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Deforestation, wood famine and environmental degradation in highland ecosystems of Ethiopia: urgent need for actions

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Summary

One of the major challenges facing Ethiopia in its strive for development is environmental degradation, which is manifested in the form of land and water resources degradation as well as loss of biodiversity. Land degradation, in turn, is expressed in terms of soil erosion and loss of soil fertility. Deforestation/devegetation has been held as one of the major factors contributing to land degradation through exposing the soil for various agents of erosion. Ethiopia, with high-intensity rainstorms and extensive steep slopes, is highly susceptible to soil erosion, especially in the highlands. The organic content of soils is often low due to the widespread use of dung and crop residues for energy. Land degradation exerts heavy impacts on agricultural productivity and production. For instance, in 1990 alone, reduced soil depth, caused by erosion, resulted in a loss in grain production of 57,000 (at 3.5 mm soil loss) - 128,000 tons (at 8 mm soil depth). It has been estimated that the grain production lost due to land degradation in 1990 would have been sufficient to feed more than four million people. The availability of land suitable for agriculture is shrinking. At the same time, the amount of land required to feed the growing population is steadily increasing. With agricultural productivity increases lagging behind population growth rates, the gap between the availability and the demand for agricultural land continues to grow. This results in severe land-use conflicts between crop farming, animal grazing and forestry. National high forests and plantations are encroached upon and cleared for cultivation or grazing by local people. State and community forest interests collide with local grazing interests on hillside land, and grazing and fuelwood / charcoal interests confront each other in the woodlands and bushlands. Forestry can play a role in reducing land pressure and land degradation. It is important to note, however, that forestry alone will not be able to solve the problem. Even if the management of existing forest resources is improved and new trees and forests are established, this may well prove futile if the need for crop and grazing land continues to grow due to high population growth rates. Using the land for forestry to improve soil fertility or to rehabilitate and conserve the environment will be viewed as secondary to using the land for cropping and grazing to meet immediate needs of survival. Hence, attempts to alleviate land degradation are critically dependent on efforts to deal with the three main underlying causes of land degradation, namely population growth, low agricultural productivity and high dependence on fuelwood, dung and crop residue as sources of household energy. Considering the magnitude of the land degradation problem, the conservation programs implemented so far are inadequate. The policy, institutional, planning and technical constraints that have been considered responsible for the inadequacy of past conservation efforts are presented. Any future initiatives aiming at overcoming the escalating land degradation problem in Ethiopia should first address these constraints realistically. There are no universal formulae or solutions to the constraints that can work across the board. Solutions should be locality specific and closely tied up with the socio-economic setup of the communities. In this regard, forestry can play a significant role in either preventing or arresting land degradation by avoiding or reducing soil erosion through reduced surface runoff and maintenance of organic matter and soil fertility. It can help in not only addressing off-farm and on-farm dimensions of soil erosion but also in maintaining the fertility of the soil thereby contributing to the alleviation of land degradation and the destruction of natural resources. The various means by which forestry can be used to address problems of land degradation are discussed as outlined in the Ethiopian Forestry Action Program.

1. Introduction

Ethiopia occupies the interior of the Eastern Horn of Africa stretching between 3° N and 15° N latitude and 33° E and 48° E, with a total area of 1.13 million km^2 (Anonymous, 1988). It has a population of 60 million (Befekadu Degefa & Berhanu Nega, 1999/2000) with *ca* 3 % annual growth. The average population density in the country is about 34 persons/km^2, and ranges between 8 and 95 persons/km^2 (Anonymous, 1988).

Ethiopia is a country of great geographical diversity with high and rugged mountains, flat-topped plateaux and deep gorges, incised river valleys and rolling plains. It has 12 river basins and 18 natural & artificial lakes (Anonymous, 1997). Over the ages, erosion, volcanic eruptions, tectonic movements and subsidence have occurred and continued through millennia to accentuate the unevenness of the surface (Anonymous, 1988). Altitudes range from the highest peak at Ras Dejen, 4620 m above sea level, down to the depression of the Kobat Sink (Afar Depression), about 110 m below sea level (Anonymous, 1988). Most of the country consists of high plateau and mountain ranges with precipitous edges dissected by the numerous streams, which are tributaries of the major rivers. The Great Rift Valley separates the western and south-eastern highlands, and the highlands on each side give way to vast semi-arid lowland areas in the east and west, especially in the south of the country. The physical conditions and variations in altitudes have resulted in a great diversity of climate, soil and vegetation.

The flora of Ethiopia is very heterogeneous and has a rich endemic element. It is estimated to contain between 6,500-7000 species of higher plants, of which about 12 % are endemic. Endemism is particularly high in the high mountains and in Ogaden. Ethiopia is said to have the fifth largest flora in Africa (Anonymous, 1997).The diversity of fauna in Ethiopia is also high, owing to the diversity in climate, vegetation and terrain. It is estimated that there are 240 species of mammals and 845 species of birds of which 22 species of mammals and 24 species of birds are endemic (Anonymous, 1997). This makes Ethiopia the richest in avifauna in mainland Africa. Although very little study has been done on the groups, six reptile and 33 amphibian species are known to be endemic. Even less is known about insects and the other groups of vertebrates, but they are likely to contain at least the same proportion of endemic species. It has a livestock population of about 30.6 million (TLU), the largest in Africa and tenth in the world.

2. Forest Resources and Their Importance in Ethiopia

2.1. Forest Resources Base

The forest and woody vegetation resources of Ethiopia had been estimated to cover more than 27.5 million ha of land in 1992 (EFAP, 1994). These resources comprise natural high forests, categorised as slightly and heavily disturbed high forests, woodlands, bushlands, plantations and on-farm trees (Table 1).

Table 1. Estimates of the area, growth stock and incremental yields of the various forests.

Forest Resource	Area (Million ha)	Growth Stock (m^3 s* / ha)	Annual Incremental Yield	
			Per Unit Area (m^3 s / ha / Y)	Total (million m^3 s)
Natural High Forest	2.3			0.3
Slightly Disturbed	0.7	90-120	5-7	
Highly Disturbed	1.6	30-100	3-4	
Woodland	5.0	10-50	1.2	6.4
Bushland	20.0	5-30	0.2	4.0
Plantations	0.2		9.6-14.4	1.6
Farm Forests	Not available	Not available	Not available	2.1

Source: EFAP, 1992; * Solid over bark

2.1. Importance of Forestry

Information on forestry activities, knowledge on the stock of forest resources in the country, data on export and import of forest products as well as employment opportunities generated by the forestry sector are scanty. Moreover, the contribution of forestry to the national income has not been surveyed systematically. Therefore, the information provided here should be considered tentative and interpreted cautiously.

2.1.1. Contribution to National Income

In the last decade (1982/81 - 1991/92), the agriculture sector accounted for 45 % of the total GDP; over the same time period, forestry accounted for about 5.5 % of the agricultural sector and 2.5 % of the total GDP (EFAP, 1994). In 1991/92, the contribution of forestry to the GDP measured Birr 406.2 million or 3.3%. These figures, however, underestimate the total contribution of the sub-sector to the country's economy. The contribution of forests in the production of coffee, spices, honey, medicinal products, animal products, etc., conservation of soil, water, biodiversity and other ecological services are not considered. Data on the export and import of forest products is scarce. Recently, exports of forest products have been almost discontinued. It has been reported that only some gum and incense products are intermittently exported (EFAP, 1994). Forestry industry employment amounted to about 2.2 % of the total work force in the country and contributed 2.8 % to employment in the agricultural sector in 1988/89. Forestry has also indirect effects on other sectors of the economy as well, the major influence being on the agricultural sector. The removal and/or destruction of forests is inevitably followed by a chain of undesirable events such as land degradation through soil erosion and loss of soil fertility. These events, in turn, affect agricultural production that results in the reduction of yield.

2.1.2. Source of Wood for Energy, Construction and Wood-Based Industries

Forests play a vital role as sources of energy. There are ample estimations regarding energy consumption and requirements. The share of the total domestic energy is: fuelwood and tree residues 70%, dung 8%, agricultural residues 7%. and the rest comes from other sources. Hence, 85% of the total energy is coming from biomass. Dung and agricultural residues represent under one-sixth, the majority is fuelwood and tree residues. Therefore, the long-term solution to Ethiopia's rural energy problem requires large-scale plantations, which should be based on research results for a greater biomass and quality production.

The supply of wood and woody biomass products in Ethiopia comes from different forest and vegetation types and production systems, including natural forests, woodlands, bushlands, industrial forest plantations, peri-urban plantations, community woodlots, catchment and protection forests and farm forestry. It is estimated that these areas produced an incremental yield of 14.4 million m^3s in 1992, of which 13.8 million m^3s (fuelwood 12.5 million m^3s) was available as wood products and 0.6 million m^3s as fodder (EFAP, 1994).

2.1.3. Source of Non-Timber Forest Products

In Ethiopia, non-wood forest products cover a wide range of products. The most important non-wood forest products in Ethiopia include honey and wax, bamboo, reeds, wild date, Gum Arabic, resin from soft-wooded species, coffee and spices, incense, edible plant products (fruits, seeds, edible oil, fat, fodder, etc.), fibers, essential oils, tannins and dyes, resins, gums and latex, ornamental plants, giant/long grasses which could be used to produce panel products and the raw grass as roofing cover for local house construction, edible and non-edible animal products, medicine, mushrooms, various extractives, flavourings, sweeteners, balsams, pesticides, etc.

They are needed in the manufacture of adhesives, confectionery, medicines, perfume, varnishes, wood preservatives, soap, pulp, dyes and printing inks. Non-wood forest products can be major sources of feedstock and energy source for forest and other industries. Medicine is one of the non-timber forest products, and traditional medicine has an important place in the health care of the Ethiopian population. It is estimated that 80 % of the people in Ethiopia rely on some form of traditional medicine for their primary health care needs. There are numerous forest plants with potential edible fruits that can be either directly consumed or processed in food industries.

2.1.4. Employment Opportunities

The number of people employed in the manufacture of wood and cork products, furniture and fixture, paper and paper products in 1993/94 fiscal year was, though the number would vary from year to year, 6180 (CSA, 1995). To this number, even though unavailable, one can add the number of labour engaged in seedling production, site preparation, planting, tending, harvesting, transportation and marketing. In general, the sector employs directly some 35,000 persons in government and industry, and some 400,000 persons in commercial wood fuel harvesting, processing and distribution (Berhanu Hika et al., 1988).

2.1.5. Environmental Protection and Maintenance

Forest vegetation is important for soil and water conservation, watershed protection, nutrient recycling, nitrogen fixation, amenity and recreation, creation of microclimate, wildlife habitat, gene conservation and sequestering carbon dioxide from the atmosphere.

3. Deforestation

There is no accurate or reliable information about the extent and location of the past and present natural forest and woody vegetation cover in Ethiopia. However, historical sources indicate that, on the basis of potential climatic climax, high forests might have once covered about 35-40 % of the total land area of the country. If the savanna woodlands are included, 66 % of the country used to be covered with forests and woodlands in the past (EFAP, 1994). However, the country’s forest and woodland resources have been declining both in size (deforestation) and quality (degradation).

As a result, it has been estimated that high forests covered 16 % of the land area in the early 1950s, 3.6 % in the early 1980s and only 2.7 % in 1989 (IUCN, 1990; EFAP, 1994). Some 5 million ha savanna woodlands were remaining at that time, giving a total forest and woody vegetation area of 7 %. In 1994, it has been estimated that such forests cover less than 2.7 % of the country (EFAP, 1994). With the current annual loss of high forests, estimated at 150,000-200,000 ha, it has been projected that the area covered by high forests may be reduced to scattered minor stands of heavily disturbed forests in inaccessible parts of the country within a few decades.

The major reasons of deforestation are clearing of forests and woodlands for cultivating crops and cutting of trees and shrubs for various purposes, notably for fuelwood, charcoal, construction material, etc. The fact that plantation forestry has been very far from meeting the demand for wood for various purposes indicates the inevitability of deforestation. The underlying causes of deforestation are, however, closely linked with the vicious cycle of mutually reinforcing factors, i.e. poverty, population growth, poor economic growth and the state of the environment.

Declining standard of livelihood of the farming communities and their close dependence on forests and woodlands have led to clearing / burning for subsistent farming, cutting of trees/shrubs for fuelwood and charcoal production (both for consumption and sale), construction material, over-grazing, burning associated with traditional apiculture, etc. Population growth and its pressure resulted in the concentration of the largest proportion of the population in the highlands leading to heavy load on the forests for cultivating crops, fuelwood, construction material and grazing. Poor economic performance was demonstrated through declining rates of economic growth between 1974 and 1990 (EFAP, 1994). With population increasing faster than the economy, the per capita income declined. These had adverse effect on natural resources, particularly forests and woodlands.

Deforestation had caused and continues to cause environmental degradation in the form of land and water resources degradation as well as loss of biodiversity.

4. Wood Famine

The demand for wood and woody biomass products is composed of demand for industrial wood products, construction wood and fuelwood. Based on assumed per capita consumption requirements, in 1992 total requirements for wood products have been estimated to be 47.4 million m^3s, of which fuelwood demand was 45 million m^3s (EFAP, 1994; Table 2). As a result, a large deficit ("**wood famine**") has occurred since 1992 (33 million m^3s), and fuelwood deficit amounted to 32.5 million m^3s. This deficit is the main cause for the **"mining"** (the volume of wood harvested in a given period exceeding the sustainable rate / incremental yield) of forest resource base of the country. This leads to reduction in the woody biomass growth stock and future incremental yields.

Table 2. Incremental yield from forest and woodland resources, projected demand and deficit of wood products

Year	Incremental Yield* (million m^3s)	Demand (million m^3s)				Deficit (million m^3s)
		Industrial Wood	Construction Wood	Fuelwood	Total	
1992	14.4	0.4	2.1	44.9	47.4	33.0
2000		0.7	2.7	58.4	61.8	
2005		0.9	3.2	68.4	72.5	
2010		1.3	3.8	79.5	84.6	
2014	10.6[a]	1.6	4.3	88.9	94.8	84.2
	30.2[b]					64.6

Source: EFAP (1994); * = incremental yield from natural forests, woodlands, bushlands, industrial forest plantations, peri-urban plantations, community woodlots, catchment and protection forests and farm forestry; a = without intervention; b = with intervention; "intervention" refers to the implementation of programs developed by EFAP (1994).

5. Environmental Degradation

In Ethiopia environmental degradation is reflected in the form of land degradation, loss and degradation of water resources as well as decline and/or loss of biodiversity. Here the focus will be on land degradation.

5.1. The Process of Land Degradation

Land degradation involves both soil erosion and loss of soil fertility. Hence, measurements of land degradation usually focus on the severity of soil erosion. Ethiopia, with high-intensity rainstorms and extensive steep slopes, is highly susceptible to soil erosion, especially in the highlands. Erodibility also depends on the soil depth and the organic content of the soil - one percent increase in organic matter reduces erodibility by about 15 percent (EFAP, 1994). The organic content of soils is often low due to the widespread burning of dung and crop residues for energy. This practice increases the susceptibility of the land to erosion.

The factors influencing soil erosion and, thereof, land degradation are multiple and mutually reinforcing. As indicated earlier, the massive removal of vegetative cover is the driving force behind land degradation. This loss is largely due to an expanding population, with its increasing demand for crops, grazing land, and fuelwood. The removal of vegetative cover for use as fodder and fuel leads to an increase in surface runoff and, thus, to higher soil erosion. With the removal of topsoil (a reduction in soil depth), there is less root anchorage for plants. In addition, there is a loss of soil nutrients and a reduction in water holding capacity.

When animal dung and crop residues are used for household fuel rather than recycled into the soil, the soil looses nutrients and organic matter. As the fuelwood scarcity grows worse, women and children have to collect fuelwood from more distant sources and substitute more and more dung and crop residues for household fuel. In the intensively farmed rural areas as well as in the drought-prone degraded areas of the north and the east, cattle dung has already largely replaced wood as the primary household energy source. All of these factors combined lead to a reduction in crop productivity. They also contribute to crop failure, reduced cropping intensity and decreased resistance to drought. This induces further land clearing and reinforces the vicious cycle of land degradation. As soil depth is reduced, croplands revert to grassland and ultimately to bare rock.

5.2. Incidence of Land Degradation

FAO (1986) made a comprehensive assessment of land degradation in Ethiopia. It was concluded that:

- Over 14 million ha in the highlands (27 % of the area) were seriously eroded, and some 6 million ha should be completely withdrawn from agricultural use to be reforested;
- A further 13 million ha (23 %) were moderately eroded;
- Of the remaining 28 million ha, about 15 million ha were susceptible to erosion, requiring proper management to prevent erosion from becoming a problem;
- Some 1,900 million tons of soil were annually eroded from the highlands, equivalent to an average net soil loss of 100 tons / ha and an annual loss of 8 mm in soil depth, with variations between 50 to 170 tons / ha depending on altitude and agro-ecological zone;
- The highest rates of erosion were found in northern and central Ethiopia, i.e. Welo, Gonder, and parts of Tigray, Gojam and Shewa;
- Erosion rates were low in parts of southeastern Ethiopia, i.e. Harerge simply because there was less soil left to erode;
- Erosion was most serious in the Low Potential Cereal (LPC) Agro-Ecological Zone (AEZ), followed by the High Potential Cereal Zone (Table 3).

Table 3. The susceptibility of land to erosion in the AEZs of the highlands

Zone	High (%)	Moderate (%)	Slight (%)
Low Potential Cereal (LPC)	63	16	21
High Potential Cereal (HPC)	36	32	32
High Potential Perennial (HPP)	48	22	30

Source: EFAP (1994)

The high percentage of land highly susceptible to erosion in the LPC zone is noteworthy, since this zone is intensively cultivated and has very limited tree cover. These figures have to be used cautiously since there have been other works (Hurni, 1988; NCSS, 1991), which claimed that soil losses from croplands in the highlands were much less than those estimated by FAO (1986). The difference between the estimates has been attributed to the use of different figures for the calculation of the cropland area, and the assumption by FAO (1986) that there is a uniform decline in crop production across all cropped areas regardless of soil depth, which is not the case (EFAP, 1994). Since there is little monitoring of soil erosion and no comprehensive follow-up to the FAO study, there is no reliable information on the trend of soil erosion.

5.3. Impact of Land Degradation on Production

Land degradation impacts on agricultural production in two major ways. First, erosion means loss of soil depth, which decreases the value of soil material as a medium for holding water for plant growth, and, second, the burning of animal dung and crop residues breaches the nutrient cycle and reduces plant production and / or the supply of livestock feeding material (some of the crop residues are diverted from animal feeding). Soil erosion also imposes losses on agricultural production through the acceleration of surface run-off.

Based on the study made by National Conservation Strategy Secretariat (NCSS) (1991), the quantitative and monetary impact of land degradation is summarized below.

- In 1990 reduced soil depth, caused by erosion, resulted in a loss in grain production estimated at between 57,000 and 128,000 tons, depending on whether the loss of soil depth has amounted to 3.5 mm or 8 mm.
- This loss also reflects the impact of 1,000 to 2,500 km^2 of cropland going out of cultivation because the soil depth fell below a minimum critical level.
- The foregone production in the livestock sector resulting form soil erosion was estimated to be between 35,000 and 78,000 TLU (tropical livestock units).
- Together, these losses represent financial losses of Birr 18 million (at 3.5 mm soil loss) or Birr 40 million (at 8 mm soil loss), equivalent to 0.5 percent and 1.1 percent, respectively of the 1990 agricultural GDP.
- In addition to agricultural production losses as a result of soil loss, the burning of dung and crop residues caused physical production losses estimated to be four (at

3.5 mm soil loss) to eight times (at 8 mm soil loss) greater than the production lost on account of soil erosion.

- In financial terms these losses amounted to 4 and 7 percent of the 1990 agricultural GDP, respectively.
- The combined impact of production losses from soil erosion and the burning of dung and crop residues is alarming. The total cereal production foregone in 1990 was equal to about one fifth of an average year's harvest of 5 million tons of grain.
- The grain production lost would have been sufficient to feed 4.4 million people, based on an annual per capita cereal requirement of 220 kg.
- To the average farmer, the financial cost of the grain and livestock production foregone (Birr in 1990) represented about 12 percent of his income (Birr 630).
- In the aggregate, the financial costs of foregone grain and livestock production over the period 1985-90 would have meant an average annual decline of between 0.33 and 0.41 percent of the agricultural GDP in 1985.
- Such production losses and their financial consequences are expected to increase as more and more cultivated land reaches the critical minimal soil depth at which point productivity drops dramatically and production is no longer worthwhile.

Even if the estimates of soil erosion and land degradation and the associated losses in agricultural production should be viewed with caution, they, nevertheless, indicate a serious situation. High priority should be given to mitigatory programs, including forestry programs. While the physical loss of soil from cropland is serious, the most important problem is the loss of nutrients and organic matter due to the burning of dung and crop residues. In areas where these practices are prevalent, tree planting to produce fuelwood, and programs to increase efficient use of fuelwood, might be more effective in arresting land degradation than conservation measures solely designed to reduce soil erosion. Although both type of measures are important, with limited resources the former should be given higher priority.

5.4. Causes of Land Degradation

The availability of land suitable for agriculture is shrinking. At the same time, the amount of land required to feed the growing population is steadily increasing. With agricultural productivity increases lagging behind population growth rates, the gap between the availability and the demand for agricultural land continues to grow. This results in severe land-use conflicts between crop farming, animal grazing and forestry. National high forests and plantations are encroached upon and cleared for cultivation or grazing by local people. State and community forest interests collide with local grazing interests on hillside land, and grazing and fuelwood / charcoal interests confront each other in the woodlands and bushlands. Forestry can play a role in reducing land pressure and land degradation.

It is important to note, however, that forestry alone will not be able to solve the problem. Even if the management of existing forest resources is improved and new trees and forests are established, this may well prove futile if the need for crop and grazing land continues to grow due to high population growth rates. Using the land for forestry to improve soil fertility or to rehabilitate and conserve the environment will be viewed as secondary to using the land for cropping and grazing to meet immediate needs of survival. Hence, attempts to alleviate land degradation are critically dependent on efforts to deal with the three main underlying causes of land degradation shown in Figure 1.

The first is *population growth*, which leads to an increase in the demand for crop and grazing land and to an increase in the demand for fuelwood. The second main cause is *low agricultural productivity*. A decline in population growth, would help to reduce the demand for crop and grazing land, so would productivity increases. Finally, the third main cause of land degradation is Ethiopia's *high dependence on fuelwood* as a source of household energy.

5.4.1. Population Growth

An expanding population mainly drives the increases in the demand for crop and grazing land as well as for energy. Table 4 shows projections for population density and land availability in the highlands. Without interventions to control population growth, the population density in the HPC zone will increase from some 62 persons / km^2 in 1985 to over 166 persons/km^2 in 2015. As a result per capita land holdings would fall to 0.6 ha. This is based on the assumption that all land within this zone is suitable for cultivation, grazing, or woodlot use, which actually is not the case. In large parts of the highlands there is virtually no unused land.

Expansion of agriculture is already reducing grazing areas. This pushes livestock herds further up the hillsides and results in encroachment on traditional forestland. With unrestricted population growth, present agricultural technology and a continued livestock growth of 1.1 percent per year, it has been projected that in the year 2000 the livestock herd will seriously exceed the maximum amount of grazing land available. A cropland crisis has been projected for the year 2010. As the average farm size approaches the minimum required to sustain a household, it is expected that migration from the rural highlands to areas where pockets of unused land are still available, and to urban centers will increase.

A decrease in the rate of population growth can only be achieved by a reduction in the fertility rate, which, in turn, cannot be expected to fall until the contraceptive prevalence rate in Ethiopia reaches 25 to 30 percent. The Ethiopian Government has recently formulated a *National Population Policy*. The importance of a successful implementation of this policy can only be underscored here.

5.4.2. Demand for Grazing Land

The demand for grazing land is determined by the size of the livestock herd, the amount of feed required to maintain an animal and the availability of feed supplies from other sources. In Ethiopia, too many animals are maintained at too low levels of productivity, with too high dependence on common grazing practices. Reductions in the herd will only occur under land pressure or if livestock productivity can be raised. The latter can be achieved by improving feed supplies from sources other than pastures. Forestry development can effectively support such a strategy.

It is essential to recognize the key function of livestock in the farming systems practiced by the highland population when assessing the size of the livestock, particularly in the heavily populated cereal farming zones. Under current conditions, farming households must keep a breeding herd of at least 10 to 12 animals to maintain a pair of oxen. In addition, in the highlands animals are kept as an investment to provide income, food and manure for the farm and for fuel. Livestock are traditionally the single most important asset of the rural highland people, particularly in the absence of private land ownership. In the lowlands pastoralists are socially dependent on their livestock resources.

Table 4. Projected rural population, population density, and land area per capita in the highlands

Zone	Rural Population ('000)			Population Density (persons / km^2)			Land Area / Capita (ha)		
	1985	2000	2015	1985	2000	2015	1985	2000	2015
High Potential Cereal	8,936	14,208	24,038	61.8	98.3	166.2	1.62	1.02	0.60
Low potential Cereal	10,622	16,889	28,573	55.9	88.6	149.8	1.79	1.13	0.67
Perennial Crop	13,385	21,281	36,005	54.5	86.6	146.5	1.83	1.15	0.68
Total High lands	32,982	52,378	88,616	56.8	90.2	152.5	1.76	1.11	0.66

Sources: IUCN (1990), EFAP (1994)

Estimates of actual and optimum livestock stocking rates suggest that overstocking of livestock is a problem in the highlands, especially in the LPC zone. In both highland cereal zones stocking rates exceed the optimum; the stocking rate in the LPC zone is twice as high as the optimum. In the lowlands the apparent under-stocking is counteracted by local overstocking, especially around water points and settlements and by seasonal surpluses. These data imply that the encroachment of forestland is an on-going problem in certain zones, and that land pressures are already likely to reduce average livestock holdings.

The low productivity of animals is a major cause behind the large average size of livestock holdings. Many animals are needed to satisfy the requirements of a rural household. Also, low productivity leads the farmer to perceive livestock production as a risky undertaking; hence the need to buy "insurance" through a larger number of animals. Low productivity is primarily a function of the available feed supply and the health of the animal. In the past, too much attention has focused on the health component and too little on the improvement of animal nutrition. Livestock policies and programs need to be adjusted accordingly.

At present there is heavy dependence on natural pastures for feed supply. Over 80 percent of all feed resources (measured in fodder units) come from pastures. Other feed resources include crop residues, cereals, stubble (grazing on farm land after harvest), pulses and industrial by-products. Overall feed resources measured in fodder units have been estimated to exceed the maintenance requirements of the existing livestock population (defined with reference to present low levels of productivity) by only about 15 percent. This suggests that there is little room for increasing the productivity of the present livestock population, given the present feed supply.

The lack of feed from non-pastures and the poor quality of feed are important constraints to effectively reducing the demand for grazing land. Forestry sector interventions can address these constraints in at least two ways. First, the adoption of new and improved farm forestry practices will increase the production of fodder as described in the previous chapter. Second, increased supply of fuelwood will enable households to return dung as input to the soil, thus increasing yield, and also to use more of their crop residues for animal feed instead of burning it for energy.

Other measures to reduce the demand for grazing land are an introduction of legumes into farming systems and rangelands, enhancement of the digestibility of crop residues, improved utilization of industrial by-products and wastes, and upgrading of fodder conservation methods. The development of a farm forestry program in Ethiopia, therefore, can offer an appropriate vehicle for the further promotion of farmers' adoption of fodder production technologies.

6. The Challenges

Since the mid-1970s, Government efforts to arrest land degradation in the highlands have focused on soil and water conservation and afforestation in degraded, low-potential areas. The emphasis has been on labour intensive physical conservation structure. The main measures have been to construct terraces and soil bunds, divert drains, plug gullies, plant trees on hillsides, and close hillsides to regenerate vegetation. Many agencies and donors assisted in the soil and water conservation program. The program has covered some 120 severely degraded catchments in food deficit areas throughout the country.

It has been reported that up to 1990/91 the soil and water conservation activities had covered less than one percent of the land area, or seven percent of the highland area, which is at risk from erosion. Considering the magnitude of the land degradation problem, the conservation programs implemented so far are inadequate. This can be attributed to the major constraints enumerated below, which are related to policy, institutional, planning and technical issues (EFAP, 1994).

- Absence of land use and forest policies and legislation.
- Frequent changes of organizational structures of institutions involved in natural resources management, conservation and development.
- Past policy on land tenure and distribution: contributed to lack of incentives among farmers and communities to adopt soil conservation measures, including afforestation of hillsides.
- Past policy of centralized top-down planning imposed work directives and alienated rural communities: leads to lack of credibility of Governments with farmers.
- Target-driven strategies placing emphasis on quantity rather than quality of work

- Linkage of soil conservation activities to the Food For Work Program (FFWP), which has its own merits and demerits: farmers have come to perceive the food as a wage for work carried out for the government rather than as an incentive to install beneficial land husbandry measures (including planting seedlings on hillsides) on land under their control
- More emphasis on labour intensive conservation measures, such as building physical structures, rather than biological conservation measures, which are less labor demanding but may be more appropriate and sustainable.
- Lack of or inadequate coordination between relevant Government and Non-Government Organizations in designing and implementing soil conservation programs.
- Weak extension advice regarding soil conservation at the farmer and community level. The main reasons cited for this are:

    - poor training of extension staff, especially in biological conservation and agronomic techniques for improved land management;
    - lack of operational support (transport in particular);
    - poor supervision of field staff;
    - organizational separation of development agents and catchment technicians; and
    - low staff morale coupled with inadequate rewards and incentives.

- Lack of sustainability of past soil conservation efforts as a result of neglect of participation by local communities in the planning process.
- Coercive top-down planning approach in which labor was mobilized to carry out pre-set work norms with a “food for work” incentive.
- Absence of detailed planning and site-specific recommendations, quality control or farmer response.
- Creation of uncertainty and passive resistance among the population as a result of villagization program, preferential treatment of producer cooperatives, land redistributions and arbitrary eviction.
- Absence of a better incentive framework, than FFWP, which rewards initial "investment" and subsequent maintenance in conservation activities.
- Insufficient attention to traditional soil conservation practices (indigenous knowledge).
- Excessive reliance on structural conservation measures, and insufficient attention to preventing erosion in the first place.
- Lack of testing, adoption and demonstration that can help in the adoption of innovative conservation activities, including vegetative measures (e.g. vetiver grass hedges).
- Weak research system in natural resources that has been unable to respond to the great challenges of land degradation.

Any effort in the fight against land degradation must provide realistic and viable solutions to the constraints enumerated above. There are no universal formulae or solutions to the constraints that can work across the board. Solutions should be locality specific and closely tied up with the socio-economic setup of the communities.

7. The Role of Forestry

Forestry can play a significant role in either preventing or arresting land degradation by avoiding or reducing soil erosion through reduced surface runoff and maintenance of organic matter and soil fertility. It can help in not only addressing off-farm and on-farm dimensions of soil erosion but also in maintaining the fertility of the soil thereby contributing to the alleviation of land degradation and the destruction of natural resources (EFAP, 1994).

7.1. Off-Farm Soil Erosion

Excessive off-farm erosion results from the destruction of protection and catchment forests, the destruction of woody vegetation on steep slopes by fuelwood gatherers, and overgrazing, which can diminish the vegetative cover so that the exposed soil easily erodes. A solution to the off-farm problem is to keep those watersheds and catchments, which are susceptible to erosion, under forests and avoid land use on steep slopes, which can result in the destruction of the vegetation.

It has been indicated that a forestry action program is required for maintaining the remaining forest resources and expanding the vegetative cover (EFAP, 1994). The proposed action program would be responsive to the problem of off-farm erosion in which four main areas can be addressed:

7.1.1. Forest Priority Areas and Protected Area System

Many of the remaining major forests and woodlands in the 58 Forestry Priority Areas (FPAs) and the Protected Area System (PAS = 9 National Parks; 4 Wildlife Sanctuaries; 8 Wildlife Reserves and 18 Controlled Hunting Areas) confer critical watersheds and catchments. To prevent forest resources in these watersheds from being rapidly destroyed by clearing, policy and institutional reform and a concomitant public sector program that can help to bring these areas under effective management should support the proposed action program. This would include the participation of local communities.

7.1.2. Catchment and Protection Plantations

While the forests in FPAs and PAS would be retained to protect the main watersheds, the protection of local watersheds and steeply sloping hills is equally important. The proposed action program provides for a major effort in mobilizing community initiatives to establish protection forests on about 2 million ha of such land.

7.1.3. Farm Forestry

Various proposed farm forestry initiatives (EFAP, 1994) can provide supplies of fuelwood, fodder and other wood products. On-farm production could reduce and possibly eliminate the current destruction of the natural forests, woodlands and the remaining trees and shrubs growing on steep slopes. It could therefore indirectly contribute to off-farm soil conservation efforts.

7.1.4. Reduction of Grazing Pressure on Steep Slopes

The continuation of area closure, which enables trees and shrubs to regenerate is encouraged, although the extent to which this can be done is limited. Hence, additional initiatives to increase livestock feed supplies would be pursued as an indirect means of reducing grazing pressures and limiting the erosive run-off from steep slopes. They include programs to promote leguminous fodder planting both on- and off-farm.

Although the above actions have been proposed in the Ethiopian Forestry Action Program (EFAP, 1994), nothing or very little has happened in line with the proposal. Hence, soil erosion, and thereof land degradation, continues at an alarming rate in the country.

7.2. On-Farm Soil Erosion

If the off-farm erosion becomes under control, the on-farm soil erosion becomes less of a problem. Otherwise, the farmer is faced with the problem of trying to control both run-off from further up-slope and run-off resulting from on-farm activities. The major initiative proposed to deal with on-farm soil erosion is a program, which encourages farmers to plant vetiver grass hedges on the contour. Furthermore, the proposed farm forestry technologies will, in varying ways, help to reduce on-farm soil erosion. Perennial vegetative cover would protect the soil by reducing the erosive effects of rainfall. This would apply especially to woody legume, farm boundary, field tree planting and woodlot planting. Windbreak planting, in addition to decreasing on-farm soil erosion, would also reduce wind erosion, which is an especially insidious problem in parts of the highlands after the seedbed has been prepared and before crop cover is established. Some of the proposed initiatives could also be combined with conventional terracing; woody legumes, for example, could be planted on the edges of the terraces.

7.3. Soil Fertility

The maintenance and improvement of soil fertility will primarily be addressed by the whole range of proposed tree planting programs. The programs for catchment and protection plantations and farm forestry would increase fuelwood availability and thereby reduce reliance of households on the use of dung and crop residues for fuel. When this organic matter is returned to the soil, it will help nutrient levels and raise soil fertility.

7.4. Contribution of Forestry

It is clear that forestry can and should play an important role in alleviating land degradation, which is probably Ethiopia's most pressing environmental concern. The review of the causes of the land degradation process in Ethiopia, as well as the lessons of previous soil conservation activities suggest that forestry needs to be given an enhanced role in soil conservation for two reasons:

- ♥ First, growing trees will contribute to restoring the nutrient cycle of the soil by reducing the amount of animal dung and crop residues being burnt for meeting household energy requirements. As pointed out above, the major share of the cost Ethiopia incurs on account of land degradation originates with the loss of soil nutrients. Encouraging people to grow trees close to or on farmland is the most obvious solution.

- Second, the relative importance of the various instruments to control soil erosion is increasingly changing in favor of forestry. Reliance on physical structures is giving way to improved conservation techniques on-farmland, re-vegetation and other biological measures, including such activities as individual farm forestry and community protection forestry.

For forestry to assume this enhanced role, the responsibilities of the public and private sector need to change with regard to promoting tree growing on-farm and with regard to the implementation of the overall soil conservation program. Past centrally driven "campaigns," mobilizing farmer labor through food distribution to construct conservation structures or to implement measures without proper involvement of local communities have not been able to produce sustainable results. To set out on a new course, an appropriate incentive structure and policy environment need to pave the way for individuals and communities to assume the responsibility of deciding how to best manage their land and tree resources, and how to alleviate the problems of land degradation. The key ingredients in such an incentive structure and policy environment are addressed under the proposed action program (EFAP, 1994).

8. Conclusion

Forestry clearly can contribute to reduced land pressure and improved control of land degradation. Land allocated by the individual, the community, or the state for growing trees should generally be managed in such a way that the benefits from the production of wood and other tree and forest products, as well as the benefits with regard to soil conservation, are optimized, while keeping the opportunity costs of alternative land uses (such as cultivation and grazing) low. Strategies to implement this principle include promoting appropriate farm forestry technologies which integrate tree growing into existing farming systems, increasing the benefits from community protection forestry and enhancing the management efficiency on state controlled forest land. These strategies need to be backed by land-use policies, particularly land tenure policies, that promote the efficient use of land.

However, an action program for forestry development can only make a sustained contribution to economic development if it is backed by various other policies, particularly a program to control population growth, supported by agricultural, livestock, and energy policies that alleviate the pressure on land resources. Planning forestry development needs to consider that the planting and use of trees must be balanced with other needs for land use. Hence, there is an urgent need for a land-use policy, as well as for strategic and sectoral land-use planning. These policies would provide incentives for efficient land use and management, guide development planning and resolve land-use conflicts.

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