sown either on seedbeds and/or seeds can be sown directly into pots. Sowing of seeds can be done either by broadcasting on the seedbed and then covered slightly by soil, or by drilling into the seedbed in a depth equal to the diameter of the seed. Sowing into pots saves time for transplanting and avoids shock and death of some seedlings during the operation. Seeds must be placed at the middle of the pot, pressed down and covered with the soil at a thickness of the seed. Large seeds need holes to be made first and then the seed is placed and covered by soil.

5.4.2 Mulching

After sowing, mulching of the seedbed is necessary to protect the seeds from being washed away during watering. Mulching is the process of covering seeds by grass or locally available materials used as a blanket for the germinating seeds.

5.4.3 Shading

Seedlings need protection against heavy rain, burning sunshine and strong winds. Therefore, they need shades constructed from locally available materials i.e. branches, bamboo stick, grasses, etc. The shades are constructed following the direction of the seedbeds and the sloping roof against the changing apparent movement of the sun seasonally.

5.4.4 Watering

Watering is a more or less continuous activity in the nursery from the preparation of beds to seedlings preparation until the seedlings reached out to the field planting. So many factors influence the water requirement for the seedlings. As a rule of thumb, the water needed on the bare-root beds or on the pots each day should correspond to a sheet or layer of water of 0.02 meters depth. Though water is always needed, there are some periods when it is especially important:

- During thinning and replanting bare-root plant in order to help plants to become better established.
- During hardening-off, in order to prepare the plants for conditions at the planting site
- Just before lifting

5.4.5 Transplanting

Transplanting is the operation of lifting the seedlings from the bed and planting them in to another beds or pots. Transplanting is a sensitive stage in the life of a plant as it usually causes shock to the seedlings even if it is carefully done. Badly done transplanting could kill the seedlings. Before transplanting seedlings, we must make sure that the pots/beds are not too wet or too dry but moist enough. Seedlings can then be lifted from the seedbed using a pointed wooden stick of a pencil size. The seedlings are collected in a small tin filled with a mixture of soil and water. Seedlings should be handled on the leaves but not the roots or the stems, as they can be easily damaged. To do the transplanting we need to erect a shade above the seedbed. Then make a small hole with the stick into the centre of the pot. The roots of the seedlings are placed carefully in the hole and the soil pressed towards the roots to ensure that there is no air pocket left. The surface of the pot is then levelled to avoid depression round the roots, which may cause dumping off. If roots are too long, they can be pruned first.

5.4.6 Root pruning

Root pruning involves the cutting of taproots and sometimes lateral roots to encourage development of a compact fibrous root system that gives the plant the best start during plantation. It also controls the depth of root penetration making the lifting of plants easier which is less harmful to plants. Pruning of roots can be done with a knife or secateurs. Care must be taken while pruning roots. The tools have to be sharp enough to cut readily than bruising the roots. A clear cut allows the wound to heal fast. The plants shall be watered soon after the pruning. It is also wise to do the pruning during a dull, cloudy day avoiding hot sunny days.

5.4.7 Cultivation and Weeding

Light cultivation of soil on the seedbed or the pot soil is necessary to facilitate aeration and infiltration because continuous watering and drying produce a hard crust on the surface. Cultivation work uproots the unwanted weeds at the same time. This operation should be done at least once in a month and sharpened wooden sticks would be enough for this purpose. Weeding is essential since weeds compete for water and nutrients. They do attract insects and diseases as well. Hence weed competition must be eliminated as much as possible. Weeding can be done manually or chemically but the latter is expensive and not environmental friendly as well. Small hoes can be used for weeding if the seedlings are widely spaced. Weeding is easier when the weeds are small. Potted plants can be weeded or cultivated using sharpened wood sticks or small hand tools.

5.4.8 Hardening up

Seedlings should get the necessary management under ideal conditions in a nursery. This makes them very often succulent that they do not withstand harsh conditions. On the other hand the situation on the planting site is quite different and they get little help. It means that they are left to the nature. Therefore, before the seedlings are planted out, they must survive in harsher situations in the nursery. The process of hardening up the seedlings to become accustomed to the harsher unprotected conditions at the establishment phase in the field could be done through creating harsh environmental conditions particularly in the absence of regular water supply or reduction of watering frequency and intensity. Hardening also involves, lifting or shifting and gradually removing any shading for several weeks before planting. This process makes the stem hard and woody, the crown relatively short but vigorous and the root system compact and well developed. Hardening off shall be done 4 to 6 weeks before planting. The process holds true for bare-rooted seedlings too. Meanwhile, pruning of the roots is also a necessary part of the tending operation.

5.4.9 Size and quality of seedlings

The size of seedlings ready for planting is important with respect to weed competition in the field. The usual size ranges from about 25 to 40 cm. But shorter seedlings can also be planted depending on the site. However, size should not be taken as the only indicator of good seedlings. Quality tree seedlings should be healthy, strong, and about 30 cm tall before planting. As a general rule, quality seedlings should have large root systems and small medium stems i.e. a balance between root mass and shoot must be achieved.

5.4.10 Culling

Culling is the rejection of seedlings due to poor size or quality. It is an important operation because it is always better to plant good seedlings in smaller areas than poor seedlings in a wide area. On the other hand, since all planted seedlings may not survive, replacement planting is necessary. Therefore, we have to keep good plants for replacement planting (beating up) as well. Hence 20 to 25% additional seedlings must be raised to compensate culled out or dead seedlings. Normally culling is done in line with lifting seedlings from the seedbed for transportation to planting sites. Generally, seedlings that don't meet the following criteria should be rejected.

Minimum 15 cm in length, shoot/root ratio not more than 2:1, woody, strong stem, healthy and no deformation

6. Afforestation

6.1 Tree planting and tending operations

Trees play an important role in the life of people. Trees provide food for human being, construction materials, fire wood, regulate climate and hydrological services. Besides, it protects soil erosion and serves as a home for wildlife. Therefore, it is vital to follow up proper management practices in establishing plantation for the intended targets.

6.1.1 Site preparation

Before seedlings arrive at the plantation sites, the removal of existing vegetation and preparation of the soil to enable the seedlings to utilize the existing soil moisture as effectively as possible, is important. To improve water infiltration and root development aeration, tilling/ploughing should be undertaken in contour line to avoid soil erosion. As compacted soil is bad for tree growth, it may cause poor root development of planted seedlings. It also causes poor infiltration of water leading to retarded growth of the trees and excessive runoff.

Site preparation for woodlots and big plantations include the removal of bushes and shrubs. In agroforestry systems however, removal of all shrubs and bushes may not be necessary since the objective is to incorporate valuable trees into the existing farming practice or pasture. Hence, during site preparation, given that the existing trees/shrubs are not harmful to the new plantation, they shall be maintained.

Considering the purpose of growing tree (fodder, timber, fuel wood or fruits) species selected for planting, it is crucial to take into account their ability to grow fast and their provision of high value returns or tolerance to drought and diseases. On sloppy grounds and moisture deficit areas, construction of physical soil conservation structures and moisture harvesting trenches around planting spots are required. High value trees such as fruit trees may need watering on the planting day if the day is sunny and there is risk for wilting up.

6.1.2 Pit size

Use of big holes may be of advantageous to the planted seedlings at the initial stages. But the effect disappears as years go by. In specific cases, sizes of the hole would depend on site condition and seedling container size. A pit size of 30 cm x 30 cm is adequate for most of the tree species. In arid areas and in hard soil surface, use of larger pit size up to 50 x 50 cm is recommended to improve water infiltration.

In general the pit size should depend on growing media or soil depth. It must be taken care of the rainfall amount, so that none of the roots of the seedlings turn upwards. This is the most common planting mistake that leads to eventual death. Actual spacing varies with species, site and the purpose of plantation.

6.1.3 Spacing

A common spacing, recommended for woodlots in the highlands is, 2x2m or equivalent to 2,500 trees/ha. For planting on poor sites, where moisture availability and mortality is a problem, a spacing of 3x3m is recommended. For other forms of planting (around homesteads, along paths and roads, etc.) no fixed rules are given. By observing trees growing under natural conditions it can be found that in low rainfall areas trees grow wider apart. In higher rainfall areas they can grow more closely together and form a forest. It is obvious that the amount of water available for a tree in plantation is proportional to stand density. In dry localities it is necessary to plant widely apart and to remove all competing ground vegetation, which increases infiltration of rain water and decreasing evaporation from the soil.

6.1.4 Water harvesting structures

In dry areas, it is important to harvest limited run offs for tree use. Therefore, construction of water harvesting structures is important as they enhance water infiltration. The water harvesting structures do protect the soil from erosion as well. There are several types that include micro basins, trenches, eyebrows, herringbones, and various physical soil and water conservation structures. Hence attention should be given in establishing trees on different structures as mentioned.

6.1.5 Seedling transport

One of the principal reasons for poor survival rate is that seedlings are mishandled during transport, loading and unloading operations. Broken or mechanically damaged seedlings have a low survival rate in the field. In many places seedlings have been treated like any other commodity especially while being transported and unloaded by dump trucks. On the other hand it is also common to transport seedlings on a donkey back or carried by people. Since people cannot afford carrying many seedlings with pots; because of the weight of the soil, they remove the plastic pots with the soil in order to carry as many seedlings as they can. This can tremendously affect the survival rate of seedlings.

Potted plants can be transported safe if they are stacked on the floor of trucks or other vehicles in an upright position. This consumes a lot of space and requires quite frequent travel to and from the planting site. Instead, the seedlings can be laid on top of the other, the shoots of two rows facing each other. In this manner the seedlings can be transported when the distance is reasonably short. However they should be unloaded and stacked in an upright position as the planting needs to start soon.

Bare-rooted seedlings can be laid down on wet banana or *Enset* leaves, sacks or other materials with the roots puddle with soil and water. The bundles of seedlings can be stacked upright on the vehicle floor. In this way, quite a large number of seedlings can be transported at a time. Where the planting site is far away and vehicles are not available, the bundles can be transported by donkeys, horses or mules.

Normally, plants arrive one day ahead of planting. Where shade and watering facilities are available, planting stock can be brought in several days before planting is to take place. As soon as the plants arrive at the planting site, they must be watered and stored in cool, moist and shaded place until they are planted.

6.1.6 Seedling planting

Planting of trees should start when the rainfall amount has accumulated to about 100mm spread over a consistent number of days or in simple terms, when the soil particles form a muddy wet bond when squeezed. Generally, tree planting should start soon as the rainy season begins properly and the soil is sufficiently moist below the rooting depth of the plants. If one wishes to establish a woodlot or fruit trees on his/her farm, agricultural practices should be adjusted to accommodate tree planting thereby avoiding any major operation problems such as ploughing or shading effect in the long term.

Planting seedling starts with digging of holes/pits with size much greater than the pot size (30x30cm) in wet areas and bigger pits (30-50cm) in moisture deficit areas

complemented by water harvesting structures. A common mistake is that sometimes the planting is started too soon. On the other hand, if planting is started too late, it may be difficult to complete a large planting programme in time, and the plants will lose the maximum benefit of rain after planting. This can be a serious matter in the areas where the rainfall is low and erratic. Usually, planting should start as soon as the soil is wet to the depth of approximately 20-30 cm. Field planting can be done in two ways.

6.1.7 Notching

Notching is used only for bare rooted seedlings. It is simply cutting of an opening (slit) in the ground with a spade or conical planting hoes. The slit has to be opened wide enough to insert the roots of the plant. After planting the slit is closed by gently pressing or compacting the soil with feet. Care must be taken especially with the bare-rooted seedlings that none of the roots should turn upward. This kind of planting is uncommon and not recommended in dry areas.

6.1.8 Pit planting

This is the usual planting method both for bare-rooted and potted plants. In most cases the planting hole is dug slightly larger than the soil cylinder of the potted plant. By removing the plastic pot and maintaining the soil intact; place the seedling at the middle of the pit about the root collar level. Cover the surrounding preferably with wet topsoil. Do not mix with dry soil or grasses. Gently compact the soil around the seedlings with hands or feet to increase contact between the roots and the soil. The soil around the plant should be left level as a depression around the stem easily creates waterlogged conditions that damage the plant.

Planting of seedlings on a dull cloudy day or during the cool hours of the day enhances the survival of seedlings. Avoid dry, sunny and windy days. Always select healthy and strong seedlings, which are about 25-40 cm of height.

Bare rooted plants are put similarly in the pit so that their roots are spread in natural position. Care must be taken not to turn the roots upward.

6.2 Maintenance of plantation

Once plantation has been established, continuous monitoring is necessary to replace individual plants that fail to grow. The following are important to be considered after planting:

6.2.1 Survival count

Survival count is done to know how much of the planted seedlings have successfully survived and grown. It must be done 2-3 weeks after planting so that replacement planting is done within the same rainy season. It can also be done in such a way that the surviving plants are counted at the end of the dry season and replacement is done soon after the rain begins. The surviving plants can be expressed in terms of percentage.

6.2.2 Replacement

One of the failures to have a well-stocked tree stands in many plantations or closures are that beating up (replacement planting) is not exercised although it is known to be a

necessity. Two to four weeks after planting, it is important to undergo survival count. In case some seedlings have died, the dead should be replaced as soon as possible. Therefore vigorous reserve seedlings have to be maintained in the nursery for replacement planting

6.2.3 Weed control

Weeding is an operation that eliminates or suppresses undesirable vegetation that would impair the growth of the trees if no such action was taken. Undesirable vegetation competes with the trees for light, moisture and nutrients. The control of weeds is an essential part of establishment practices in tree plantations. Failure to keep young plants free from weed competition often leads to mortality and delayed canopy closure. Different species differ in their tolerance to competition from weeds.

6.2.4 Other Tending Operations

Depending on the objectives of planting trees, there are also other tending operations such as thinning and pruning. Thinning is a silvicultural operation that reduces the number of trees within the stand, while pruning is reducing the branches of trees to produce a knot-free timber especially for conifers that have no natural pruning habit.

6.2.5 Protection of newly planted trees

Protection includes preventing damage by fire, pests, domestic animals, wildlife grazing and man. Hence, it is extremely important to make the whole community aware of the importance of protection. Damage to small trees is sometimes caused by wild animals, but more often by livestock. In areas where browsing pressure is high, it might be necessary to erect fences or construct protection round the young seedlings. Of course, the easiest way will be keeping livestock away from the plantation. All species, particularly fodder species, require protection from grazing animals during the first 2-3 years after establishment. In general, the average annual growth rate increases slowly during the first initial years, then reaches a maximum and falls gradually as the tree becomes older.

7. Agroforestry Development and Management Practices

7.1 Historical Background

Throughout the world it has been the practice to cultivate tree species and agricultural crops in intimate combination. For example in Europe before middle age there was clear felling trees and plant or sow tree species along with agriculture crop. In tropical America, many societies have traditionally simulated forest conditions in their farms in order to obtain the beneficial effects of forest structures. Farmers in Central America, for example, have long imitated the structure and species diversity of tropical forests by planting a variety of crops with different growth habits. Plots of no more than one-tenth of a hectare contained, on average, two dozen different species of plants each with a different form, together corresponding to the layered configuration of mixed tropical forests: coconut or papaya with a lower layer of bananas or citrus, a shrub layer

of coffee or cacao, tall and low annuals such as maize, and finally a spreading ground cover of plants such as squash.

In Asia there is a complex and sophisticated type of shifting cultivation. In clearing the forest for agricultural use, they deliberately left certain selected trees which, by the end of the rice-growing season to prevent excessive exposure to the sun. In Africa, it is a long lasting experience to grow herbaceous crops with trees and shrubs. Farmers claim that the system is a means of conserving human energy by making full use of the limited space won from dense forests. For example Gedio people in Ethiopia have good experience of integrating tree components to the farming system. It is an indigenous practice that is still working sustainably. The upper storey is always multi-purpose tree species, the middle is followed by coffee, various fruit trees and enset (Ensete ventricosum), and then the lower stratum covers multi-faceted herbaceous crops. There are innumerable examples of traditional land-use practices involving combined production of trees and agricultural species on the same piece of land in many parts of the world.

In General, agroforestry is a new name for a set of old practices. It is a practical solution to maximize productivity and diversification of products per unit area, which enables farmers to improve their livelihood through proper land management. It shouldn't be considered as the only solution to problems of land and water degradation as well as an answer to shortages of food, fuel wood, cash income, animal fodder and building materials.

Factors that had contributed to the general acceptance of agroforestry as a system of land management are:

- The assessment of development policies by the World Bank
- Re-examination of forestry policies by the Food and Agriculture Organization (FAO) of the United Nations
- A re-awakening of scientific interest in intercropping and farming system
- The deteriorating food situation in many areas of the developing world
- An increasing spread of tropical deforestation and ecological degradation
- The energy crisis of the 1970's and consequent price escalation and shortage of fertilizers
- The establishment by the International Development Research Centres (IDRC) of Canada of project for identification of tropical forestry research centre

7.2 Definition of Agroforestry

Agroforestry is a collective name for land use systems and technologies in which woody perennials are deliberately used on same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence (RRB Leakey, 1996).

The definition implies that:

- Agroforestry normally involves two or more species of plants or plants and animals, at least one of which is a woody perennial

- An agroforestry system always has two or more outputs
- The cycle of an agroforestry system is always more than one year, and
- Even the simplest agroforestry system is more complex, ecologically (structural and functionally) and economically, than a mono-cropping system.
- Trees, agricultural crops, pastures, livestock and soils are components of agroforestry systems. Other components, namely insects and fish, occur in specialized systems.

7.3 Objectives and Goals of Agroforestry

The main objective of the Agroforestry practice is to enhance and magnify the positive interactions among trees/shrubs, ground cover, crops, livestock and water in order to increase the overall production and diversity in a given unit of land which ultimately results in environmental sustainability, economic sustainability and social sustainability.

7.4 Agroforestry classification

7.4.1 A framework for classification

The most obvious and easy-to-use criteria for classifying agroforestry systems are the spatial and temporal arrangements of components, the production aims or outputs from the system, and the social and economic features. They correspond to the systems structure, function (output), socioeconomic nature, or ecological (environmental) spread. These characteristics also represent the main purpose of a classification scheme. Therefore, the sets of criteria for classification agroforestry are:

- *Structural basis*: refers to the composition of the components, including spatial arrangements of the woody component, vertical stratification of all the components, and temporal arrangement of the different components.
- *Functional basis*: refers to the major function or role of the system, usually furnished by the woody components (these can be of the service or protective nature, e.g., windbreak, shelterbelts, soil conservation).
- *Socioeconomic basis*: refers to the level of inputs of management (low input, high input) or intensity or scale of management and commercial goals (subsistence, commercial, intermediate).
- *Agro ecological basis*: refers to the environmental condition and ecological suitability of systems, based on the assumption that certain types of systems can be more appropriate for certain ecological conditions; i.e., there can be separate sets of agroforestry systems for arid and semiarid lands, tropical highlands, lowland humid tropics, etc.

No single classification scheme can be accepted as universally applicable since each criterion has pros and cons. Therefore, classifications of agroforestry systems have to be purpose- oriented and sometimes use a combination of criterias. Based on the nature of the component (woody perennials, herbaceous plants, and animals) agroforestry systems are classified into three main categories:

- Agrisilviculture: It covers all systems in which land is used to produce both forest trees and agricultural crops, either simultaneously or alternately. Agrisilviculture

also includes growing of perennial crops such as coffee, cocoa, and citrus, papaya etc. with forest trees.

- *Silvipasture:* It is a land management system in which trees are managed for the production of wood as well as rearing of domestic animals. The trees may include both wood yielding trees and fodder trees while the fodder could include naturally grassed or improved fodder grasses seeded artificially. The system allows grass cutting and a well controlled grazing (blocks are used on rotation).
- Agrisilvipasture: It is a combination of Agrisilviculture and Silvipasture systems. The land is managed for the simultaneous production of agricultural crops, trees and grazing for animals. It is a unit of land that is managed under crop rotations or practices, which may include production of food crops, fodder and wood with provision of grazing domestic animals.

7.5 Agroforestry in croplands

Trees can be integrated with crops in a number of ways. They may be dispersed randomly across the field, planted in rows between other plants or planted as separate stands for orchards or woodlots. Trees can also be used to mark boundaries or as live fences. Around homesteads they can be grown in a mixed fashion with varying heights and types. Generally, there are four major groups of agroforestry technologies that are consisting of fifteen different practices.

7.5.1 Home gardens/Multistorey farming

This is a traditionally known type of agroforestry practice in the tropics. They are also referred to as “Home gardens / multistory farming”. The vegetation consists of a variety of tree shrubs, food crops, vegetables and medicinal plants. Animals can also be incorporated around the homestead where the mobility is restricted to fixed area. The biomass produced from the different vegetation can be used to produce compost for use in the farmlands. Moreover, the leaves are fed to the animals and the woody products for the different needs of the farmer. The multi-layered trees and shrubs combined with vegetables and fruits can generate additional income and food to the individual households.

7.5.2 Dispersed trees on farmland

There is intensive interaction between crops and trees when grown together. Dispersed trees in farm lands is another practical example of traditional agroforestry arrangement in which trees dispersed in farm fields form an integral part of a cropping system. In traditional system the trees regenerate naturally and they are more or less homogenously distributed throughout the field.

Farmers deliberately maintain certain species, which from long experience are found to be beneficial to both the annual crops and additional benefits described earlier. *Acacia* species are most known for growing scattered in farmlands for their nutrient adding properties and fodder for animals while pruned branches are used for fuel and fencing. Smilarly Cordia African and other ingenious trees are traditionally grown on farm land.

In places where such practice is not introduced, selected tree seedlings for the agro-ecology can be produced and planted haphazardly in the farmland (about 50 seedlings/ha). For the first few years the seedlings planted must be kept free from livestock interference as the seedling could be trampled and damaged by the animals. On the other hand weeding and mulching is important to protect them against competing plants and high evaporation during the dry season. The trees can be lopped or pollarded and the leaves, twigs and branches are used for soil fertility improvement, fodder, fuel, farm tools, etc.

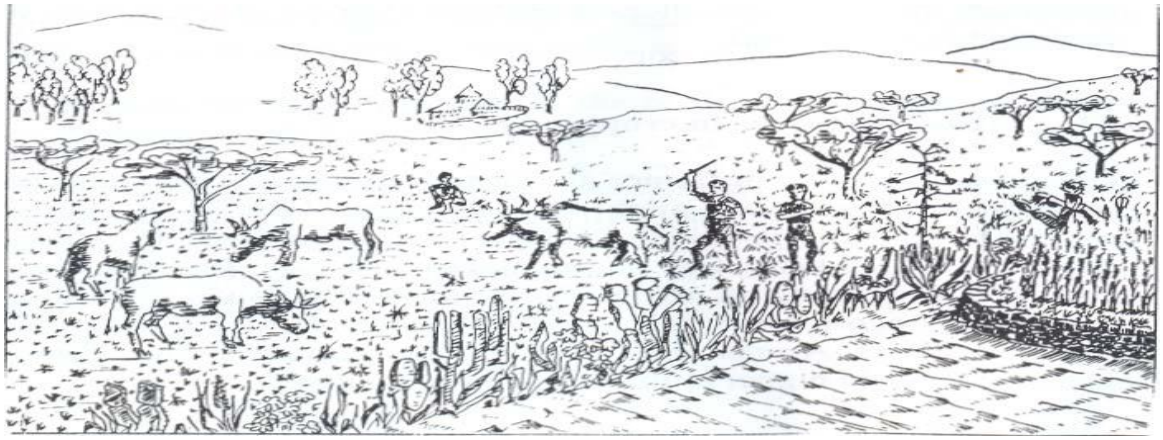

Figure 1: Dispersed trees in crop land

7.5.3 Alley cropping

Alley cropping is also known as hedgerow intercropping. It is an agroforestry system where rows of woody plants are raised together with annual crops planted between the allies. Small trees or shrubs, frequently pruned to prevent them from producing too much shade are grown in relatively compact rows (between 2 and 4m apart but not exceeding 6m) and crops are grown in the space between the rows (the alley).

The type of trees planted for alley cropping depends on the rainfall amount and the soil conditions. In this system the woody plants are cut regularly where the leaves and twigs are used as mulch to add nutrients to the soil reduce evaporation and suppress weeds that compete with the annual crops.

If the trees are big enough, complete pollarding, lopping or coppicing method could be employed to avoid the shading effect of the trees during the cropping season. The product from pollarding, lopping or coppicing can be used for the various uses mentioned above. Alley cropping requires fairly strict follow up during planting and frequency of pruning in order for the technique to give good results.

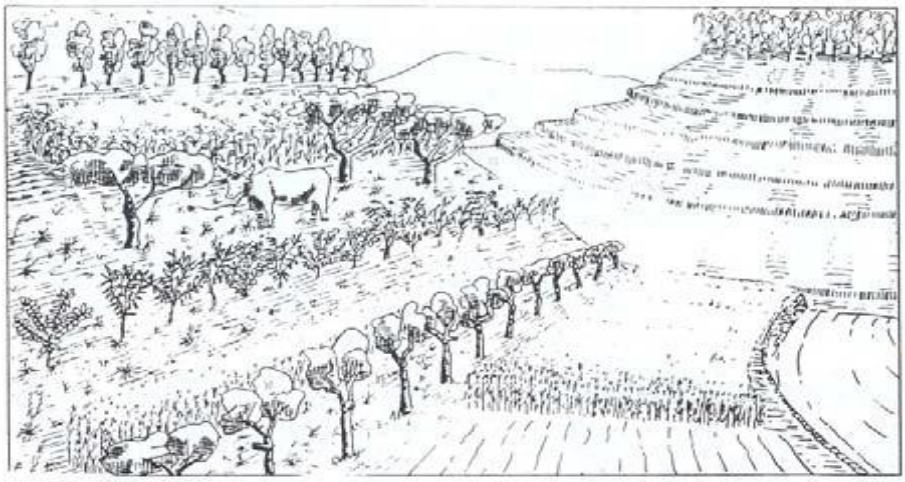

Figure 2: Alley cropping

7.5.4 Contour vegetation strips

This is a combination of different vegetations i.e. trees. Shrubs, grasses and other creeping plants systematically planted with the principal objective of controlling run-off and hence soil erosion. Moreover, they contribute to the fertility of soil and as a source of fodder simultaneously. The different types of plants at different heights provide good soil coverage. The tree species includes *Acacia* species, *Leucaena, Sesbania, Grevillea, Prosopis, Croton*, etc. while the understorey vegetation includes *Dichrostachis, Stylosanthes, Lablab*, etc.

7.5.5 Improved fallows

Non-productive arable lands can be reclaimed within shorter period restoring the soil fertility through incorporating suitable tree species. Some examples are *Acacia* species, *Leucaena, Sesbania, Calliandra, Prosopis, Cajanus cajan etc.* Improved fallows can be established through direct seeding or planting of seedlings. Fallows may take long time before they are restored. Therefore, land for annual crop production must be secured to sustain a family, which might not be feasible easily where land is scarce. Once the trees are protected from livestock until they are well established, it does not require much tending or management thereafter.

7.6 Agroforestry in-between Places

7.6.1 Farm boundary (Borderline Trees)

Borderline trees consist of trees or shrubs established to delineate individual farm fields or plots. They serve as property markers while providing wood and other products for various purposes. They normally do not occupy too much space nor do they shade large areas of the fields. Since the trees are not actually grown on farm fields, they do not interfere (obstruct) with the regular farming operations. *Mangifera indica*, *Calatropis procera*, *Euphorbia abyssinica*, *Commipora erythraea* and *Acacia* species are among the ones recommended for boarder line planting.

Trees of other suitable species can also be planted around farmlands in one or two rows in view of producing woody biomass for different purposes where the trees provide protection for the annual crops against strong winds at the same time. The branches facing towards the crop field need to be pruned to a higher level in order to avoid the shading effect of the trees. The branches can be utilized as per the need of the farmer in question. A good deal of distance must be kept from the rows of the trees and the tree species need to have deeper root systems for different rooting zones than the agricultural crops grown inside. Care must be taken however, not to plant *Eucalyptus* species along farm boundaries because of its negative effects until research confirms the right variety to use for agroforestry purpose. In places where *Eucalyptus* trees were planted as boundary plantation, the adjacent farmers have started complaining about its negative effect on their crops.

Fig. 5 Trees and shrubs on borderlines and boundaries

7.6.2 Live-fence

A live fence is an artificially planted wall of vegetation to protect crops or pastures from animals and people. Live fences consist of dense hedges or closely planted trees around a garden or farm field to protect it from free grazing livestock. They are also planted around houses and other buildings to serve similar purposes. This technique differs from boarder line planting in that more of shrubs are used and they are densely spaced. This is a very important alternative to traditional wood fences, which need maintenance very often. Many species adapt to the use of live fences. *Euphorbia* species,*Acacia machrostachya, Acacia nilotica, Balanites aegiptica, Calatropis procera, Commiphora africana, Parkinsonia acculeata, Erythrina abyssinica* and *Zyziphus* are among the recommended species for live fencing.

For better performance as live fence, it is worth considering that the trees are thorny, easily coppicing, relatively unpalatable and fast growing ones. Live fencing can also be established from cuttings, especially from some species such as members of *Euphorbia* and *Commighora* species. Freshly cut branches from these species produce roots and sprout if they are planted at the beginning of the rainy season.

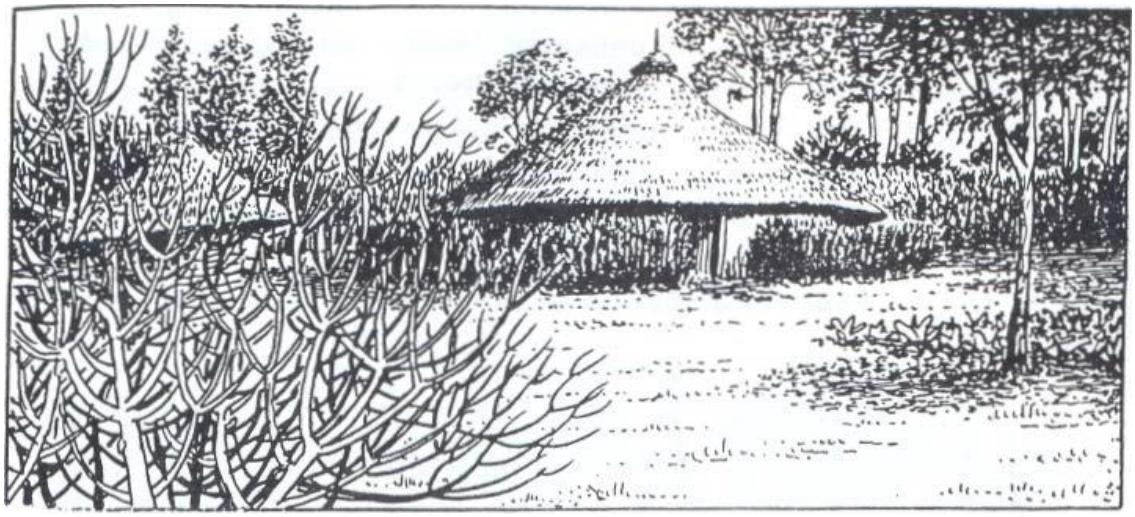

Fig. 6 Live-fences

7.6.3 Trees and shrubs along roads and paths

Planting trees along the roads or walking paths is common in many places where the principal objective is for shading but also for wood and other products. Trees must be planted on major roads to allow enough space for two vehicles to pass and additional space on the roadside for emergencies. The width of the road should not be less than 6 meters and additional space must be kept around curves to enable good visibility. Therefore trees must not be planted too close to the road and the spacing between the planted trees not less than 6 meters.

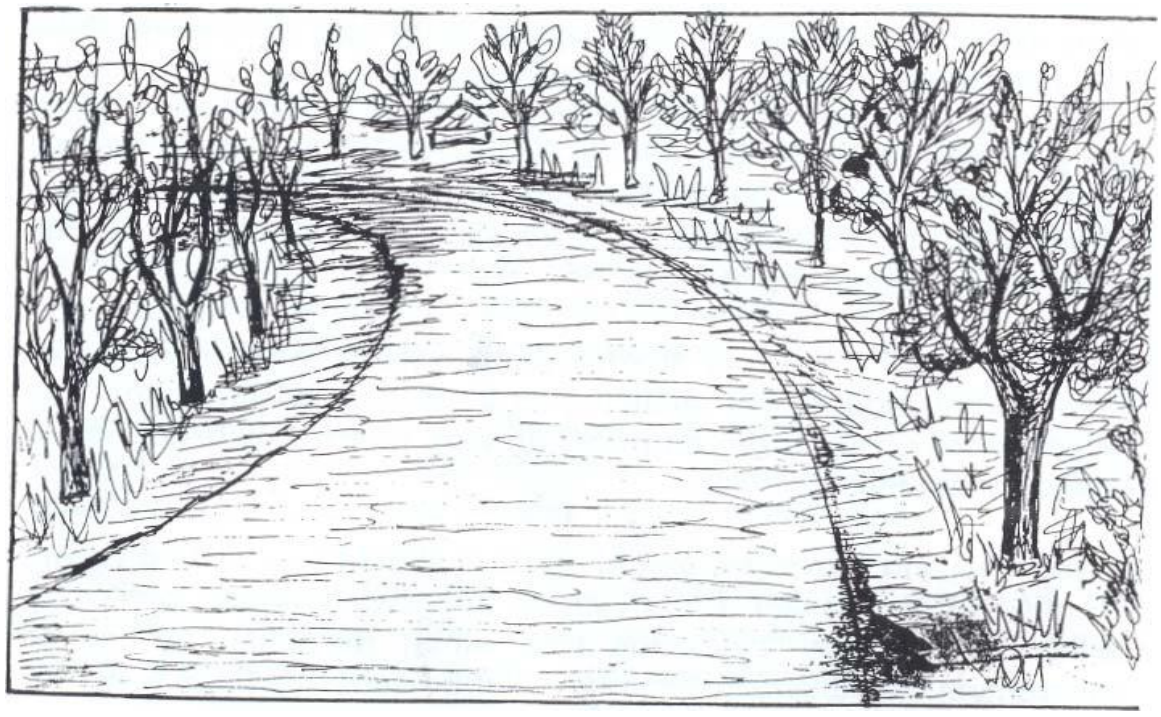

Fig. 7 Trees and shrubs along roads and path

7.6.4 Trees and shrubs along waterways and flood plains

Flood plains are located along the flatter and more stable portion of rivers, stream banks or on the edge of lakes and ponds. These places often include trees, shrubs and woody vines as well as vegetable crops, medicinal plants, spices and root crops. These sites have a unique production potential because of their access to water and fertile soils.

7.6.5 Trees and shrubs around houses and public places

Decorative and shelter planting around houses may take many forms. Such places may be excellent sites to demonstrate new agroforestry practice or species to the local community. The use of woody plants in public spaces may range from a single large tree of religious or cultural significance to trees, which could provide shade, fruits or fodder. The trees may be planted in sites such as around houses, public meeting places and markets, wells, clinics or places of warship.

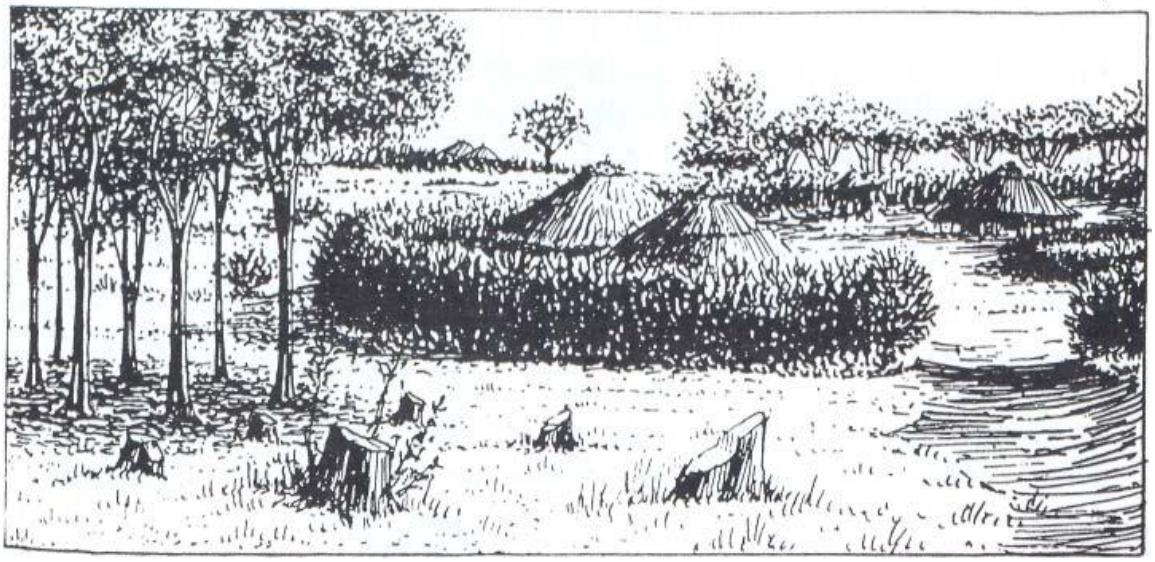

Fig. 8 Trees at home stead plots

7.6.6 Wind breaks

Windbreaks are strips of trees and other vegetation intended to reduce the force of wind, thereby contributing to minimization of wind erosion, evaporation, and wind damage to crops. Sometimes windbreaks are referred to as shelterbelts although this term is used for wider strips of vegetation with more rows of trees and shrubs than windbreaks. Remarkably higher results have been observed where crop yields from fields protected by windbreaks are consistently higher than those unprotected fields. Windbreaks have high potential in farming areas where cereal crops such as millet and sorghum are grown. The windbreak trees can also provide significant quantities of fuel wood and poles without affecting their primary function if systematically harvested.

The density of vegetation determines the effectiveness of a windbreak. A vegetation density of 60-80 percent seems to work best in arid areas. But if the vegetation is too dense and blocks the wind completely, it causes turbulence close to the ground loosening the soil particles which are picked up by the wind. Wind that carries soil particles causes damages to crops through the scratching effect of the sediment load on plant tissues.

7.7 Agroforestry with structural conservation measures

7.7.1 Trees and shrubs on terraces

The trees, shrubs and grasses planted on terraced cropland can protect and strengthen terrace structures. They can do this in two ways: by providing surface cover of grass and leaf litter and by creating deep root network in the subsoil. Trees and shrubs planted on the dry upper terrace risers may also shelter crops and improve the soil in this exposed, and often least productive, site on the terrace. Trees and shrubs can add to the diversity and value of products from the terraces, often using places that would

otherwise be unproductive. Trees can either be placed at the toe of terrace riser or along its edge. In areas where soil moisture is scarce, tree roots can better grow along the toe. In fact, the soil immediately behind the edge of the terrace is drier than anywhere else on the structure. A greater portion of the leaf litter will fall near the edge the terraces if the trees are planted along the edge. Thus, in terms of site improvement and effect on crops, the best place for trees at the edge of a terrace, whereas in terms of the tree's own requirements, the toe of the raiser is best. Trees may also help stabilize rock-wall terraces and the earth behind them, fastening themselves by sending roots into rock crevices deep below the surface and acting as anchors to tie different soil layers together, thus reducing the chance of mass earth movements such as mud slide. Trees planted on any slope which is unstable due to high level of soil moisture, may improve stability by absorbing some of the excessive water, thus reducing water pressure and helping to prevent soil slippage down the slope.

7.7.2 Protection and stabilization of waterways and gullies

Trees and shrubs can play a major role in stabilizing artificial waterways and gullies, as well as natural stream banks. Properly located in the channel section, woody vegetation helps decrease water velocity along the channel ages and protects soils, gravel or rocks from the erosive forces of flowing water. Once well established plants can completely stabilize small washouts and gullies and can complement physical erosion, control structures in larger channels. Trees, shrubs and herbaceous plants in such sites may also provide fuel wood, small poles, fodder, fruit, medicine, bee forage, oil seeds or fibres.

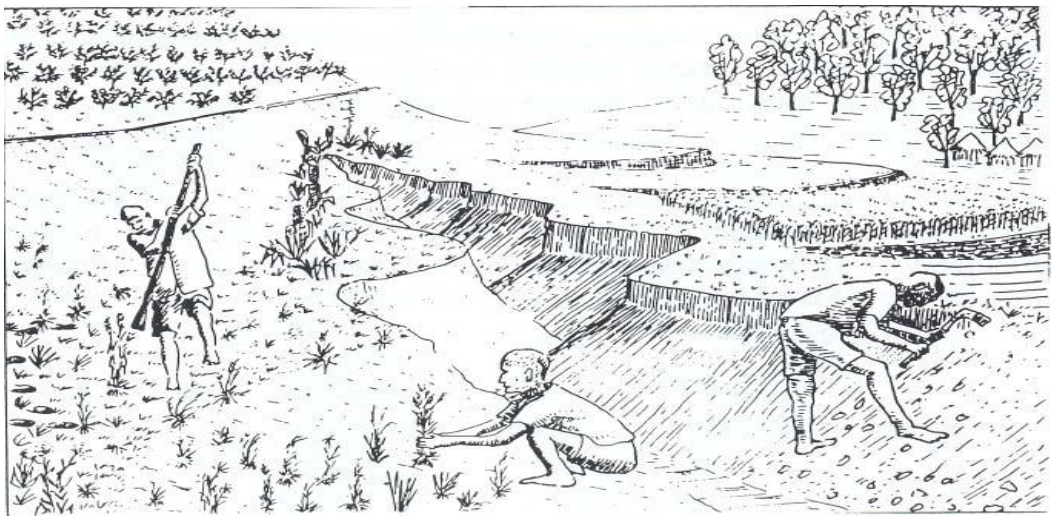

Fig. 9 stabilization of waterways

Fig 10 Stabilization of water ways and gullies

7.7.3 Micro-catchments for water harvesting

Micro-catchments are V-shaped, semi-circular (half-moon) herringbones or eyebrows that are ridges of soil built around a seedling. It collects and holds runoff water so the seedling can use it. The size and layout of micro-catchments vary according to local conditions. Where rainfall is relatively high (600-800 mm per year) a large number of small structures should be used to catch enough water however avoid flooding. In areas with lower rainfall, the micro-catchments may be quite large. Micro-catchments are most effective on gentle slopes of 3-5%, in areas where watering cannot be done regularly. The soils should be fairly deep sandy loams which can hold water during the dry season. A series of micro-catchments can be arranged on slopes so that they can catch the overflow from micro-catchments above. Since micro-catchments need a lot of work to build, they are best used for high- value trees, such as fruit trees.

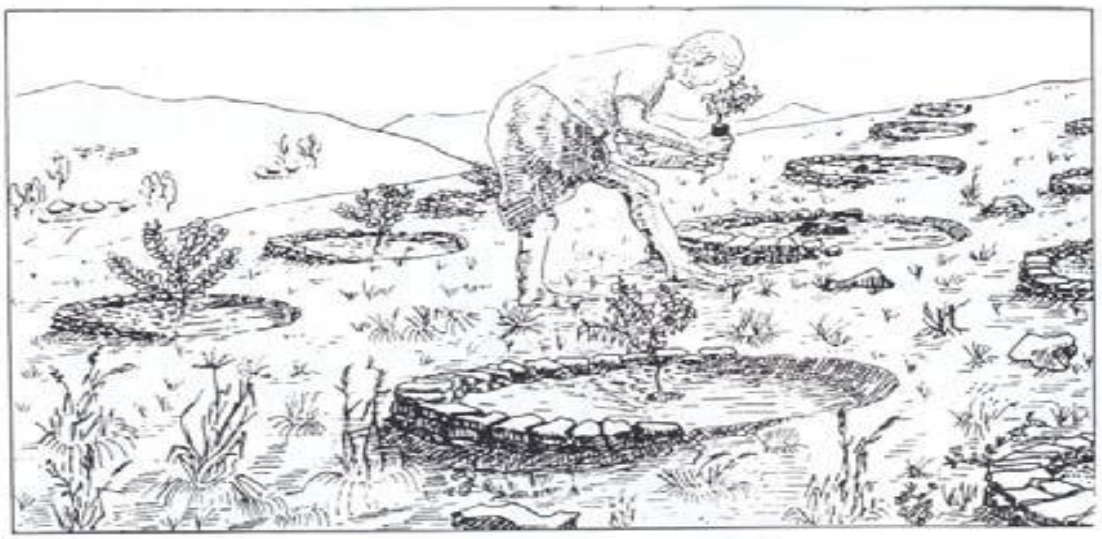

Fig 11 Trees, shrubs and grasses on small earth work structures

7.7.4 Agroforestry in Pastures and Rangelands

The production of livestock can be increased and sustained if fodder trees are incorporated in pastures. This is increasingly important in arid and semi-arid areas for a simple reason that shrubs and trees are the most important nutrition source during the dry season. Branches, fruits, leave and twigs provide a good deal of protein andare consumed by animals which lead to their weight gain. The other advantage is that grass production is higher under the shade of fodder trees and lasts longer time than those growing in open fields.

7.8 Trees to be selected for agroforestry practices

- The roots should be non-competitive with other components especially resource sharing with shallow rooted crops
- Suitable for soil conservation purpose in which nutrient export should be controlled.
- Possibility of Nitrogen-fixing:
- High quality of nitrogen fixing multi-purpose species is much more preferable
- Physical and chemical composition of leaves and pods:
- Fodder and mulching material is of high quality
- High in nutrient content
- Phenology (leaf flash, flowering and fruiting) and cycle: Season of fodder and mulch materials availability
- Response to management practices (pruning, coppicing, pollarding and lopping)
- Crown size, shape and density: Production of large amount of leaves, mulch and fruits
- Suitable for timber and pole production, shading effect, etc.
- Multi-steamed habit: Fuel wood and pole production

- Height: Ease of harvesting leaves, fruits and branch wood shading or wind effect

7.8.1 Management practices for MPTs

Selecting a wonderful multi-purpose tree species alone doesn't help much in meeting the purpose of agroforestry development. To tap envisaged benefits, there should be proper management practice that fits for each tree species. The management practice should be planned ahead of developing any agroforestry practices. Though, there are various types of management practices, the followings are most commonly applied in agroforestry practices:

Coppicing: It deals with cutting trees at a height of 35-40 cm from the ground. Before applying the practice, one should properly know whether the species respond to coppicing or not. It should also be clearly known for which agroforestry practices coppicing is best applied.

Pollarding: This is a management system that deals with cutting of trees at a height of 2m from the ground. The height helps in protecting the young emerging shoots from the damage of animals. Since the pollarded tree stays for a longer period of time, the opportunity of volume increment will be high. Normally the standing trees in such practice are used for timber production.

Lopping: It is the application of partial or full removal of branches for the purpose of fuel wood, fodder production or mulching. Prior to the application of this management practice, one should properly know the response of the species for the practice.

Pruning: It is the removal of dead branches and any branch that interferes with proper growth of trees. Generally, the system helps in modifying the overall stand of the tree and it can be applied for any tree species as well as agroforestry practices.

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9. Annexes

9.1 Exercises

What is the nursery area required to produce 800,000 seedlings/year?

Plastic pots can be supplied only to the limited extent of approximately 400,000/yr. Due to a shortage of fencing materials, loading and unloading of vehicles will take place outside the nursery and consequently no inside roads are needed. The diameter of the pots is 5cm and the spacing for the bare-root seedling is 5 x 20 cm. The area includes fence and windbreaks (Refer Table 2).

Calculation:

400,000 x 0.05m x 0.05m = 1,000m^2 beds for pots

Area for production of potted seedlings will be 1,000m^2 x 2 = 2,000m^2

Bare-rooted seedlings

400,000 x 0.05m x 0.20m = 4,000m^2 beds of bare-roots

Area for bare-root production = 4,000m^2 x 1.8= 7,200m^2

Total area of production is 2,000m^2 + 7,200m^2 = 9,200m^2

If the diameter of the pot is 5cm, what will be the area needed to produce 1 million seedlings?

The ratio between total area for production (beds for pots, germination beds, pathways, etc.) and total area of beds is approximately 1.8:1?

Calculation:

1seedling covers an area of 0.05m x0.05m

1million seedlings will cover _____

$$\frac{\text{1million seedlings x 0.05m x 0.05m}}{\text{1seedling}} = 2{,}500m^2 \text{ beds}$$

Total area for production will be 2,500m^2 x 1.8 = 4,500m^2

Calculate the seed requirement of *Acacia decurrens*, for producing 100,000 seedlings. The seed has purity% of 90.

Calculation:

Acacia decurrens has about 50,000 seeds per kilogram. 90% purity can give

50,000 x 90/100 = 45,000 pure seeds.

With 80% germination, you will need 45,000 x 80/100 = 36,000 pure seeds.

Thus, 100,000/36,000 = 2.77kg or 2.77x50, 000 = 138, 5000 seeds

If the diameter of the pot is 6cm, the area needed to produce 100,000 seedlings will be ____ (the ratio given is 3:1)?

100,000 seedlings x 0.06m x 0.06m = 360m^2 beds

Total area for production will be 360m^2 x 3 = 1,080m^2

What are the yearly requirements of cattle manure, compost or forest soil for plastic pots of 400,000 as well as 4,000 m2 bare-rooted seedlings, if 1-2 m3/ha of cattle manure is added to the bare-root beds and between 20-30% of the pot volume is added with cattle manure? (Also calculate the amount of nursery soil needed for the pots. The mixing ratio is 30% or approximately 1/3 manure (compost or forest soil) to 2/3 nursery soil and the pots have a diameter of 5cm and a height of 15cm.)

Calculation

The total requirement of soil-mix needed is determined by multiplying by the total number of pots. The pot diameter is 5cm or 0.05m and the height is 15cm or 0.15m.

The pot volume = $(0.05/2)^2$ x pi x 0.15 or 2.9 x 10^{-4}

The total number of pots is 400,000/yr and the total volume of soil-mix is equal to 400,000 x 2.9 x 10^{-4} = 116 m^3. Out of this 1/3 (39 m^3) should be manure, compost or forest soil; the rest (77 m^3) should be nursery soil.

The area of bare-root beds is 4,000m^2 or 0.4 ha. The manure needed is equal to 1.5 x 0.4 = 0.6m^3. The total requirement of manure, compost or forest soil is approximately 40m^3 per year and the volume of nursery soil to be used in the pot is 77 m^3.

The area covered by plastic pots is 1,000 m^2 and by bare-root seedlings is 4,000 m^2. What will the daily water requirement be, when the nursery is used to its maximum production?

Calculation:

The bare-root beds or pots need a sheet or a layer of water of 0.02 meter depth

Thus, 5,000m^2 x 0.02m = 100m^3 water per day

6.2. Seedlings plantation and sample moisture harvesting structure

© MoA. The degarded land rehabilated by vegtation and ediable fruits

Moisture harvesting and planting structure for seedlings

© MoA, Ethiopia

© MoA. Biological and physical soil conservation- half moon and micro basin for water percolation

9.2 Computation for seed requirement

Total seedlings required per species for a given watershed

No	Species	Places where to plant, area in hectares, Number of seedlings per species						Total seedlings No
		Agroforestry (…. ha)	Area closure(..ha)	Physical structures (.ha)	Gully rehablit. (.ha)	Woodlot (…ha)	Others (...ha)	
1	Acacia saligna							
2	*Azadrichta indica*							
3	*Cordia africana*							
4	*Grevillea robusta*							
5	Hagenia abyssinica							
6	Juniperus procera							
7	L. Leucocephala							
8	Olea africana							
9	P. falcatus							
10	Avocado							
11	Mango							
12	Orange							
13	Papaya							
Total								

9.3 Amount of seed (in kg & No) to produce seedlings from each species

No	Species	Seeds/kg (000)	Germination %	Seedlings required(No)	Allowance (25%)	Total seeds	
						Kg	No
1	Acacia saligna						
2	*Azadrichta indica*	6-7	30-50				
3	*Cordia africana*	2.5-4.5	40-60				
4	*Grevillea robusta*	80-110	60-80				
5	Hagenia abyssinica	350-500	20-30				
6	J. procera	450-500	20-30				
7	L. Leucocephala	18-20					
8	Olea africana	6.5-7	20-50				
9	P. falcatus	1.5-2.5	50-60				
10	Avocado						
11	Mango						
12	Orange						
13	Papaya						
Total							

9.4 Costs of seed

No	Species	Seed required in Kg	Unit price	Total price	Remarks
1	Acacia saligna				
2	*Azadrichta indica*				
3	*Cordia africana*				
4	*Grevillea robusta*				
5	H. abyssinica				
6	Juniperus procera				
7	L. Leucocephala				
8	Olea africana				
9	P. falcatus				
10	Avocado				
11	Mango				
12	Orange				
13	Papaya				
Total					

9.5 Tree management and use of some useful species

No	Tree species	Management	Uses	Remarks
1	Acacia abyssinica *(Yehabesha girar)*	Lopping and pollarding	Fuel, construction, handles, medicine, fodder, bee forage, soil improvement, and shade	Drought resistant. Plant on marginal lands & gullies.
2	*Acacia albida (Girar)*	Pollarding and lopping	Fuel, furniture, medicine, fodder, soil cons., shade and wind break	If planted mixed with millet and sorghum, gives good prod. It flushes leaves in dry season, fodder for animals.
3	*Acacia decurrense (Girar)*	Coppicing	Fuel, post, fodder, soil improvement, shade, windbreak and for tannery.	Protects landslide, produces good harvest if planted as wood lot.
4	*Acacia melanoxylon ((Girar)*	Pollarding or lopping	Fuel and lumber.	Fast growing for lumber production
5	Acacia nilotica *(Girar)*	Lopping and pollarding	Fencing, windbreak and shade	
6	*Acacia polyacantha(Gmarda)*	Coppicing, lopping or pollarding	Fuel, timber, farm tools, medicine, fodder, soil cons., nitrogen fixation, live-fence, shade and wind break	Fast growing and termite resistant.
7	*Acacia saligna(Girar)*	Coppicing, lopping or pollarding	Fuel, fodder, soil conservation, shade and food preservation.	
8	Acacia tortilis*(Girar*)	Lopping	Fuel, lumber, fodder, Apiary and roap making.	Avoid goats until the tree grows.
9	*Albizia gummifera* (Sesa*)*	Lopping and coppicing	Fuel, lumber, utensils, fodder and bee forage	Shade for coffee, leaves used to ripen banana
10	*Albizia lebbeck* (Sesa)	Lopping, pollarding and coppicing	Fuel, post, lumber, fodder, medicine, apiary, soil cons. tannery and soap making(roots)	If planted along rivers, minimizes soil erosion

11	Albizia schimperiana *(Sesa)*	Pollarding and coppicing	Fuel, lumber, apiary, soil improvement and shade	
12	Annona muricata (Gishita)	Regular weeding, Prune to induce branching and height control and pollarding	Food, medicine, insecticide, fish poison and ornamental	Good fruit tree in home gardens
13	Azadirachta indica *(Kinin*)	Lopping and pollarding	Fuel, lumber, medicine, fodder, pesticide, oil and soap making	Has medicinal value and is useful tree in degraded areas.
14	Balanites aegyptica	Coppicing	Fuel, lumber, post, handles, food(fruits), fodder, gum, and soil improvement.	good for dry areas, produces fruits in dry season and termite resistant. Juice from fruits and bark kills Bilharzias and Guinea worms.
15	*Cajanus cajan* (Yergib ater)	Needs weeding and care as it is easily attacked by pests.	Fuel, food, fodder, bee forage, basketry and, soil fertility	Good in dry areas. It produces fruits 4-5 years continuously
16	Cassia siamea *(Yefeerenj digita)*	Lopping and coppicing	Fuel, lumber, fodder, soil conservation and wind break	Fast growing, if eaten by pigs it can be poisonous. Termite resistant.
18	Casuarina cunninghamnia *(Shewshewe, Arzelibanos)*	Pruning produces good quality lumber.	Fuel, lumber, post, fodder(young twigs), soil conservation and windbreak	Hard for sawing and may bend or twist while drying.
19	Casuarina equisetifolia *(Shewshewe, Arzelibanos)*	Pruning for better quality lumber.	Fuel, post, lumber, fodder, mulching, nitrogen fixation, paint making and tannery.	Can grow in saline soils too.
20	Catha edulis *(Chat)*	Pollarding	Fuel, medicine and drug,	Cash generating plant
21	Citrus aurantifolia (*Lomi)*	Pollarding to induce branches.	Food and medicine	Income generating plant

22	Citrus retculata (*Menderin*	Same as for 18 above.	Food	Produces good in areas 1500-1800 m. a..s.l.
23	Citrus sinensis *(Birtukan)*	Prune to induce branching and height control.	Food	It is a good income generating plant.
24	Cordia africana (*Wanza)*	Pollarding, lopping and coppicing.	Fuel, lumber, utensils, food, shade and soil conservation.	Good for homestead and on farm plantations.
25	*Croton macrostachyus (*Bisana)	Pollarding, lopping and coppicing.	Fuel, lumber, post, handles, fodder, mulching and medicine.	
26	*Erythrina brucei* (Korch)	Pollarding and coppicing	Fuel, handicrafts, fodder, mulching, nitrogen fixation and fruits for necklace.	Propagation by cutting, Good live fence and endemic to Ethiopia.
27	*Eucalyptus camaldulensis* (Key bahirzaf	Coppicing and pollarding	Fuel, post, bee forage and windbreak	Susceptible for termite attack.
28	*Eucalyptus saligna* (Key bahirzaf*)*	Coppicing	Fuel, pulp, utensils, medicine, bee forage, shade and windbreak.	
29	*Eucalyptus viminalis* (Key bahirzaf)	Coppicing	Fuel, post, lumber, bee forage and pulp.	
30	*Kigelia aethiopica (Sausage tree)*	Coppicing	Fuel, post, timber, fodder, bee forage, dye, medicine, and soil fertility	Unripe fruits are poisonous. The tree is not competitive with crops
31	*Kigelia africana (Sausage tree)*	Coppicing	Fuel, post, timber, fodder, bee forage, dye, medicine, and soil fertility	Unripe fruits are poisonous. The tree is not competitive with crops
32	*Lawsonia inermis (Henna)*	Lopping	Fuel, fodder, dye, medicine, perfumes, thatching and ornamental	Produce volatile oils with pleasant odour. Dye is good for colouring of clothes, leather, nails, skin and hair.

33	*Leucaena leucocephala* (Lusina zaf)	Lopping and coppicing	Fuel, post, fodder, bee forage, green manure and soil fertility,	Control expansion as it reproduces rapidly. Do not feed more than 20% as a mix for fodder.
34	*Lonchocarpus laxiflorus*	Coppicing and pollarding	Food, fodder, bee forage	
35	*Mangifera indica* (Manago)	Lopping and grafting	Fuel, fodder, bee forage, shade, windbreak, soil conservation and gum making.	Grafted mangoes give quality fruits.
36	Markhamia lutea	Coppicing and pollarding	Fuel, charcoal, poles, post, timber, tool handles, medicine, mulch , bee forage and soil conservation	The wood is fairly termite resistant
37	*Melia azedarach*	Lopping, pollarding and coppicing.	Fuel, post, handles medicine, bee forage, shade and windbreak.	Fruits are poisonous.
38	*Milletia ferruginea* (Birbirra)	Coppicing and pollarding	Fuel, construction, handles utensils, shad and fishing.	Good shade tree for coffee.
39	*Moringa oleifera* (Shiferaw*)*	Coppicing, pollarding or lopping	Food (leaves and fruits), medicine, fodder, bee forage, soil conservation, shade, windbreak, spice, oil and water purification.	Vegetable oil, cosmetics and soap making.
40	*Olea africana* (Weira*)*		Fuel, post, panelling, milk flavouring and floor making.	Slow growing but very hard wood.
41	*Perkinsonia aculeata (Ye eyerusalem ishoh)*	Pollarding	Fuel, fodder, bee forage, mulch and soil conservation.	Good for rehabilitating degraded areas.
42	*Prosopis juliflora*	Lopping, pollarding and coppicing	Fuel, food, fodder (Fruits), bee forage and soil conservation	Fast growing, competes with food crops therefore avoid planting with them.
43	*Psidium guajava (*Zeitun)	Pollarding, lopping or coppicing.	Fuel food and handles.	Termite resistant, leaves easily decompose.

44	*Rhamnus prinoides (*Gesho*)*	Coppicing	Fuel, medicine and beverage,	Hoeing and watering produces good production & Income
45	*Ricinus communis* (Gulo)		Oil for medicine and lotion. By-product can be used as fertilizer.	Drought and termite resistant. Poisonous to animals.
46	*Schinus molle*	Pollarding, lopping and coppicing	Fuel, bee forage, soil conservation, windbreak, pesticide & spice/seeds.	Good for road side planting
47	*Sesbania sesban* (Girangire*)*	Pollarding and coppicing	Fuel, post, fodder, mulch, soil conservation, shade, nitrogen fixing and soap making (leaves)	Good for combining with annual crops.
48	*Tamarindus indica* (Humer)	Lopping, pollarding and Coppicing.	Fuel, lumber, food (Fruits), beverage (Fruits), fodder, mulch, nitrogen fixing,	Beverage from the pulp is rich in vitamin C.
49	*Tamarix aphylla*	Coppicing	Fuel, lumber, fodder, mulch, soil cons., nitrogen fixing, windbreak and fire control	Produces salty elements, need not be planted mixed with agric. crops.
50	*Terminalia browni* (Abalo)	Lopping, pollarding and coppicing.	Fuel, hand tools, handles, mulch soil improvement and paint	Termite resistant and its shade does not affect crops to grow
51	*Ziziphus moritania* (Kurkura)	Lopping, Coppicing or pollarding.	Fuel, utensils, fodder, soil conservation, fencing and food	Propagation possible via seed, cuttings, root suckers.
52	*Ziziphus spina-christi* (Kurkura)	Lopping and pollarding	Fuel, utensils, fodder, soil conservation, fencing and food	Good for dry areas

Annex 5.5. **የዛፍ ዝርያዎች አያያዝና የአጠቃቀም ስልት**

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
1	የአበሻ ግራር፡-አከሽያ አብስኒካ	፡-ሎፒንግና ፖላረድንግ፡- መጠቀም ይቻላል	ማገ፣ ከሰል ምሰሶ የአጥር እንጨት፣ የአጅ መሣሪያዎች እጀታ፣ መድሃኒት፣ ለከብት መኖ፣ የንብ አበባ፣ የአፈር ለምነት ለመጠበቅ፣ ለከብቶች ጥላ	ድርቅን የመቋቋም ባህሪ ስላለዉ አፈሩ በተጐዳ አካባቢና በገሊዎች አካባቢ ቢተከል መልካም ነዉ፡፡
2	አኬሽያ አልቢዳ	ቅርንጫፎችን ሙሉ በሙሉ በመቁረጥ ወይንም ዋና ዋናውን ቅርንጫፍ ሳይቆርጡ ቅጠሎችን የያዙትን ንዑስ ቅርንጫፎች ብቻ በመቁረጥ መጠቀም ይቻላል፡-ሉፒንግ ዓይም ፖላርዲንግ	ማገ፣ ከሰል፣ ለቤት ቁሳቁሶች ማዘጋጀት፣ መድሃኒት፣ ለከብቶች መኖ ለአፈር እንክብካቤ ለጥላና ለንፋስ መከላከያ	ዓ.ሃ በሚያዝሉ አካባቢዎች ቢተከል ጥሩ ነዉ. ከማሽላና ዘንጋዳ ከመሳሰሉት ጋር ቢተከል ጥሩ ዓ.ጤት እንደሚሰጥ ጥናቶች ይጠቁማሉ ዛፉ በተለይ በበጋ ዓቅት ቅጠል ስለሚይዝ ለከብቶች መኖነት ጠቃሚነቱ የታመነበት ነዉ.
3	አከሽያ ዲከረንስ፡-ግራር፡-	ዛፉ፣ ከተቆረጠ በኋላ በኮፒሲንግ ራሱን መተካት ይችላል!!	ማገ፣ ከሰል፣ ምሰሶ፣ የከብት መኖ፣ ለማር ምርት ለአፈር ጥበቃ፣ ለአፈር ለምነት ጥላና ለነፋስ መከላከያ፣ ለቆዳ ማለስለሻነት፡-ቅርፊቱ፡-	የመሬት መንሸራተት በሚታይባቸዉ. አካባቢዎች ቢተከል አፈሩን ጨብጦ ለመያዝ ያገለግልላ፣ ቅርፊቱ ለቆዳ ሥራ ከፍተኛ አስተዋጽኦ ስላለው ገበሬዎች በጎሎት መልክ እንዲተክሉት ቢደረግ ኢኮኖሚያዊ ጠቀሜታ ይገዓ ሉ፡፡
4	አኬሽያ ሚላኖዛይሎን፡-ግራር፡-	፡-በሉፒንግ ዓይንም ፖላርዲንግ፡- በከፊልና ሙሉ በመሉ ቅርንጫፉን በመጐንደል ዘዴ መጠቀመ ይቻላል	ማገ፣ ከሰል ጣውላ አጥር፣ ጥላና የነፋስ መከላከያ ለሙጫ ያገለግላል	በጣም ፈጣንና ለጣዓ.ላ ምርት ሊጠቅም የሚችል ዛፍ ነው
5	አኬሽያ ናይሎቲክ፡-ግራር፡-	በሉፒንግና ፖላርዲንግ መጠቀም ይቻላል	ማገ፣ ከሰል እጀታ ሥራ ለቅርጻ ቅርጽ ሥራ፣ ቅጠሉና ሥሩ ለመድሃኒት፣ ለንብ እርባታ፣ ለአፈር ለምነት ለነፋስ መከላከያ ለሙጫ ሥራ ለቆላም ደረቅ ፍሬዓ. ለጥርስ ቡርሽ ለጉንፋን፡-ፍሉ፡- መድሃኒት	እንጨቱ በጣም ጠንካራና ምስጥን የመቋቋም ሃይል ያለዓ. በመሆኑ ለቤት ሥራ ያገለግላል፡፡
6	አኬሽያ ሳልግና፡-ግራር፡-	በኮፒሲንግ ዓይም ፖላርዲንግ፡- መጠቀም ይቻላል	ማገ፣ የከብት መኖ፣ ለአፈር ጥበቃ፣ ለጥላ፣ ለሙጫና ምግብ እንዳይበላሽ ለማድረግ	በጐርፍ የተጠቁ አካባቢዎችን ለማልማትና የጐርፍ አደጋን ለመከለከል በገደላገደል አካባቢዓች ቢተከል ጠቀሜታ አለዓ.

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
7	አኬሽያ ቶርቲሉስ፡-ዱኒግራር፡-	ሎፒንግ መጠቀም ይቻላል ያላደጉ ችግኞችን ከፍየሎች መከላከል አስፈላጊ ነው	ማገ፣ ጣውላ፣ ከሰል፣ የከብት መኖ እንቡጦችና ቅጠሎች፡- ለንብ ርባታ፣ ለገመድ ሥራ፡-ፋይበር ቅርፊቱ፡-	ዛፉ በተፈጥሮ ዕድገቱ አዝጋሚ ቢሆንም በጥሩ እንክብካቤ ከተያዘ በአሸዋማ መሬቶች ላይ ጥሩ ዕድገት ያሳያል፡፡ በተለይ በግጦሽና በአዝርዕት ማሣ ውስጥ ቢተከልጥሩ ነው፡፡
8	አልቢዚያ ጋሚፈራ፡-ስሳ	በምልመላ፡-ሎፒንግ፡- በለጋነቱ ከተቆረጠ እንዲያቆጠቁጥ በማድረግ፡-በኮፒስግ፡-መተካት ይቻላል	ማገ፣ ከሰል፣ ሙቀጫና ገበቴ የመሳሰሉ የቤት እቃዎችን ለምስራት ለከብቶች መኖ ለንብ ርባታ ያገለግላል	ቅጠሎቹ ሙዝ እንዲበስል ለማረደግ ይጠቅማሉ ለቡና ተክሎች ጥላ ጠቀሜታ አለው
9	አልቢዚያ ለቤክ፡-ሌበክ	፡-ሎፒንግ፣ ፖላርዲንግ ኮፒሲንግ፡- መጠቀም ይቻላል	ማገ፣ ከሰል፣ ምሰሶ ጣዕላ መድሃኒት፣ የከብት መኖ ንብ ርባታ ለአፈር ለምነት ለመጠበቅ ለቆዳ ማለስለሻ፡-ቅርፊቱ፣ ለሣሙና ሥራ፡-ቅርፊቱ፡-	ዛፉ በዝቅተዓ ቦታዎች ላይ ቢተከል ጥሩ ዓ·ጤት ይሰጣል በተለይም በዓንዞች ዳር ቢተከል አፈሩ እንዳይታጠብ ይረዳል
10	አልቢዚያ ሸምፐሪያና፡-ሶሳ፡-	በቅርንጫፍ ምልመላና ፡-በኮፒስግ፡- መጠቀም ይቻላል	መገ፣ ከሰል፣ ለጣውላ፣ ለክብሪት ሣጥን፣ ለንብ እርባታ ለአፈር ለምነት ለጥላ	
11	አዛድሪያክታ ኢንዲካ፡-ክኒን፡-	ሎፒንግ ፡-ፖላርዲንግ	ማገ፣ ከሰል፣ ለጣውላ መድሃኒት፣ የከብት መኖለንብ መኖ ፀረተባይ ዝይትና ሣሙና	ዛፉ በመድሃኒት በኢትዮጵያ ውሰጥ በጣም የታዓቀ ነዓ፡፡ በተለይ ቅጠሉን በማድቀቅና ከውሃ ጋር በመደባለቅ እንደነቀዝ የመሳሰሉ ተባዮችን ለመቆጣጠር ይቻላል በጣም በተራቆቱ አካባቢዎች ቢተከል ለአፈር እንክብካቤ ይጠቅማል
12	ባላናይቲስ ኢጅኘቲክ	፡-በኮፒሲንግ፡-መልሶ እንዲያቆጠቁጥ በማድረግ ዘዴ መጠቀም ይቻላል	ማገ፣ ከሰል፣ ጣዓላና መሰሶ እጀታዎችን ለመሥራት፣ ፍሬዓ· ለምግብነት ለከብት መኖ ለሙጫ ለአፈር ለምነት፡-መስፐቺንግ፡-	ለደረቅ አካባበዎች በጣም ጠቃሚ ነዓ· ምክንያቱም ፍሬ የሚሰጠዓ· በበጋና ደረቅ በሆነበት ዓቅት ስለሆነ፣ እንጨቱ ምስጥን የመቋቋም ኃይል አለዓ· ከፍሬዓ·ና ከቅርፊቱ የሚገኘዓ· ጭማቂ ቀንድ አዓ·ጣዎች የመግደል ሃይል ስላለዓ· ቢልሀርዚያና ጊኒዓርምን ለመከላከለ ጠቀሜታ አለዓ·
13	ካጃነስ ካጃን፡-ርግብ አተር፡-	በተለያዩ ተባዮች ሊጠቃ ስለሚችል ጥንቃቄ ያስፈልጋል በወቅቱ መከርከም አለበት	ማገ፣ ለምግብነት፡-ፍሬው ለከብት መኖ፡-ቅጠሉ ፖዱ፡- ለንብ መኖ ለቀርጫት ሥራ ግንዱ ለአፈር ለምነት ፡-መልችና ናይትሮጅን፡-	ለደረስ አካባቢዎች ጠቃሚነት ያለው ሲሆን ከ4-5 ዓመታት ያለ ማቋረጥ ፍሬ ሊሰጥ ይችላል

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
				የአፈርን መሸርሸር ለመላከል ጠቃሚ ነዓ፡
14	ካሲያ ሲያሚያ፡-የፈረንጅ ድግጣ፡-	፡-ሎፒንግና ከፒስንግ፡- መጠቀም ይቻላል	ማገ፣ ከሰል፣ ጣዓ፡ላና ምሰሶ ለከብት መኖ ለንብ መኖ፣ ለአፈር እንክብካቤና ለነፋስ መከላከያ	ዛፉ ፈጣን እድገት ያለው ሆኖ በከብቶች ስለማይጠቃ በቀላሉ ሊያድግ ይችላል፡፡ ቅጠሉ ለአሳሞች ከተሰጠ መረዛማ ሲሆን ለቀንድ ከብቶች ግን አደጋ የለውም፡፡ ምስጥን የመቋቋም ኃይል አለው፡፡
15	ካሹዋሪና ካኒንግሀሚያ ሸውሸዌ፡-አርዘሊባኖስ፡-	ዓደጉን የሚያድጉትን ቅርንጫፎች መመልመል ጥሩ ጣውላ ያስገኛል በዛፎቹ ሥር ዙሪያ አፈር ማስታቀፍ ለአፈሩ ለምነት ሊያገለግሉ የሚችሉ ኖዲዩልስ እንዲዳብሩ ይረዳል	ማገ፣ ከሰል ጣዓ፡ላና መሰሶ ያልበሰሉ ንዑስ ቅርንጫፎች ለከብት መኖ ለአፈር እንክብካቤና ለነፋስ መከላከያ	እንጨቱ በጣም ጠንካራ ስለሆነ ለምስጥ አስቸጋሪ ከመሆንም በላይ በሚደርቅበት ዓቅት ሊገለበጥ ስለሚችል ጥንቃቄ ይጠይቃል፡፡ እንጨት በምሰጥ ይጠቃል፡፡
16	ካሹዋሪና እክስትፈልይ ሸውሸዌ፡-አርዘሉኖስ፡-	የተሻለ ጣዓ፡ላ ለማግኘት የጐን ቅርንጫፎችን መመልመል	ማገ፣ ከሰል ምሶሶና ጣውላ፣ የከብት መኖ የአፈር ርጥበት ለመጠበቅ፡-መልች፡-ለናይትሮጂን ፈክሌሽን፣ለቀለም ሥራ፣ ለቆዳ ማለስለሻ፡-ቅርፊቱ፡-	በጨዋማ አካባቢዎች ሊያድግ ይችላል
17	ሲትረስ አውራንቲፎሊያ፡-ለ ሚ፡-	ቅርንጫፎቹን እንዲበዙ ለማደረግ መጐንደል፡-ፖላርድ፡- እንዲሁም ቅርንጫፎቹን አግድም ማጐበጥ ይህም ፍሬዎች በሚደርሱበት ጊዜ በቀላሉ ለመልቀም ያመቻል	ፍሬዎቹ ለምግብነት ቅጠሎቹ ለመድሃኒትነት ይዓ፡ላሉ	ለገበሬዎች ገንዘብ በማሰገኘት ጠቀሜታ ያለው ስለሆነ ሊተኮርበት ይገባል
18	ሲትረስ ሬቲኩላት፡-መንደሪን፡-	በተራ ቁጥር 17 የተመለከተው ለሎሚ የሚደረገው ዓይነት እንክብካቤ ያስፈልገዋል	ፍሬዓ፡ ለምግብነት	በኢትዮጵያ ውስጥ ከ1500 አስከ 1800 ሜትር ከፍታ ጥሩ ውጤት ሊሰጥ የሚችል ተክል ነው
19	ሲትረስ ሳይነንሲስ፡-ብርቱካን፡-	መመልመል ቅርንጫፍ እንዲበዛና ቁመቱ አጠር ብሎ እንዲያድግ ይረደል	ፍሬዓ፡ና ጭማቂዓ፡ ለምግብነት	በዘር፣ ወይም በማጣበቅ ዘዴ ሊራባ የሚችል ተክል ነው
20	ኮርዲያ አፍረካና፡-ዋዛ፡-	ፖላርዲንግ ሎፒንግና ኮፒሲንግ በማድረግ መጠቀም ይቻላል	ለማገ፣ ለጣዓ፡ላ ለልዩ ልዩ የቤት ቁሳቁሶችን ለመሥራት ፍሬዓ፡ ለምግብነት፣ ለጥላና ለአፈር እንክብካቤ	ጣዓ፡ላዓ፡ ጠንካራና ለቤት ቁሳቁሶች ሥራ ቀላል ሲሆን፣ ለምገዛ ግን አስቸጋሪ ነዓ፡ አተከከሉ ጥቅጥቅ ብሎ ቢሆን ቀጥ ያለ ግንድ ለማግኘት ይረዳል

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
				ለንሮ አካባቢና ለማሣ ዓ·ስጥ ተከላ ተስማሚ የሆነ ተክል ነዓ·
22	ክሮቶን ማክሮስታኪስ፡-ብሳና፡-	ፖላርዲንግ፣ ሎፒንግ፣ ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ከሰል፣ ጣዓ·ለና ምሰሶ፣ ለእጀታ ሥራ፣ ለከብት መኖ ለአፈር እንክብካቤ ፡-መልች፡- ፍሬውና ከሥር የሚገኙ ፈሳሽ ለአባለዘር በሽታ መድሃኒት መሆኑ ይታዓቃል	ከምግብ አዝርዕት ጋር አልፎ አልፎ ቢተከል ጉዳት የሌለው ተክል ነው
23	ኩኘረስስ ሉሲታኒካ፡-የፈረንጅ ፅድ፡-	ችግኞቹ አድገው አረምን መቀቋም እሰኪችሉ ድረስ ማረም ያስፈልጋል ምልመላና ማሳሳትም አስፈላጊ ይሆናል በተለይ የተተከለው ጣዓ·ላ ለማግኘት ለአጥር አገልግሎት ከሆነ አዘወትሮ መከርከርም አስፈላጊ ነዓ·	ለጣዓ·ላ፣ ለምሰሶ፣ ለነፋስ መከላከያና ለቤት ዙሪያ አጥር ያገለግላል አልፎ አልፎ ግቢን ለማስዋብም አገልግሎት አለው፡፡	ዛፉ ፈጣን እድገት ስላለው ከተተከለ ከ10 ዓመት በኋላ ምሰሶ ሊመረትለት ይችላል ለጣውላ ከሆነ ግን 20 ዓመታት በአማካይ ይፈልጋል፡፡
24	ኤሪትሪና ብሩሲ፡-ኮርች፡-	ፓላርዲንግ ዓይም ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ለቅርጻ ቅርጽ ሥራ፡-የንብ ቀፎ መቀመጫ ከበሮ፡-ለከብቶች መኖ የአፈር እርጥበትን ለመጠበቅ መልች ለአፈር መደበር፡-ናይትሮጅን ፊክሲሽን ፍሬዓ· ለአንገት ጌጣጌጥ፡-አሸክታብ፡-	ዛፉ በጉንደላ ሊራባ ይችላል፡-5-10 ሣ.ሜ ዓ·ፍረት ያለዓ·ን ቅርንጫፍ በመቁረጥ፡- ዛፍ በተለይ ለግቢ አጥር በዓንዞች ዳር ቢተከል የአፈር መሸርሸርን ለመግታት ያገለግላል ይህ የዛፍ ዝርያ በኢትዮጵያ ብቻ የሚገኝ ስለሆነ ተገቢዓ· እንክብካቤ ቢደረግለት መልካም ነዓ·
25	ኢኳሊፕተስ ካማልዱለንሲስ፡-ቀይ ባህርዛፍ፡-	ኮፒሲንግ፣ ፖላርረዲንግ መጠቀም ይቻላል	ማገ፣ ከሰል ምሰሶ፣ ጣዓ·ላ ለንብ መኖ፣ ለነፋስ መከላከያ አበባዓ· ከፍተዓ ኔክታር የማያመነጭ ስለሆነ ንቦችን በመሳብ ከፍተዓ አስተዋጽኦ እንደለዓ· ይታዓቃል፡፡	ለምስጥ በቀላሉ ስለሚጠቃ ችግኞቹ እስኪያድጉ ድረስ ጥንቃቄ ያስፈልጋል ለበት ዙሪያና ፡-ሆምስቲድ፡- በመንገች ዳር ዳር እንዲሁም ከማሣ ራቅ ብሎ ቢተከል መልካም ነዓ·
26	ኢኳሊፕተስ ግሎብሉስ፡-ነጭ ባህር ዛፍ፡-	ጉቶው መልሶ እንዲያቆጠቁጥ በማድረግ ፡-ኮፒስንግ፡- መጠቀም ይቻላል	ማገ፣ ከሰል ፣ ምሰሶ ሸኒር፣ ኘላይዓ·ድ፣ መድሃኒት የንብ መኖ የንፋስ መከላከያ ጠቃሚ ዘይት	ከዛፍ የሚመነጨው ዘይት ምስጥን ለመቋቋም ስለሚረዳ ለመብራትና ስልክ ምሰሶዎች ጠቀሜታ አለው

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
				ዛፉ የአፈር ንጥረ ነገሮችንና ርጥበትን ስለሚሻማ ከአዝርዕት ጋር መተከል የለበትም
27	ኢኳሊፕተስ ሳሊግና፡-ቀይባህርዛፍ፡-	ጉተው መልሶ እንዲያቆጠቁጥ በማድረግ ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ከሰል ለዓረቀት ምርት የሚያገለግል እንጨት ፡-ፐልኘ ዓ·ድ፡- ልዩ ልዩ የቤት መሥሪያ መድሃኒት የንብ መኖ፣ ጥላና የንፋስ መከላከያ	ይህ ዛፍ ከምግብ እህሎች እጠገብ መተከል የለበትም ዛፉ ቀዝቃዛና ርጥብ ተራሮች አካባቢ ቢተከል ጥሩ ውጤት ይሰጣል
28	ኢከሊፕተስ ዘሚናሎስ ፡-ቀይ ባሕርዛፍ፡-	ጉቶው መልሶ እንዲያቆጠቁጥ በማድረግ ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ምሰሶ፣ ጣዓ·ላ፡-ቀላል ስለሆኑ እንደ ሣጥን፣ የጣራና የወለል እንጨት፡-ለንብ መኖ፣ ለዓረቀት ሥራ ፋይበር፡-	ዛፉ ውርጭና የእሳት አደጋን ለመቋቋም ይችላል በቤቶች አካባቢ፡-ሆምስቲድ፡-በመትከል የማገና ለቤት መሣሪያ አንጨቶችን ለማምረት ይቻላል ቅርንጫፎቹ በቀላሉ ሊጉብጡ ስለሚችሉ እንደ ቅርጫት የመሳሰሉ ነገሮችን ለመሥራት ይጠቅማል
29	ግራቨሊያ ሮቡስታ	ዛፉ ሊራባ የሚችለው በዘር ብቻ ነዓ·	ማገ፣ ከሰል ምሰሶ ጣውላ የከብት መኖ፡-ቅጠሎች፡-የንብ መኖ ለአፈር ጥበቃ ለግቢ ውበት ለንፋስ መከላከያ	በተለይ ከሴት አበባ የሚገኙ ፍሬ የአንጀት ትላትሎችን ለማጥፋት ይረዳል ከምግብ አዝርዕት ጋር ቢተከል ችግር አይፈጥርም ሆኖም የሚፈጠረውን ጥላ መቀነስ አስፈላጊ ይሆናል፡፡
30	ሀጀንያ አብሲኒካ፡-ኮሶ፡-	ዛፉ ሊራባ የሚችለው በዘር ብቻ ነዓ·	ማገ፣ ምሰሶ ጣውላ ለወንበር፣ ጠረጳዛ ወለል ንጣፍ ለቅርጽ ቅርጽ መድሃኒት፣ የአፈር ርጥበት መጠበቅ፡-መልቺንግ፡-፣ግሪን ማኑር ለእሳት መከላከል	ከሴት አበባ የሚገኘው ፍሬ የአንጀት ትላትሎችን ለማጥፋት ይረዳል ከምግብ አዝርዕት ጋር ቢተከል ችግር አይፈጥርም ሆኖም የሚፈጠረውን ጥላ መቀነስ አስፈላጊ ይሆናል
31	ጂኒፐርስ ኘሮሲራ፡-የአበሻ ጥድ፡-	ዛፉ ለጣዓ·ላ የሚሆን ከሆነ መመልመልና መሳሳት አስፈላጊ ይሆናል፡፡ ሊራባ የሚችለዓ· በዘር አማካይነት ብቻ ነዓ· ሆኖም ጀኒሬት ስለሚያደርግ ለደን ልማት ጥሩ ነዓ·	ማገ፣ ጣዓ·ላ ምሰሶ ለወለል፣ ለጣራ ለእርሳስ እንጨትና ለልዩ ልዩ ተገጣጣሚዎች ያገለግላል	ከዛፉ የሚወድቁት ቅጠሎች አፈሩን አሲዳም ሊያደረጉት ስለሚችሉ ከምግብ አዝርዕት ራቅ ብሎ ቢተከል ጥሩ ነው እንጨቱ ምስጥን በመቋቋም የታወቀ ነዓ·

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
32	ጃስቲካ ሽምፐሪያና፡-ሰንሰል፡-	በሎፒንግ መጠቀም ይቻላል በችግኝ ፡-በዘር፡-አማካይነት ሊራባ ቢችልም በአብዛኛው ግን ቅርንጫፎችን አፈር ለማስታቀፍ ነው ቆርጦ በመትከል ይራባል	ለማገና ለግቢ አጠር እንጨቱ በኢትዮጵያ ለልዩ ልዩ ለእንጀራ መጋገሪያ በሰፊዓ· ይዓ·ላል	ከ1500-2800 ሜትር ከፍታ ባላቸው ደረቅና ርጥብ ወይና ደጋ አካባቢዎች ሊተከል ይችላል
33	ሉሰና ሊዩኮሴፋላ፡-ሉሱና ዛፍ፡-	በሎፒንግና በኮፒስንግ ዘዴ መጠቀም ይቻላል	ማገ፣ ከሰል፣ መሰሶ፣ የከብት መኖ፣ የንብ መኖ፣ ግሪን ማኑር አፈር ለማዳበር፡-ናይትሮጅን ፊክስንግ፡-	ዛፉ በከፍተዓ ፍጥነት ሊራባ የሚችል ስለሆነ ዓደ አረምነት እንዳይሸጋገር መጠንቀቅ ያስፈልገል ሚሞስያን የተባለዓ· በቅጠሎቹ ዓ·ስጥ የሚገኝ ንጥረ ነገር የከብቶቸን ፀጉር የማሳጣት ባህሪ ያለዓ·ና እንዳንዳም የሆድ ዕቃ ሕመም ሊያስከትልባቸዓ· ይችላል ስለሆነም በከብቶች መኖ ዓ·ሰጥ ከ20 በመቶ እጅ በላይ መጨመር አደገዓ ይሆናል
34	ማንኒፈራ ኢንዲካ ፡-ማንጉ፡-	በሎፒንግ በማጣበቅ ዘዴ መጠቀም ይቻላል ፈጣን እድገትና ጥሩ ምርት ለማግኘት ግራፍቲንግ፡-የጥብቂያ፡-ዘዴ መጠቀም ጥሩ ነዓ·	ማገ፣ የከብት መኖ ለምግብነት፡-ፍሬዓ·፡-ለንብ መኖ፣ ለጥላ፣ ለንፋስ መከላከያ ለአፈር እንክብካቤና ለሙጫ	የተመረጡ ዝርያዎችን መጠቀም ጣፋጭና አነስተዓ ፋይበር ያለዓ· ፍሬ ማግኙት ይቻላል ፍሬዓ· ቫይታሚኒ ኤ ና ሲ ለማግኘት ይረዳል
35	ሜለያ አዛዳራክ	ፖላይዲንግ፣ ሎፒንግ፣ ኮፒሲንግ፣ መጠቀም	ማገ፣ ምሰሶ ለመሣሪየዎች እጀታ ለመድሃኒት ለንብ መኖ ጥላ ነፋስ መከላከያ	ፍሬዎቹ ለሰዎች፣ እንስሳትና ለሮዎች አደገዓ መርዞቸ ስለሆኑ መጠንቀቅ ያስፈልግል ዛፉ በመጠኑም ቢሆን ምሰጦችን የመቋቋም ሃይል አለዓ·
36	ሚሊቴያ ፈሩጃኒያ ፡-ብርብራ፡-	፡-ኮፒሲንግና ፖላርዲንል መጠቀም ይቻላል	ማገ፣ ለበት ሥራ፣ ለእጀታዎች ለቤት ቁሳቁሶች መሥሪያ ለጥላ፣ ለአሣ ማጥመጃ	ቡና አብቃይ ለሆኑ አካባቢዎች በጥላ ዛፍነቱ ጠቃሚ ዛፍ ነው
37	ሞሪንጋ አሊፈራ፡-ሽፈራው ፡-	፡-ኮፒሲንግ፣ ፖሊርዲንግ ሎፒንግ መጠቀም ይቻላል	ቅጠሎችና ፍረዓ· ለምግብነት ያገለግላል፣ ለመድሃኒት፣ ለከብት መኖ፣ ለንብ መኖ፣ ለአፈር እንብካቤ ለጥላ ለነፋስ መከላከያ ለቅመምነት፡-ሥሮቹ፡-ዘይት ፡-ከፍሬው፡-ለውሃ ማጣራት ተግባር፡-ፍሬዓ·፡-	ዛፉ በቀላሉ ሊራባ የሚችል ስለሆነ በቤት ዙሪያ ፡-ሆምስቲድ፡- ቢተከል ተስማሚ ነዓ· ቤንዘይት የተባለው ንጥረ ነገር እንደ ሰዓት የመሳሰሉትን ለማጽዳት ይጠቅማል

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
				የአትክልት ዘይት፣ ሳሙናና የቁንጅና ቅባቶች ለመሥራት ያገለግላል
38	አሊያ አውሮፒያ፡- አፍሪካና ፡-ወይራ፡-	አዝጋማ እድገት ያለው ዛፍ ሲሆን ሊረባ የሚችለው በችግኝ አማካይነት ነው፡፡	ማገ፣ ከሰል ምሰሶ ለነሊንግና ለዓለል ንጣፍ የሚሆን እንጨት ለዓተት ዕቃ ማጠንት	እንጨቱ በጣም ጠንካራ ሰለሆነ ለአጥር ይጠቅማል
39	ፖርኪን ሶኒያ አኩላታ፡-የኢሩሣል ም እሾህ፡-	ፖላርዲንግ መጠቀም ይቻላል	ማገ ከሰል፣ የከብት መኖ፣ የንብ መኖና፡-መልች፡- ለአፈር እንክብካቤ	ችግኞቹ በቀላሉ በምስጥ ሊጠቁ ስለሚችሉ መጠንቀቅ ያስፈልጋል ዛፉ የተጐዱ አካባቢዎች መልሶ ለማገገም ከፍተኛ አሰተዋጽኦ ያለው ነዓ፡
40	ሲዲየም ጉዋቫ፡-ዘይቱን፡-	ፖላርዲንግ፣ ኮፒሲንግ፣ ምልመላ መጠቀም ይቻል	ማገ፣ እጀታ ለመሥራትና ፍሬዓ፡ ለምግብነት እንጨቱ ምስጥን የመቋቋም ባህሪ አለው ቅጠሎቹ በቀላሉ ሊበሰብሱ ስለማይችሉ ለአፈሩ ንጥረ ነገር፡-ኦርጋኒክ ማተር፡-ሊጨምሩ አይችሉም	ፍሬው አብዛኛውን ጊዜ በዝንብና በዓፎች ስለሚጠቃ ጥንቃቄ ማድረግ ጥሩ ነዓ፡ ፍሬው ለገበሬዎች የገቢ ምንጭ ከመሆኑም በለይ ቢበላም ቫይታሚን ሲን በማግኙት ይረዳል ዛፉ ከ3-4 ዓመታት ውሰጥ ፍሬ ሊሰጥ የሚችል ሲሆን እስከ 30 ዓመት ድረስ ያለማቋረጥ ሊያፈራ ይችላል
41	ራሀምነስፒርኖይደስ ፡-ጌሾ፡-	ኮፒሲንግ መጠቀም ሲቻል አረም ኩትኳቶ ቢቻልም በመስኖ ውሃ ማጠጣት አስፈላጊ ነው	ማገ፣ ሥሩ ለመድሃኒት ቅጠሎቹ ለቀላልና ለመሳሰሉት መጠጦች ማጣፈጨ ይዓላሉ ሥሮቹ ደምን ለማጥራት ጥቅም ላይ እንደሚውሉ ይታወቃል!!	በጓሮ አካባቢ መትከል የተለመደ ነው
42	ሬሰኒሰ ክማኑስ፡-ጉሎ፡-	ተክሉ ሊረባ የሚችለው በችግኝ አማካኝነት ነው	ዘይቱ ለመድሃኒትና ለአካል ቅባት፡-ቦይሎሽን፡-ያገለግላል	ተክሉ ድርቅን ከመቋቋሙም በላይ ምስጥ አያጠቃዓ፡ም ቅጠሉና የዛፉ ሽፋን መርዛማ ስለሆነ ለእንስሳትና ለሮዎች መኖ ሊሆን አይችልም የዘይቱ አተላ ለማዳበሪየነት ሊያገለግል ይችላል
43	ሽይነስ ሞሌ፡-ቁንበርበሬ፡-ቱርማንቱሪ፡-	ፖላርዲንግ ሎፒንግ ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ከሰል፣ የንብ መኖ፣ ለአፈር እንክብካቤ ለነፋስ መከላከያ፡-ፍሬው፡- ለቅመምነት ለተባይ ማሰዓገጃ፡-ቅጠሉ፡-	የዛፉ ዕድሜ እጨመረ በሄደ ቁጥር ቅርንጫፎቹ ሊዓድቁ ስለሚችሉና ሥሮቹም የመስፋፋት ፀባይ ስላለዓ፡

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
				ከቤቶቹ ተጠግቶ ባይተከል መልካም ነዉ፡ በመንገቹ ዳር ቢተከል ጥሩ ነዉ፡
44	ሴስባኒያ ሴስባን	፡-ፖላርዲንግ፣ ኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ለምሰሶዎች፣ የከብት መኖ፣ ለአፈር እንክብካቤ ለጥላ፡-በተለይ ለቡና ተክል፡-፣ ቅጠሎቹ ለሳሙና ይዉላሉ	ዛፉ ለናይትሮጅን ፊክሴሽን የሚሰጠዉ አገለግሎቱ የታዓቀ በመሆኑ ከምግብ አዝርዕት ጋር ተሰባጥሮ ቢተከል ጥሩ ዓጤት ይሰጣል
45	ታማራደስ ኢንዲካ፡-ሁመር፡-ሮካ፡-	፡-ፖላርዲንግ፣ ኮፒርስንግ፡-መጠቀም ይቻላል	ማገ፣ ከሰል፣ ጣዉላ ፍሬዉ ለምግብነት ለቅምምነት ለመጠጥ ያገለግላል ለከብት መኖ ቅጠሉ ይዓዉላል፣ ለመልች፣ ለናይትሮጅን ፊክሲሽን ያገለግላል ከፐልፑ የሚገኘዉ መጠጥ በቫይታሚን ሲ የበለፀገ ነዉ፡	በቤት አካባቢና በምንጮች ዙሪያ ቢተከል መልካም ነዉ፡
46	ታማረደስ አፈላ	በኮፒሲንግ መጠቀም ይቻላል	ማገ፣ ከሰል፣ ጣዉላ የከብት መኖ መልች ለአፈር እንክብካቤ ለነፋስ መከላከያ ለእሣት መከላከያ በተለይ ከቅጠሎቹ ጋር የሚዓድቀዉ ጨዉ በሳት ለመቀጣጠል ስለማይችል ለእሣት አደጋ መከላከያነቱ ይመረጣል ስለሆነም ፋየር ብሬክ መስመሮች ላይ ቢተከል ጥሩ ነዉ፡	ዛፉ ጨዋማ ነገር በማመንጨት ስለሚታዓቅ በሥሩ የሚገኘዉ አፈር የጨዉ ይዘት ሊጨምር ይችላል ከዛፉ የሚዓድቀዉ ጨዉ በሥሩ የሚገኝ እጽዋትንም ሊያጠፋ ይችላል ስለሆነም በአጠገቡ መዘራት የለባቸዉም፡፡
47	ተርሚናሊየ ብራዉኒ	ሉፒንግ፣ ፖላርዲንግ ኮፒሲንግ መጠቀም ይቻላል	ማገዳ፣ ከሰል የእጅ መሣሪያዎች እጀታ፣ ለከብት መኖ ለመልችና ለአፈር መሻሻል፣ ለቀለም ሥራ	ግንዱ ምስጥን የመቋቋም ባህሪ ስላለዉ ለቤት ሥራ አገልግሎት ከፍተዓ ነዉ፡፡ በተለይም ለአዝርዕት ጐተራ ሥራ ይመረጣል ምንም እንኳን ጠቅጣቃ ቅርንጫፍ ቢኖርም በሥሩ አዝርዕት ቢዘሩ ጉዳት አያስከትልም
48	ቨርኖኒሪያ አሚግደሊና፡-ግራዋ ፡-	ፈጣን ዕድገት ያለው ዛፍ ሲሆን በኮፒስንግ መልሶ እንዲያቆጠቁጥ በማድረግ መጠቀም ይቻላል ቅርንጫፎችን ቆርጦ በመትከልም ሊራባ ይቻላል	ማገ፣ ቅጠሉ ለእንስሳት መኖ ሥሩ ቅርፊቱና ቅጠሉ ለመድሃኒት መልች ለግቢ አጥር ያገለግላል ግንዱ ምስጥን ለመቋቋም ለአጥር ሥራ የተመረጠ ነዉ፡	

ተቁ	የዛፉ ስም	ሊደረግለት የሚገባ እንክብካቤ	ከዛፉ የሚገኙ ዋና ጥቅሞች	ምርመራ፡-ተጨማሪ
49	ዚዝፈስ ስፖይና ክሪስቲ፡-ቁርቁራ፡-	ፈጣን ዕድገት ያለው ዛፍ ሲሆን ሉፒንግ፣ ፖሳርዲንግ በከፈልና ሙሉ በሙሉ ቅርንጫፎችን በመጉንደል መጠቀም ይቻላል	ማገዳ፣ ከሰል ለቤት ቁሳቁሶች ሥራ ለከብት መኖ ለአፈር ጥበቃ ለአጥር ፍሬዓ፡ ለምግብነት ያገለግላል	ለደረቅ አካባቢዎች ጠቃሚ ዛፍ ስለሆነ ሊተኮርበት ይገባል፡፡

9.6 Recommended species for Agroforestry based on agro-climatic zones

Dry Weina Dega, 1500-2300m.a.s.l., Annual rainfall 1400mm

Tree species	Planting site				No. of seeds per k.g. (000)	Germination period (Days)	Germination %	Period in Nursery (Months)	Treatment before sowing
	Homestead	On farm	Farm boundary	Pasture Land					
Acacia abyssinica	x	x		X	10-12	7-21	25-60	8-9	Immerse in boiled water for 24 hrs and cool
Acacia saligna	x		x	X	7-14				
Acacia tortilis		x			8-9	7-14	60-90	8-9	
Albizia gummifera	x	x		X	7-10	14-18	70-80	7-8	Immerse in boiled water for 24 hrs
Azadiarachta indica	x	x	x	X	6-7	10-21	30-50	11-14	
Cajanus cajan	x	x	x	X	2-4			3-5	
Casuarina equisetifolia	x	x	x	X	60-90	15-21	50-70	7-8	

Cordia africana	x	x	x	X	215-415	40-45	40-60	5-7	
Croton macrostachyus	x	x		X	20-20	18-25	40-50	6-8	
Cupressus lusitanica	x		x		160-290	15-21	30-50	7-8	Immerse in cold water for 48 hrs.
Gravillea robusta	x		x		80-110	10-21	30-50	8-10	

Moist and Wet Weina Dega, 1500-2300, Annual rainfall over 1400mm.

Tree species	Planting site			Pasture Land	No. of seeds per k.g. (000)	Germination period (Days)	Germination %	Period in Nursery (Months)	Treatment before sowing
	Homestead	On farm	Farm boundary						
Acacia abyssinica	x	x		X					
Acacia albida	x	x		X	10-13	7-21	40-90	8-9	>> >>
Acacia decurrens	x		x	X	50-80	14-21	80-95	8-9	Immerse in boiled water and cool for 48hrs
Acacia melanoxylon	x		x	X	30-40	2-14	40-70	9-10	>> >>
Acacia tortilis		x		X	8-9	7-14	60-90	8-9	
Albizia gummifera	x	x			7-10	14-18	70-80	7-8	Immerse in boiled water and cool for 24 hrs
Albiizia schimperiana	x	x			8-10	14-21	50-60	7-8	

Azadrichta indica	x	x	x	X	6-7	10-12	30-50	11-14	
Cajanus cajan	x	x	x	X	2-4		60-70	3-8	Immerse in cold water for 24hrs.
Casuarina cunninghamiana	x	x	x	X	1400-1600	18-21	55-90	7-8	
Cordia Africana	x	x	x	X	2.5-4.5	10-45	40-60	6-7	
Croton macrostachyus	x	x	x	X	20-25	18-25	30-50	6-8	
Cupressus lusitanica	x		x		170-180	18-21	30-50	7-8	
Dovyalis abyssinica	x		x		30-40	7-21	75-95	7-8	
Eucalyptus globulus				X	2000-3000	7-14	80-100	4-5	
Eucalyptus spp				X	2000-3000	7-14	60-80	8-10	Immerse in cold water for 48 hours
Juniperus procera	x	x	x	X	450-500	5-60	20-30	12-16	

Moist and wet Dega, 2300-3200 m.a.s.l., Annual rainfall over 1800mm

Tree species	Planting site				No. of seeds per k.g. (000)	Germination period (Days)	Germination %	Period in Nursery (Months)	Treatment before sowing
	Home stead	On farm	Farm boundary	Pasture land					
Acacia abyssinica	x			x	10-12	7-21	25-60	8-9	Immerse in boiled water for 24 hrs and cool
Acacia decurrens	x	x	x	x	50-80	14-21	25-80	8-9	>> >>
Acacia melanoxylon	x		x	x	50-80	7-14	40-70	9-10	>> >>
Arundinaria alpina	x		x		Cuttings			10-15	
Cajanus cajan	x	x	x	x	2-4	10-15		11-14	Immerse in cold water for 24 hrs.
Casuarina equisetifolia	x	x	x	x	1000-1500	15-21	50-70	7-8	
Casuarina cunninghamnia	x	x	x	x	1400-1600	15-21	55-90	7-8	
Croton macrostachyus	x	x		x	20-25	18-25	40-50	6-8	
Cupressus lusitanica	x		x	x	170-350	15-21	30-50	7-8	
Enset ventricosum	x				Veg. rep		50-90	7-8	

Eucalyptus viminalis				x	2000-3000	7-14	25-95	4-5	
Eucalyptus globulus				x	8000-9000	7-14	80-90	4-6	
Grevillea robusta	x	x	x	x	80-110	10-21	60-80	8-10	
agenia abyssinica	x	x	x	x	350-500	14-21	20-30	7-8	
Juniperus procera	x	x	x	x	450-500	5-60	20-30	12-16	
Lucaena Leucocephala	x		x	x	18-20	14-21		3-5	
Olea capensis	x	x	x	x	6.5-7	60-70	20-50	12-14	
Pododcarpus falcatus				x	1.5-2.5	60-70	50-60	12-14	
Rahmnus proinodes	x								
Tree lucern	x	x	x	x			50-90		Immerse in cold Water for 24 hrs.