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**Agroforestry and Community Forestry for Rehabilitation of Degraded  
Watersheds on the Ethiopian Highlands**

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# **Agroforestry and Community Forestry for Rehabilitation of Degraded Watersheds in the Ethiopian Highlands**

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## **Abstract**

Despite the efforts made to develop Ethiopian agriculture over the years, the problems of hunger, famine, and malnutrition and land degradation still linger and present the greatest threat to the survival of the nation. With the new thrust to produce more food using high input and single crop farming, today's farmers grow only one or two crops in monoculture systems. The traditional diversification of farmlands, which arguably has been the source of sustenance in rural Ethiopia since time immemorial, has largely been abandoned. Furthermore, deforestation, accelerated soil erosion, and land degradation are now serious problems in Ethiopia. As a result crop and livestock yields are generally very low and the recent drought has aggravated the situation. The land use system is associated with the decrease in the size of holdings both for arable and grazing lands. Thus there is a continued trend toward the conversion of forested and marginal lands to agricultural lands, resulting in massive environmental degradation and a serious threat to sustainable agriculture and forestry.

While agroforestry should not be taken as a panacea for land-use problems in Ethiopia, it may be considered as a potential alternative to some of the wasteful land-use practices in the country. Agroforestry is a dynamic, ecologically based, natural resources management system that, through integration of trees on farms and agricultural landscapes, diversifies and sustains production for increased social, economic, and environmental benefits for land users at all levels (World Agroforestry Center 2003). In this paper we will present different agroforestry practices and their potential, as well as research needs on the Ethiopian Highlands based on a Diagnostic and Design survey conducted by ICRAF and the Technical Committee for Agroforestry in Ethiopia in 1990. The second part of the paper will present a case study on rural tree planting on farm and community lands in the Alemaya Basin, Hararghe Highlands, Ethiopia. This study was conducted by the Alemaya University of Agriculture in the 1980s and was funded by FAO. If properly practiced and managed, these agroforestry and community forestry programs can serve as a means to alleviate problems of soil erosion and land degradation. They can also provide food, fuelwood, and fodder for the farm family. Agroforestry can be viewed as a strategy to overcome the lack of success in past tree planting by providing opportunities for both food and tree production on the same unit of land, thus reducing competition for this scarce resource. Agroforestry can also serve as a model for sustainable agriculture and forestry practices.

**Key words:** Agroforestry, community forestry, land degradation, deforestation, highlands, watersheds, natural resource management.

## **1. Introduction**

Ethiopia, situated in the horn of Africa with a population of 64 million and annual rate of growth of 2.9 percent (WRI 2001), is overwhelmingly an agricultural country. Farm products account for over half the country's gross domestic product, and 90 percent of its exports. The majority of the population is engaged in subsistence farming. While agriculture is the basis of the economy, productivity is significantly limited because of severe land degradation.

Reports on the forest resources of Ethiopia are dominated by the alarming deforestation that goes on unabated and at an accelerating rate. Nationally, the current deforestation rate of natural forests is estimated at 160,000–200,000 ha per annum (EFAP 1994). Deforestation takes place in both forests and farm woodlands and it is recognized as the most severe environmental problem in Ethiopia. The National Conservation Strategy of the Federal Democratic Republic of Ethiopia (FDRE) identifies deforestation as a major problem, not only in the forest proper, but also as it affects other sectors such as crops, animal husbandry, water resources, and wildlife habitat. Ethiopia relies on its diverse biological resources for its socioeconomic development, and these resources are now under severe pressure.

Ninety-four percent of the Ethiopian population relies on wood-based and biomass fuel for household energy. Scarcity of firewood has become acute in many parts of the country causing a continuous rise in prices, and thus increasing the economic burden on the household budget. Animal dung and crop residues are increasingly being used for household fuel rather than being added to the soil to improve soil fertility, thus further exacerbating the problems of environmental degradation.

Poverty and natural resources/environmental degradation are negatively reinforcing; that is, as the land is degraded, agricultural productivity is lowered, resulting in decreasing incomes and food security. This in turn leads poor people from both rural and urban areas to engage in activities that further degrade the natural resources and environment in order to obtain

supplementary incomes and to sustain a living. As a result, the level of poverty in Ethiopia also worsens and population increases exacerbate the problem.

While agroforestry should not be taken as panacea for all land-use problems in Ethiopia, it may be considered as a potential alternative to some of the wasteful land-use practices that exist in the country. According to Raintree (1987), agroforestry is usually viewed as an unconventional way of raising trees by foresters and unconventional cropping method by agronomists. Appreciation of the system comes, however, when we begin to view trees as plants that promote productivity and we recognize that when trees are grown together with agricultural crops, forest products can be more accessible to rural people. Rural Ethiopia cannot afford to put aside land for either agriculture or forestry alone. Given the unprecedented population increase, large estates and/or large blocks of plantations may soon be a thing of the past. The future holds that both agricultural and forest products are needed by rural people simultaneously, not alternatively. There is an urgent need for the increased diversification of Ethiopian farmlands. Against this background, we discuss agroforestry and agroforestry practices within the context of the circumstances in Ethiopia. The review in this section focuses on two parts: the first part focuses on defining the concept of agroforestry along with some of the most common practices of agroforestry in Ethiopia. The second part briefly describes a community forestry project conducted as a case study on the Hararghe Highlands of Ethiopia

## **2.1 Concepts and definitions of Agroforestry**

Agroforestry is a new name for an old set of land-use practices. It is an integrated approach to solving land-use problems by allowing farmers to produce food, fiber, fodder, and fuel simultaneously from the same unit of land. A common characteristic feature of all forms of agroforestry is that a tree component is deliberately grown or retained in an agricultural setting. Various definitions for the term agroforestry have been given through the years since its advent as a scientific approach to land-use problems in the early 1980s. The best and probably official

definition is the one that is commonly used by the World Agroforestry Center: "Agroforestry is a collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry system there are both ecological and economical interactions between the different components" (Lundgren and Raintree 1982).

The concept of agroforestry is based on the development of the interface between agriculture and forestry. It is a sustainable multiple-production system whose outputs can be adjusted to local needs. The main components of agroforestry systems are trees and shrubs, crops, pasture, and livestock together with the environmental factors of climate, soil, and landform. Other components (e.g., bees, fish) occur in specialized systems (Young 1989). Under this definition, a variety of combinations of plants may be possible. But there are two important features that identify agroforestry from other land-use systems:

- There must be a tree component deliberately grown or retained in the land-use system
- There must be significant interaction, positive and/ or negative, between the woody and non-woody components of the system.

Agroforestry, therefore, involves two or more species of plants and /or animals at least one of which is a woody perennial and with two or more outputs. Owing to the variety of mixtures, therefore, even the simplest agroforestry system is more complex both ecologically and economically than a mono-cropping system. The aim and rationale of agroforestry lies in optimizing production based on the interactions between the components and their physical environment. This will lead to higher sum total and a more diversified and /or sustainable production than from a monoculture of agriculture or forestry alone.

Numerous definitions and concepts of agroforestry are available in the literature. Although the many definitions vary in some ways, substantive similarities are always there. For

further reference, please see the different agroforestry definitions compiled by Nair in *Agroforestry Systems in the Tropics* (1989) and *An Introduction to Agroforestry* (1993).

## **2.2 Classification of Agroforestry systems**

The most common set of criteria used to classify agroforestry systems and practices are (Nair 1989; 1993):

- Structural basis—refers to the composition and arrangement of the components, both spatial and temporal.
- Functional basis—refers to the main function or role of the components especially the woody components as for soil conservation and soil fertility improvement.
- Socioeconomic basis—refers to the intensity or scale of management and goals of the system.
- Ecological basis—refers to the environmental and ecological suitability of systems. There can be separate sets of agroforestry systems for arid and semi-arid lands or humid and sub-humid tropics.

All agroforestry systems are characterized by three basic components namely, the woody perennials (trees/shrubs), the herbaceous plants (crops, pasture species), and the animals. Based on these three basic components, agroforestry systems can also be classified for all practical purposes according to their component composition (Nair 1989; 1993):

- Agrosilvicultural systems
- Silvopastoral systems
- Agrosilvopastoral systems.

Other specialized agroforestry systems can also be defined (for example, apiculture with trees, aquaculture involving trees and shrubs, and multipurpose-tree lots).



### **2.2.1. Agrosilvicultural systems**

This is an agroforestry system where agronomic crops are combined with shrubs/trees on the same unit of land for higher or better-sustained production of annual crops, fodder, and wood. In any one agroforestry system, there can be more than one agroforestry practice. An agroforestry system is identified by certain types of practices that, taken as a whole, form a dominant land-use system in a particular locality, characterized by environment, plant species and arrangement, management, and social and economic functions. Although an agroforestry practice is a distinctive arrangement of components in space and time, when the combinations are arranged in time sequence, such practice is called *taungya* practice. The combinations can also be arranged in space, such as the hedgerow/mixed intercropping practice.

### **2.2.2 Silvopastoral systems**

This is an agroforestry system where range crops and/or animals and trees are combined for better production of grasses and fodder. This combination can be arranged as a pure stand with fodder trees/shrubs planted as a protein bank (with cut-and-carry fodder production) and/or mixed in different configurations such as living fences of fodder trees and hedges. The trees and shrubs and grass components are arranged in such a way that their healthy coexistence is not disrupted. The acacia-dominant system in the arid parts of Ethiopia, Kenya, and Somalia are good examples of this system.

This system can be practiced on both range and forest lands for the production of both feed and woody materials. This system could also be practiced on sloping ground by growing grasses and trees/shrubs together for soil conservation purposes. The main objective of this practice is to supply feed for livestock during the dry season with high quality tree leaves and pods. This will substantially increase the productive capacity of poor and scarce pasture lands common on the Hararghe Highlands. Fuelwood and construction poles can also be produced with this system.

### **2.2.3 Agrosilvopastoral systems**

This is an agroforestry practice by which food, pasture, and tree/shrub crops are combined on the same unit of land for the production of grass and browse feed, biomass for fuelwood and green manure, and food for human consumption.

This system is practiced when the farmer needs all the benefits that would be obtained from silvipasture and agrisilviculture systems from a unit of land. Usually, such a system is practiced on cultivated land. Alternative rows of hedges, grass strips and/or crops would form such a system, a form of alley cropping.

Agrosilvopasture is also practiced when the cropland is constrained by slope and threatened by erosion. These are very common problems of land use in most of the Ethiopian Highlands; therefore, this system has potential for use in various regions of the country.

The above definition and discussions of agroforestry systems and practices encompasses many well-known land-use systems long practiced in the Ethiopian highlands. Thus, it is apparent that agroforestry is only a new word for an old practice: it is based on forestry, agriculture, animal husbandry, land resource management, and other disciplines that all form the systematic background of land use. Furthermore, it encompasses an awareness of interactions between humans and the environment and between demand and available resources in a given area. Although science can improve agroforestry practices, an important aspect of the problem of Ethiopia is to mobilize and implement what is already known.

### **2.3 Some common examples of agroforestry practices in Ethiopia**

The practices included here are just a few among the countless and diverse agroforestry practices that exist in Ethiopia; by no means do they represent an exhaustive list of systems and practices. For in-depth reading of the most common agroforestry systems in the Ethiopian highlands we refer readers to Hoekstra et al. (1990). This section will give brief description of

the practices we think are most common in the Ethiopian agricultural landscape. A short description of each practice is followed by potential for use and possible research needs in Ethiopia.

### **2.3.1 Scattered trees in crop lands**

This practice involves the growing of individual trees and shrubs in wide spaces in croplands. Dispersed trees grown in farmlands characterize a large part of the Ethiopian agricultural landscape. Trees would be grown in a scattered form over a crop field, usually between 1–20 trees per hectare to minimize impact on the companion crop. In such mixed intercropping, lopping and pollarding of trees would be practiced. Some good examples of this practice include *Cordia Africana* intercropping with maize in Bako and western Ethiopia; *Acacia albida*-based agroforestry in the Hararghe Highlands and Debrezeit area (Hoekstra et al. 1990).

The system has much potential for supplying fodder, poles, farm equipment, fuelwood, and agricultural improvements (Poschen 1986; Abebe 2000). Some possible research needs include soil-plant interactions, soil fertility and N-fixation studies on wide range of species, crop-tree yield studies and optimum tree density, socioeconomic studies, and species selection and screening including seed tests, establishment, and management.

### **2.3.2 Home Gardens of the SNNP Region**

Home gardens can be found in many parts of southern and southwestern regions of Ethiopia. Crops such as coffee, enset, pepper, and numerous kinds of vegetables are dominant components of the Ethiopian home gardens (Getahun 1988). Trees like *Cordia Africana*, *Milletia fruginea*, *Albezzia gummifera*, *Ficus* species, and *Acacia* species are among the species that form the upper storey of home gardens. The structural complexity in the Ethiopian home gardens is varied and ranges from complex and diverse forms containing numerous species and strata, as in

Sidama of the SNNPR, to the less complex forms, with one or two crop/tree mixtures, as in the Gurage Enset home-compound farms.

Home gardens supply much of the basic needs of the local population and help reduce the environmental deterioration. The beauty and quality of the landscapes of Sidama, for example, stand in stark contrast to the treeless farmlands of much of Ethiopian agricultural lands. Research on Ethiopian home gardens is at its infancy, with the exception of a few quantitative and descriptive studies (Getahun 1988; Abebe 2000; Negash et al. 2002). Multi-disciplinary biophysical studies, including soil-plant interactions and socioeconomic studies on home gardens, are needed for better understanding and use of these ecologically sound agroforestry systems.

### **2.3.3 Hedgerow intercropping**

This form of agroforestry is practiced in many parts of Ethiopia. The sorghum/maize and chat (*Catha edulis*) hedgerow intercropping in the Hararghe Highlands of eastern Ethiopia is one such example. The shrub chat is a stimulant cash crop that generates cash for the farmer. Although the soil regenerative properties of the system are not obvious, it has undoubtedly helped in the soil conservation of the hilly landscapes of Hararghe (Bishaw and Abdelkadir 1989).

Another form of hedgerow intercropping that has recently been introduced and has been widely tested in the scientific community is alley cropping. Experiments with alley cropping have been done at the International Livestock Research Institute (ILRI), Ethiopian Forest Research Center, and Alemaya University of Agriculture, among others (Hoekstra et al. 1990). Alley cropping is an agroforestry technology suited to humid and sub-humid tropics and entails the growing of food crops between hedgerows of planted shrubs and trees, preferably leguminous species. The hedges are pruned periodically during the crops' growth to provide biomass and enhance soil nutrient status (Nair 1989; 1993). There is great potential for use of the

system in Ethiopia, particularly to improve soil and water conservation in the hilly and mountain ranges for which Ethiopia is known.

Research on interaction at the tree-crop interface, species screening, and socioeconomic studies are some of the research areas that are needed to verify and underline the adoptability of the system to the humid and sub-humid areas of Ethiopia that can support the system (Bishaw and Abdelkadir 1989).

#### **2.3.4 Riparian zone vegetation**

There are numerous perennial and intermittent rivers in Ethiopia. Some of these rivers and streams do support large numbers of species in relatively dense vegetation, which to the onlooker gives the appearance of a seemingly unbroken canopy cover. A case in point is the vegetation along the Awash and Eliwoha waterways, which contains diverse and multi-layered species. The most common riparian species along these rivers are *Acacia tortilis*, *A. nilotica*, *Balanites aegyptica*, *Tamarindus indica*, *Tamarix* spp., and *Ziziphus* spp. The riparian vegetation is an important source of fodder for livestock during the dry season, and is a source of food for humans, medicinal plants, fuelwood, and wood for utensils. It is also home to many bird species and other wild animals. Pastoral people along the Awash River, for example, often rely heavily on gathered foods from these forests along waterways. The riparian woodlands also contain numerous browsable fodder and shrub species that produce dry-season fodder. The Afar nomads protect and highly revere these wooded lands. Research needs include techniques for the establishment of special food and fodder reserves in riparian areas, selection and screening of riparian species, management and use of riparian areas, water-harvesting techniques, and socioeconomic studies.

### **2.3.5 Enclosures and natural regeneration of species in woodlands and pasture**

The establishment of enclosures will be a realistic and cheap approach to the improvement of pastoral and degraded woodlands in Ethiopia. The single most important approach to improve the woodlands and pastures is to establish enclosures and provide protection against grazing and tree felling. Once this is done, trees and grasses will often regenerate quickly and grow without intervention. Examples of successful enclosures in Ethiopia include those undertaken by the Tigray Regional Government on a large part of the inhospitable Tigray Terrains, and enclosures established by Self Help International (SHI), Ireland, in the dry lands of the Rift Valley of southern Showa. Wherever enclosures were established, the impact on regeneration has been substantial. The enclosures were established with the consent and involvement of the local community. Research needs include testing the effectiveness of enclosures under various plant communities, adoption and scaling up, socioeconomic studies, species selection, natural regeneration and enrichment planting studies, and water harvesting.

### **Community Forestry Practices in the Hararghe Highlands Ethiopia**

The term community forestry was defined in 1978 as “any situation which immediately involves local people in forestry activities. It embraces a spectrum of situations ranging from woodlots in areas which are short of wood and other forest products for local needs through the growing of trees at farm and community level to provide cash crops and the processing of forest products at the household, artisan or small industry level to generate income, to the activities of forest dwelling communities. The activities so encompassed are potentially compatible with all types of land ownership. While it thus provides a partial view of the impact of forestry on rural development, it does embrace most of the ways in which forestry and the goods and services of forestry directly affect the lives of the rural people” (FAO 1978).

Based on the definition above, community forestry is perceived as encompassing all activities that are carried out by individual households, farmers as well as activities involving the community as a whole. These activities are not only limited to tree planting on farms and households, but also include activities such as the use and the management of natural resources and the supply or provision of tree products from the surrounding vegetation. Community forestry also refers to the promotion of self-help management and use of trees to sustainably improve the livelihoods of the local people.

The community sector of Ethiopia's forestry has been assigned to strive for meeting the basic needs of the rural as well as partly the urban population in both fuelwood and construction poles, including other small-scale timber. Soil and water conservation through afforestation and land rehabilitation also were outstanding efforts of the sector. Despite major problems of deforestation and land degradation, massive soil conservation and afforestation programs were undertaken in Ethiopia since the early 1970s (Hurni 1990; Gamachu 1990). These programs were undertaken by various agencies of the government through the assistance of international and bilateral organizations such as FAO. The Community Forestry Department of the Ministry of Agriculture was the main government agency involved in the planning and execution of soil conservation measures and afforestation programs.

The College of Agriculture (now Alemaya University) was involved in the Afforestation and Soil Conservation program in the early 1980s. This project was funded by FAO/UNDP, (TCP/ETH/8904). The main objectives of the community forestry project were (1) to establish community woodlots to meet the demands of fuelwood, construction materials, and fodder from trees planted outside forests; (2) to promote soil conservation measures to reduce degradation of soil resources and improve productivity of agricultural lands; (3) to establish roadside and farm border plantings to serve as wind breaks and shelter belts, and (4) to reduce the pressure from the remaining natural forests and to conserve biodiversity (Bishaw 1988; Bishaw and Uibrig 1989).

### **3. Materials and Methods**

#### ***3.1 Description of the study area***

To undertake the afforestation and soil conservation program, a representative site in the Haraghe Highlands, Alemaya Basin, was selected. The Alemaya Basin lies between altitudes of 1,850 and 2,200 m and has a mean annual rainfall of 850 mm (500–1,260 mm). It has a mean annual temperature of 7.8°C (with an extreme minimum of 4°C) and a mean maximum of 22.9°C (with an extreme maximum of 29°C). The annual mean is about 15.8°C (Hawando 1982).

The Legeambo Farmer's Producer Cooperative, one of the project sites, is about 7 km from the town of Alemaya and is accessible by car. This cooperative has a total land area of 631.5 ha and had a population of 1, 557 in 1979/1980 (Bishaw 1988).

#### ***3.2 Organization and Budget***

At the time, the College of Agriculture, with funding from FAO/UNDP tried to introduce and implement modern technologies and methods into the rural areas, with special emphasis on afforestation, soil conservation, and alternative energy sources. For this project a total of U.S. \$35,000, which is 50 percent of the budget, was offered by FAO/UNDP, the rest was covered by the college in the form of technical assistance and material aid.

In addition, the different governmental organizations from the Hararghe Administrative Region and Alemaya Sub-district gave full support in organizing the project work. Members of the Legeambo Cooperatives were actively involved in implementing the project.

### **4. Planning and Implementing the Afforestation Program**

#### ***4.1 Manpower***



The staff members of the Forestry Section, in consultation with an FAO silviculturist, conducted the afforestation program. Dr. Bishaw, who is the senior author of this paper, was the team leader for the afforestation program. In addition, 20 students from the Department of Plant Sciences participated in surveying and mapping the afforestation site and vegetation cover of the area. Five permanent employees from the Forestry Section were also involved in seed collection, nursery preparation, raising seedlings, and in clearing and preparation of the tree-planting site.

#### ***4.2 Selection of Tree Species***

To fulfill the objectives of the afforestation program, the expert group surveyed the project area and recommended the most adaptable species to provide for immediate needs of the farmers. Furthermore, the group also tried to identify species having more than one of the required characteristics for fulfilling the afforestation objectives. Based on the above criteria, the following tree species were selected: *Acacia cyanophylla* Lindl., *Casuraina equistifolia* L., *Cupressus arizonica* Greene, *Eucayptus camaldulensis* Dehn, *Eucalyptus globulus* Labill, *Eucalyptus saligna* SM, and *Grevillia robusta* A. Cunn.

#### ***4.3 The Raising and Care of Seedlings***

Seed for afforestation program were collected from the Alemaya College campus and additional seeds were brought from the Forestry Research Center in Addis Ababa. Some of the seed were given pre-sowing treatment such as soaking in hot and cold water to break dormancy. The college forest nursery was used to raise the needed seedlings for the afforestation program. A plastic tube filled with soil was used so that seedlings would have a ball of earth around the root system and be supplied with enough soil nutrients and moisture when transplanted into the field. This is intended to ensure high survival rate of seedlings when planted out in the field. The

seeds were sown directly into the plastic tubes to reduce transplanting cost. Two to three seeds were sown per plot and if more than one germinated the others were removed.

Optimum care, such as watering, mulching, shading, and weeding, was provided at the nursery to produce healthy and vigorous seedlings for field planting. Furthermore, hardening and grading of seedlings was done before field planting. It took 7-12 months, depending on the species, for the seedlings to reach the required size (25-30 cm) for field planting. Table 1 shows the species of seedlings raised during the 1979/1980 afforestation program in the Alemaya Basin.

Table 1: Seedlings raised during the 1979/1980 planting season

Species	Number	Condition
<i>Acacia cyanophylla</i>	10,000	Potted
<i>Casuarinae euistifolia</i>	10,000	Potted
<i>Cupressus arizonica</i>	5,000	Potted
<i>Eucayptuscamaldulensis</i>	25,000	Potted
<i>Eucalyptus globulus</i>	25,000	Potted
<i>Eucalyptus saligna</i>	10,000	Potted
<i>Grevillia robusta</i>	5,000	Potted
Total	90,000	

Source: Bishaw 1988

#### ***4.4 Selection and Preparation of planting site***

The site selection for the afforestation program was based on land capability classification of the project area. Land that is above Class 5 and up to Class 7 was designated for tree planting. In general, sites that were not used for crop production and grazing were assigned for tree planting.

Site preparation, such as clearing and digging holes, was done by farmers with technical advice from the Forestry Section workers. Different spacing was used for field planting: 2.5 m x 2.5 m and 1.5 m x 1.5 m.

During field planting, sites were prepared with different plot sizes from 0.5 to 2 ha. Trees were planted on top of the hills and inside gullies to control erosion, and on roadsides and farm borders as wind breaks and shelter belts. Thus, during the 1979/1980 planting season about 33,000 tree seedlings of different species were planted on about 20 ha of land.

## **5. Results and Discussion**

Even though trees were planted by the million in different parts of the country, there was no follow-up to determine whether the seedlings survived or not. But the Forestry team in the Legeambo afforestation program carried out a study on survival of seedlings. It is hoped that this information will give some idea of the adaptability of some of the species to the soil and climatic conditions of the area. The results of the study are shown in Table 2. Seven months after the initial planting, a survival study showed a relatively good rate of survival, 58 percent, as compared to the national average, which is less than 20 percent (Uibrig 1989; Gamachu 1990).

A management plan for the woodlots was prepared by Bishaw (1985) however there was no opportunity to initiate trials for its immediate implementation. The main objective of the management plan was to expand the afforested area to an extent of self-sufficiency in fuel wood and pole production. In general, management of the woodlots was based on sustained yield principles, thus, recommendations were given on necessary silvicultural treatments, such as on new afforestation and replacement planting, cultivation and weeding and intermediate cuttings or thinning. Moreover, planning for final felling was based on principles of area regulation (Bishaw 1985).

Table 2: Survival of six tree species seven months after planting in Legeambo Farmers' Producer Cooperative, Alemaya Basin.

	Number of seedlings planted	Dead Seedlings percent	Surviving Seedling percent
<i>Cupressus arizonica</i>	3,985	33	67
<i>Casurinae euistifolia</i>	3,225	46	54
<i>Acacia cynophylla</i>	1,683	48	52
<i>Eucayptus camaldulensis</i>	7,731	48	52
<i>Eucalyptus globulus</i>	735	49	51
<i>Grevillia robusta</i>	206	29	71
Total	16,565		
Mean		42.2	57.8

Souce: Bishaw 1988

## 6. Conclusions and Recommendations

The active participation of the farmers in the planning, design and implementation of the afforestation work and their training in forestry techniques, i.e., on the establishment and management of woodlots helped guarantee success in the community forestry projects. The first afforestation, conducted on a relatively good quality site, enabled the production of harvestable crops within a short period of time. This was helpful toward convincing farmers of the benefit of growing trees at the initial stages of a community forestry program.

At least one cultivation and weeding before the onset of the small rains for the newly afforested areas was essential. This reduced the competition for soil nutrients and moisture and thereby helped improve growth and survival of seedlings.

One of the many management factors in community woodlots is that of the intermediate cutting or thinning. Since most of the community woodlots were operated by the farmers themselves, their knowledge of the thinning operation was of primary importance for the proper utilization of community forests. Selective thinning is recommended between ages 4 and 6 years to provide a ready supply of wood to the farmers, to improve the stand quality by eliminating damaged and cracked trees, and to regulate intake of light and demands on soil moisture and nutrients.

Once they reach maturity, trees can be harvested for fuelwood and construction poles by farmers for household consumption or sale of products. The monetary value of forest products and the inputs will help increase understanding of community forestry as an important sector of the economy.

The establishment of cooperatives provided a good opportunity for community forestry development at that time. However, there was a change of government in Ethiopia in 1990/1991, which led the country from a socialist-oriented to market-oriented system. During this time of uncertainty, farmers were reluctant to wait and see what the results of changes in ownership, land use rights, and tree tenure might be. Instead, they cut all of the trees in the Alemaya Basin. For future projects, therefore, the land and tree tenure policy of the country should encourage farmers and should provide guarantees concerning planting and growing trees on their land.

Finally, the methodology applied and the experience gained from community forestry development and soil conservation work in the Alemaya Basin has been very successful. We recommend that such demonstration work be applied with some modifications to other parts of the country to ensure forestry development in Ethiopia.

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