Deforestation and Land Degradation in the Ethiopian Highlands: A Strategy for Physical Recovery

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Abstract

Deforestation, accelerated soil erosion, and land degradation are serious problems in Ethiopia. To overcome these problems, efforts have been made to launch afforestation and conservation programs; success to date, however, has been limited. This paper will discuss agriculture and forestry practices in the Ethiopian highlands and try to identify the causes of deforestation and land degradation there. Agroforestry and social forestry practices, plantation forestry, and conservation of the remaining forests are proposed as a strategy for physical recovery. Social and policy issues such as local participation in natural resource management and the existence of clear land and tree tenure policies are critical for the long-term sustainability and expansion of forests in Ethiopia. In general, tree planting through agroforestry and social forestry should be an integral part of rural development programs to provide the community with food, fuel wood, income, and environmental benefits. Increasing public awareness through education about forestry and natural resource conservation is vital for maintaining Ethiopia's remaining natural forests and biodiversity.

Introduction

Forests and the benefits they provide in the form of wood, food, income, and watershed protection play a critical role in enabling people to secure a stable and adequate food supply. Deforestation and land

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degradation in Ethiopia, however, are impairing the capacity of forests and the land to contribute to food security and to provide other benefits such as fuel wood and fodder. Ethiopians are facing rapid deforestation and degradation of land resources. Population increases have resulted in extensive forest clearing for agricultural use, overgrazing, and exploitation of existing forests for fuel wood, fodder, and construction materials. Forest areas have been reduced from 40 percent a century ago to an estimated less than 3 percent today. The current rate of deforestation is estimated at 160,000 to 200,000 hectares (ha) per year, and fertile topsoil is lost at an estimated rate of one billion cubic meters per year (FAO 1981; UNEP 1983; Constable 1985; Kuru 1990; Yirdaw 1996), resulting in massive environmental degradation and constituting a serious threat to sustainable agriculture and forestry.

To reduce these problems, rural afforestation and conservation programs on farms and community lands have been practiced in Ethiopia for the past three decades. The Ministry of Agriculture, in collaboration with national and international organizations, has made efforts to implement agroforestry and community tree planting programs. Rural tree planting on farm and community lands was identified as the most important area of international development. In addition, the United Nations Development Program, in consultation with the Food and Agricultural Organization (FAO), has been helping Ethiopia to promote tree planting and soil conservation programs in the highlands since the early 1970s (FAO 1985). The objectives of these activities were: (1) to meet the needs for fuel wood, construction materials, and fodder from trees planted outside forests; (2) to reduce degradation of soil resources and improve productivity of agricultural lands; and (3) to reduce the pressure from the remaining natural forests and conserve biodiversity.

Additional research on agroforestry and transfer of technology has been conducted by the International Center for Research in Agroforestry (ICRAF), in collaboration with national research and development institutions on the East African highlands since the mid-1970s (Nair 1990; Hoekstra, Torquebiau, and Bishaw 1990). The primary objectives of this collaborative research were to identify potential agroforestry practices and research needs using "Diagnosis and Design" methodology developed by ICRAF. As part of this effort, a blueprint for

"Agroforestry: Potential and Research Needs for the Ethiopian Highlands" was prepared by the Technical Committee for Agroforestry in Ethiopia, in collaboration with ICRAF scientists. Based on altitude, topography, and intensity of land-use systems, the following were identified as agroforestry practices for the Ethiopian highlands: alley cropping, trees in home gardens, fodder tree planting, trees as living fences, farm boundary and road side planting, woodlots and agroforests, trees on contour bands, and gully planting (Hoekstra, Torquebiau, and Bishaw 1990).

Despite the large commitments of scarce resources by both governmental and nongovernmental agencies, however, success in tree planting and conservation has been limited. Current tree-planting practices result in less than 20 percent tree survival on average nationally (Uibrig 1989; Gamachu 1988). This problem is only one of several major obstacles hindering the development of forestry programs in Ethiopia.

This paper will review agriculture and forestry practices in the Ethiopian highlands and discuss the causes and consequences of deforestation and land degradation in the country. The study proposes agroforestry and social forestry practices, plantation forestry, and conservation of the remaining natural forests as a strategy for physical recovery in Ethiopia. In summary, some recommendations on social and policy issues will be given to help promote tree planting and natural resource conservation in Ethiopia.

Country Background—Ethiopia

Geography and Agro-Ecology

Ethiopia, situated in the horn of Africa, has an area of 1,100,000 km^2 (472,000 square miles). With a population of over 62.5 million and an annual rate of growth of 2.9 percent (WRI 2001), Ethiopia is the second most populous country in black Africa, after Nigeria; in land area, it is the ninth largest. Although the whole of Ethiopia lies within the tropical altitudes, the climate is cool in the highlands and warm in the lowlands. The annual range of temperature is relatively small because of the proximity to the equator. Rainfall variability generally increases as rainfall total decreases and thus is generally greatest in the lower rainfall areas of the north and northeast highlands. The rainfall is uni-modal

(i.e., falling mainly during one season of the year). Climate is determined mainly by the altitude, which dominates all aspects of land use because of its influence on temperature.

The country has a wide range of agro-ecological zones reflecting the wide variation in rainfall (both quantity and distribution), temperature, altitude, topography, and soils. According to studies by Getahun (1978) and Constable (1985), three broad major agro-ecological zones comprise the highland zones of Ethiopia: the High Potential Perennial (HPP) Zone, the High Potential Cereal (HPC) Zone, and the Low Potential Cereal (LPC) one (see Table 1).

Table 1. Major agro-ecological zones of the Ethiopian highlands

Zone	Climate	Growing Period (no. of days)
HPP zone	Warm and more humid	Mainly > 240
HPC zone	Intermediate rainfall	Usually > 180
LPC zone	High variability, occasional drought	Mainly 90–150

The FAO's concept of growing periods was used to classify the land-use systems into distinctly different agricultural potentials. This growing period concept takes into account influences on plant growth—not only precipitation and evapo-transpiration, but also temperature and stored soil moisture. However, it is broadly defined here as the number of days in a year that plants can grow without irrigation.

Agriculture and Land Degradation

Agriculture is the dominant sector of the Ethiopian economy, with 85 percent of the population living in rural areas. Agriculture provides about 52 percent of the country's gross domestic product, 80 percent of its employment, and 90 percent of its export earnings (World Bank 2000; CIA 2001). Ethiopia's economy is largely dominated by subsistence agriculture, and crop and livestock farming are the principal practices. Mixed farming dominates the highlands, with crop and livestock farming practiced in the same management unit. The production system is mainly rain fed, subsistence-based, and smallholder-oriented.

Crops such as barley, teff, wheat, and beans are grown in the higher altitudes, while sorghum and maize are the principal crops in the mid and low altitudes. In addition, coffee, sweet potatoes, *chat,* various vegetables, fruits, and groundnuts are extensively cultivated. Cattle, sheep, and goats constitute the livestock in the highlands. Crop and livestock yields in the highlands are very low, and the recent drought has aggravated the situation. Furthermore, population pressures have decreased the size of holdings, including both arable and pasturelands, leading to conversion of forested and marginal areas into agricultural lands (Hoekstra, Torquebiau, and Bishaw 1990; Bishaw 1993).

Soil degradation in Ethiopia can be seen as a direct result of past agricultural practices in the highlands. The dissected terrain, the extensive areas with slopes above 16 percent, and the high intensity of rainfall lead to accelerated soil erosion once deforestation occurs. In addition, some of the farming practices within the highlands encourage erosion. These include cultivation of cereal crops such as teff (*Ergrotis tef*) and wheat (*Triticum sativum*), which require the preparation of a finely tilled seedbed, the single cropping of fields, and down-slope final plowing to facilitate drainage. Furthermore, sociopolitical influences, especially insecurity of land- and tree tenure, have discouraged farmers from investing in soil conservation practices.

Soil degradation is thus the most immediate environmental problem facing Ethiopia. The loss of soil and the deterioration in fertility, moisture storage capacity, and structure of the remaining soils all reduce the country's agricultural productivity. Soil erosion is greatest on cultivated land, where the average annual loss is 42 tons/ha, compared with five tons/ha from pastures. As a result, nearly half the soil loss comes from land under cultivation, even though these lands cover only 13 percent of the country. Not surprisingly, the highest average rates of soil loss are from formerly cultivated lands that are currently unproductive because of degradation and little protective vegetative cover (Hurni 1990).

The present status and rate of soil erosion in Ethiopia call for immediate action to retard and reverse this degradation process. However, the present population growth rate of 2.9 percent, in comparison with the annual agricultural growth rate of 2.4 percent (Hammond 2001), will

lead to even more intensive use of cultivatable and pasture land to produce more food and feed for the growing human and livestock populations. Hence, it is clear that intensification of land use must be accompanied by technological innovations that will lead to increased productivity, while simultaneously conserving the soil resource.

Forest Resources of Ethiopia

Natural Forests

High forests, either coniferous or broad-leaved vegetation, covered 35–40 percent of Ethiopia before human settlement took place. With the inclusion of savanna woodlands, some 66 percent of the country was originally covered with forest or woodlands (Britenbach 1961; Wood 1990; Kuru 1990; Yirdaw 1996). Over the last 3,000 years there has been progressive deforestation, which has accelerated tremendously during the last century. Rapid population growth, extensive forest clearing for cultivation, overgrazing, movement of political centers, and exploitation of forests for fuel wood and construction materials without replanting reduced Ethiopia's forest area to 16 percent in the 1950s and to 3.1 percent by 1982 (UNEP 1983). Further estimates of the distribution of forest and woodland areas based on information from LANDSAT imagery (1979) revealed that 2.8 percent of the land surface is under forest and woodland (Kuru 1990; MOA 1991; Table 2).

Table 2. Natural forest vegetation coverage of Ethiopia in 1990

Vegetation	Area (million ha)	Coverage (%)
High forests	3.44	2.8
Riverain and mangrove	1.30	1.1
Bamboo woodlands	0.45	0.4
Mixed deciduous	2.50	2.0
Acacia-Boswellia and wooded grasslands	20.00	16.0
Subtotal	27.69	22.3
Other lands	92.31	77.7
Total	120.00	100.0

The highland forests can be broadly divided into dry and moist montane forests. The dry montane forests are dominated by hard-leaved evergreens, while the moist montane forests are characterized by large broad-leaved and soft-leaved species (Bekele 1994). The dry montane forests are dominated by *Juniperus procera, Podocarpus gracilor,* and *Olea europaea,* while the wet montane forests consist of such species as *Aningeria adolfi-friederici, Olea welwitschii, O. hochstetter,* and *Croton macrostachyus.* Mountain cane (*Arundinaria alpina*) stands are also found at humid highland elevation areas (2,500–3,400 meters) in scattered but large and compact stands (FAO 1981). However, because of deforestation, much of the highlands at present are covered with wooded grasslands in which secondary tree species, including *Acacia abyssinica, Acacia negrii,* and *Acacia pilispina,* occur (Friis 1992).

The remaining natural forest areas are located primarily in southern and southwestern Ethiopia. High forests in these areas have been identified and efforts are being made to conserve, protect, and manage these resources on a sustained-yield basis. At present, however, accessible high forest areas are exposed to various development project pressures, including coffee and tea cash cropping, human resettlement, grazing, and logging operations (MOA 1991).

Due to the immediate significance and long-term impact of these problems, efforts have been made to identify the remaining high forests designated as 57 National Forest Priority Areas (NFPA). These areas would cover 3.44 million hectares, or 2.8 percent of the country (Table 2). Proper protection and management of these NFPA is questionable, however, because of the lack of clear and efficient forest policy.

The influence of humans and their domestic animals has profoundly altered both the vegetation and the landscape, and little natural highland vegetation remains today. Ecological degradation, including deforestation and erosion, is widespread, particularly in the northern and central highlands. Though not as severely degraded, the southern parts of the highlands are being increasingly affected (Getahun 1988; Hurni 1990).

Forest Plantations

Forests plantations are defined by FAO (1993) as forest stands established artificially by afforestation on land where forests previously did

not grow, or forest stands established artificially by reforestation on land that had supported forests within the previous 50 years (or within living memory) that involves the replacement of the previous trees by new and essentially different trees. Julian Evans defines plantations simply as a forest crop or stand raised artificially either by sowing or planting (cited in Yirdaw 1996).

In Ethiopia, plantation forestry began near the turn of the nineteenth century, when Emperor Menelik requested that a fast-growing tree species be planted to overcome the fuel wood shortage he faced at the time. During the early 1900s, most of Addis Ababa was reportedly covered by forests; in 1964, eucalyptus plantations covered about 13,500 ha (FAO 1985). Today, there are about 162,000 hectares of plantation forests and about 36,000 hectares of urban fuel wood plantations. These are managed by the state, and eucalyptus is the main plantation species (MOA 1991).

Ethiopia's forest resource conservation, development, and utilization today are not the product of a long-evolving process in which different land-use planning measures have been devised to meet the changing needs and various ecological conditions of the country. The absence of sound and comprehensive land-use policies encompassing the identification, selection, and appropriation of suitable areas for forestry development, based on production and environmental protection, is the outstanding forestry problem in Ethiopia (MOA 1991).

Community Forestry and Soil Conservation

Community forestry has been defined by FAO (1978) as any situation that intimately involves local people in a forestry activity. It embraces a spectrum of situations ranging from woodlots in areas that are short of wood and other forest products for local needs, through the growing of trees at the farm and community level to provide cash crops, and the processing of forest products.

Despite major problems of deforestation and land degradation, massive soil conservation and afforestation programs have been ongoing in Ethiopia since the early 1970s (Hurni 1990; Gamachu 1988). These programs were undertaken by various government agencies with the assistance of international and bilateral organizations. The Community Forestry and Soil Conservation Department of the Ministry of

Agriculture is the main government agency involved in the planning and execution of soil conservation measures and afforestation programs. The department is involved mainly in three activities: farm forestry, community forestry, and soil conservation.

In the Farm Forestry Program, farmers are encouraged to establish small private plantations around their homes—usually various species of eucalyptus. In the Community Forestry Program, farmers are encouraged to plant trees on community lands. The Community Forestry Program provides technical and financial support in the establishment of nurseries and the planting of seedlings. The Soil Conservation Unit is involved with terracing and other soil protection schemes. The Department of Community Forestry and Soil Conservation works directly with farmers who provide labor.

The World Food Program of the United Nations has been involved in soil conservation, afforestation, and small-scale irrigation projects in Ethiopia since the mid-1970s and continues to support these efforts. Its assistance is mainly through the Food for Work Program, where farmers who work on the projects are provided with grain and vegetable oil.

Various documents of the Community Forestry Department (CFD) indicate that by September 1986, close to 500,000 ha of farmland and 175,000 ha of hillside had been terraced, and 181,000 ha of land afforested by the Community Forestry Program throughout the country. Although the achievements were impressive, CFD reports that soil conservation and afforestation activities have declined over the years, and the enthusiasm manifested in the early years of the programs seem to have faded (Hurni 1990; Gamachu 1988).

The problems seem to be related to disincentives among farmers for soil conservation measures and afforestation programs. These activities, although part of a "development package," are not viewed by farmers as ensuring an immediate return. Soil conversation measures take some land out of production, placing more pressure on existing farm- and grazing land. This is particularly the case in northern Ethiopia, where there is a shortage of agricultural land. Farmers are also required to provide their labor and time for activities that from their point of view do not generate immediate benefits.

Moreover, there is no clear legal base for determining ownership of community forests. Farmers tend to assume that the forests belong to the State and, therefore, that they do not have the right to use and own these forests. Additionally, the massive national soil conservation and afforestation efforts between 1976 and 1985 were often seen as government-imposed activities. Since these initiatives were not accompanied by education and proper incentives, farmers did not perceive individual benefits to themselves (Gamachu 1988; Hurni 1990).

Strategy for Physical Recovery

Various international organizations and consultants, including the World Bank, in the *Ethiopian Highland Reclamation Study* (Constable 1985); FAO, in *Preparatory Assistance to Research for Afforestation and Soil Conservation* (Davidson 1988); ICRAF, in *Agroforestry: Potential and Research Needs for the Ethiopian Highlands* (Hoekstra, Torquebiau, and Bishaw 1990), all have emphasized in their recommendations the need for conservation-based integrated development as a strategy to overcome the degradation of land resources and improve agriculture and forestry development in Ethiopia. Moreover, priorities indicate that the initial effort be directed to areas where environmental degradation is high and food production returns are low.

To overcome deforestation and land degradation in the Ethiopian highlands and to provide the people with food, fuel wood, and fodder on a sustainable basis, three natural resource management strategies are proposed:

1. Implementation of agroforestry and social forestry in the rural areas where subsistence farming is practiced
2. Expansion of both industrial and non-industrial plantation forestry on currently uncultivated and sloping lands
3. Conservation of the remaining natural forests to conserve species and biodiversity

If properly practiced and managed, these measures will help achieve sustainable production and environmental protection in the Ethiopian highlands.

In the subsequent sections, I will discuss the contributions of agroforestry and social forestry to alleviating food insecurity, fuel wood, and

fodder shortages while providing environmental benefits in the Ethiopian highlands, as well as the potential of plantation forestry to provide wood and other benefits. Strategies for the conservation and enrichment of the remaining natural forests will also be addressed.

Agroforestry and Social Forestry

Agroforestry is not a totally new concept in Ethiopia; rather, it is an age-old practice whereby farmers maintain trees in croplands. Such woody perennials are retained for their multiple uses and benefits, such as their nitrogen-fixing properties and soil improvement capacity, and the provision of fodders, fuel wood, and fruits (Hoekstra, Torquebiau, and Bishaw 1990).

The role of agroforestry in satisfying the basic needs of the rural peoples of Ethiopia is large, but little research has been initiated to identify suitable agroforestry technologies and appropriate tree species for specific areas. Based on the work done by the Technical Committee for Agroforestry in Ethiopia, however (Hoekstra, Torquebiau, and Bishaw 1990), I propose the following agroforestry technologies as appropriate for land-use systems in the Ethiopian highlands. Even where the proposed technologies have not been implemented, they can at least serve as baseline information for further development of agroforestry.

1. *Alley cropping.* Alley cropping is an agroforestry system in which food crops are grown in alleys formed by hedgerows of trees or shrubs. The hedgerows are cut back at planting and kept pruned during cropping to prevent shading and reduce competition with food crops. When there are no crops, the hedgerows are allowed to grow freely. The primary reasons for introducing alley cropping into the farming system are to improve soil fertility, produce fodder and fuel wood, and aid in soil conservation.
2. *Fodder tree planting on unproductive pasture and degraded hillsides.* Fodder trees and shrubs can be planted as pure stands on degraded lands and/or mixed in different configurations with grass and herbaceous legumes on unproductive pasturelands. This practice will involve a cut-and-carry system from stands planted on hillsides. The main objective of this practice is to supplement the low quantity and -quality feed sources available for livestock during the dry season

with high-quality tree leaves and pods. This will substantially increase the productive capacity of poor and scarce pasturelands common in the Ethiopian highlands.

3. *Tree planting in home gardens and woodlots.* Tree planting in home gardens and woodlots on poor quality sites and steep slopes is a common practice in the Ethiopian highlands. Moreover, planting of single species and mixtures of species on micro-sites, such as steep slopes and rocky or marshy sites within farmlands, can be increased. The main objectives of this practice are to produce fuel wood and construction poles for the community. Moreover, trees planted around homesteads can serve as windbreaks and shelter belts for humans, as well as provide feed and shelter for animals. Additional food supply and cash income could be obtained by planting fruit trees around homesteads.
4. *Tree planting as living fences on farm boundaries and roadsides.* Both internal and external farm boundaries may be used for tree planting to produce poles, timber, fuel wood, and fodder. The design of this planting scheme can include planting trees in lines or rows in border areas and along roadsides. The main objective of this practice is to provide an alternative source of cash to farmers and to supply fuel wood, which is otherwise scarce. Such tree plantings can also indirectly influence the crop-livestock production system by acting as windbreaks and shelterbelts.
5. *Tree planting on contour structures and inside and along gullies.* This planting scheme has a wide range of applications because it does not compete with crop production for land. Land scarcity is acute in the densely populated highlands, where farmers tend to use every available piece of land without regard to soil conservation. Thus, tree planting on contour structures and inside and along gullies will greatly help in soil and water conservation. The main objective of this scheme is to aid bench terraces and gully stabilization, and help prevent runoff and soil erosion, all of which are very common in the highlands. The additional use of wastelands for tree planting will contribute to the economic and natural resource base of communities. However, these trees, especially when stands are young, will not adequately protect soil unless ground vegetation is also managed properly.

Agroforestry and social forestry as land-use systems have great potential for alleviating the land degradation problems associated with poor traditional farming practices in the Ethiopian highlands. They can also improve agriculture and forestry production on a sustained basis by providing food, fuel wood, and fodder for farm families.

Forest Plantations

Establishment of forest plantations to provide timber and construction materials, pulp and paper for industry and public use, and fuel wood for urban dwellers is essential for Ethiopia's future economic development. Plantations can be established as pure and/or mixed stands with appropriate silvicultural techniques. This can be achieved through the private sector by establishing industrial plantations and nonindustrial private forests. Encouraging private sector involvement in developing industrial forest plantations potentially can increase self-sufficiency in wood production and contribute to the national economy. Furthermore, encouraging farmers and small landowners to be involved in tree-growing schemes will help them generate household income.

In order for plantations to be successful in checking deforestation and to satisfy the growing need for timber, they must be managed based on ecosystem principles. Improvement in forest legislation concerning plantations and participation of the local population in forest plantation work is essential. Plantations should not merely promote tree crops, but also should help alleviate environmental problems and promote the well-being of the local community.

Natural Forest Protection and Conservation

Protected forests can be defined as predominantly natural areas safeguarded by law or custom where species and ecosystems are conserved for current and future generations. Since the best way to maintain species is to maintain their habitats, protected areas are an essential means for sustaining diversity. Protected areas also help stabilize the local climate, protect watersheds, and prevent erosion, and constitute the most widespread mechanism for conserving Ethiopia's remaining natural forests. However, protection of the present natural forest is generally inadequate, and conservation must be part of a broader process of

managing the whole landscape. Thus, protected areas will contribute to the conservation of Ethiopia's remaining natural forests if they are able to meet the legitimate developmental aspirations of the people who live in and around them (Sayer, Harcourt, and Collins 1992).

Protection and conservation of the remaining natural forests is critical to protect species and biodiversity in Ethiopia. The identification, demarcation, and preservation of the remaining natural forests and wildlife will be beneficial to present as well as future generations.

Social, Economic, and Policy Issues

Deforestation and land degradation should be seen as the most important issues threatening the survival of Ethiopia and her people. Floods, drought, desertification, drying of streams, and soil erosion are connected one way or another with the process of forest exploitation and destruction. Although various strategies for tree planting and natural resource conservation in the Ethiopian highlands are proposed, their successful implementation will be limited unless the following social, economic, and policy issues are addressed properly.

Participation of the Rural and Urban Population

The participation of the general public in both rural and urban areas in tree planting and conservation of the natural forests is very important to achieve the proposed strategies. Involving farmers and local people who live around the forests in tree planting and natural resource management is critical for conservation and the development of forestry. This can be done through a participatory process where farmers and local people are involved in planning, design, and implementation of the management plan. This exchange of information and creation of partnerships will help build confidence and provide reassurance that the programs are relevant to their needs and ensure that they have a sense of responsibility to the project.

Attention should be given to the creation of effective local management organizations to mobilize farmers in the conservation, development, and appropriate use of forests and agroforestry products. Institutional arrangements at the community level are often key elements in natural resource conservation measures such as planning agroforestry and tree planting for

field implementation. The FAO experience with small farmer development projects suggests organizing farmers into small homogenous groups of about 10–15 farmers or heads of families so the people can more easily obtain government service. These informal groups work best when farmers have similar incomes, problems, and aspirations (Rao 1986).

Economic Incentives

Wood should not be considered a free good; rather, it should be considered a commodity requiring land, labor, and capital to produce. Pricing wood based on capital and resources invested, as well as demand and supply in the marketplace, will create incentive for establishing forest plantations and small private forests in the country. The government must create economic incentives for tree growing and for otherwise adopting suitable agroforestry and tree-planting practices by rural people.

Direct credit to farmers is another financial matter to be addressed. New mechanisms must be devised, as there is little experience organizing credit for tree crop cultivation in developing countries. Incentives may involve supplying seeds and seedlings, either free of charge or at a nominal price. Ensuring an adequate supply of hand tools for planting and temporary food aid can encourage farmers to participate in tree planting and in the adoption of agroforestry technology. Another way to provide incentives is for the community to provide the land and labor, while the forest service or NGO provides the seedlings, fertilizers, and technical assistance. When the crop is harvested, the net profit is shared on a proportional basis, depending on input, as agreed upon.

Land and Tree Tenure

Successful long-term agroforestry and tree-planting strategies require land tenure systems that guarantee continued ownership of land. As Nair (1990) indicated, the incentive for investing in soil-fertility improvement for the future is low unless the benefits accrue to the tree planter. This holds true in Ethiopia today, where land is still under the communal control of the government. Unless land is redistributed to individual farmers and they are guaranteed continuous ownership, success in the adoption of agroforestry and tree planting in the Ethiopian highlands is unlikely.

Ethiopia's land and tree tenure policy should therefore be changed to reward farmers who invest in agroforestry and forest plantations, which require long gestation periods. Land and tree tenure policy should give landowners and farmers incentives not only for planting but for stewardship of the forests. Without clear policy, it is difficult to offer incentives for farmers and landowners to grow trees. Active laws are needed to save the land and the environment, and suitable institutions to implement the laws. Commitment from the government is also needed to implement forest policy that will fully consider the crisis of environmental degradation and the stagnation of agriculture.

Education and Research

Adequate forestry and natural resource education, research, and extension service are needed to meet the demand for and challenges of managing natural resources on a sustainable basis. Strengthening the country's education and research institutions to train qualified forestry and natural resource professionals with appropriate knowledge of forestry and agriculture in Ethiopia is required.

Research in agroforestry in Ethiopia in general should emphasize the development of appropriate technologies to increase agricultural productivity and the reclamation of degraded highlands. Research in plantation forestry should also focus on production of fiber and other benefits while maintaining ecosystems. Conservation of the natural forests should be given adequate attention, and research in these forests should focus on improving the natural regeneration of the various species and the conservation of biodiversity.

A multidisciplinary approach is needed for success in agroforestry and natural resource education, research, and extension. All professionals concerned with agriculture, forestry, and natural resources should come together and work toward developing strategies for sustainable agroforestry and natural resource management that will ensure food security for the rural poor and long-term sustainability of the resource base upon which other development sectors depend.

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