Poverty and natural resource management in the Central Highlands of Eritrea

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Chapter 3

Agriculture, Energy and Land Degradation in Eritrea

3.1 Introduction

Agriculture, energy and land degradation are closely related in rural areas of Eritrea. The agricultural sector is currently the major link between the economy and the environment. The major types of land degradation in the country, soil erosion, nutrient depletion and deforestation are mainly due to traditional low external input farming practices, expansion of agriculture into marginal areas, overgrazing and high dependence on biomass energy. This chapter discusses the major characteristics of the agricultural, forestry and energy sectors, the nature and extent of land degradation and the underlying causes of land degradation in the Highlands of Eritrea.

3.2 The state of Eritrean agriculture

At present agriculture is the most important sector in Eritrea. With over 70 percent of its population employed in agriculture the country may be described as agrarian. Crop and livestock sectors together provide a means of livelihood and the basis for food security for the majority of the population. The contribution of the sector to the national economy, however, is very modest both due to the small scale of the farms and low productivity. Agriculture contributes about 16 percent to the gross domestic product. The country's domestic grain balance is generally less than the consumption requirements, and often much less.

3.2.1 Land size and land use

In terms of land size Eritrea may be considered well endowed relative to its population. The total population of Eritrea is estimated at 4 million in 2000. This means that the average population density for the country in that year[4] was about

[4] Given the current high levels of population growth in the country, population will double every 25 years.

32 persons per km^2. These figures could, however, give a misleading view of the pressure on land resources, as they do not distinguish between the highlands and the lowlands, which are characterized by varying degrees of population concentration and economic activities. The Highlands of Eritrea comprise about 16 percent of the total land area and are settled by more than half of the total rural population of the country. The lowland areas, which comprise the largest proportion of the country's land area, are occupied by pastoral and agro-pastoral societies. Sedentary farmers mostly live in the highlands with crop production as the main economic activity. In most parts of the Highlands of Eritrea shortage of land is a serious problem. In fact it has been a root cause of social conflicts and environmental degradation.

Moreover, due to rugged topography in the highlands and climatic conditions unsuitable for agriculture in the lowlands, only 12 percent of the land is suitable for rain-fed agriculture (FAO, 1994; MOA, 2002b). Only 3.5 percent of the total land or 29 percent of the potentially cultivable land is currently under cultivation (see Table 3.1). While there remain vast areas in the western lowlands suitable for rain-fed cultivation, which are not currently cultivated, almost all the potentially cultivable lands in most parts of the Central Highlands are already cultivated. In fact, crop production in many areas of the highlands has been extended to steep-slope hillsides leading to high levels of soil erosion. Table 3.1 shows that more than 50 percent of the land is used for grazing and more than one third of the land is either too dry or too degraded to be used for any economic activity.

Table 3.1 Land use in Eritrea, 2001

Land use	Area (1,000 ha)	Percent
Cropland	439	3.5
Rain-fed	417	
Irrigated	22	
Grazing land	7,000	56.3
Woody Vegetation	737	5.9
Highland forest	53	
Plantations	10	
Woodland	674	
Urban land	13	0.1
Barren land	4,243	34.1
Total	12,432	100.0

Source: MOA (2002b)

3.2.2 Crop production

Crop production in Eritrea is mainly cereal-based with barley, wheat and taff grown in the highlands and sorghum and millet grown at lower altitudes. Pulses, mainly chick peas, beans and peas are grown in the highlands while oilseeds are more important in the lowlands. The total area cultivated to each crop and crop yield in the period 1994-2004 is given in Table 3.2.

Despite the high proportion of population employed in the agricultural sector, domestic production of food crops is much lower than the country's food requirements. Domestic cereal production in the past 10 years on average met only 40 percent of the total cereal requirement of the population, but in some years it was as low as 10 percent (FAO, 2005). Riely (1995) observed that crop production in 1994, which at the time was described as the best in recorded history, covered only 44-59 percent of the food requirement of the population that he predicted that Eritrea would continue to face a food deficit in the foreseeable future. Cultivated area and yield of the major crops in 1998 were 22% and 41.5% higher than that of 1994. Nevertheless, total production was still much lower than domestic food requirements. Even in good years, the country produces only 60 percent of its food needs. This is a result of the combined effects of small cultivated area and low yield levels.

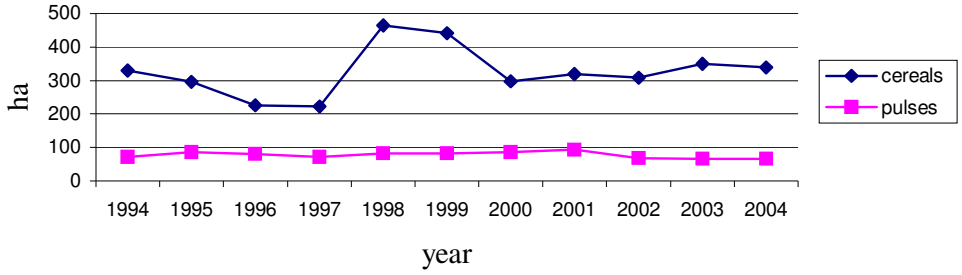
Average farm size is generally less than 1 hectare per household in the Central Highlands and 2 hectares in the lowlands. The average per capita cropland is 0.14 hectares or 0.7 ha per household (assuming a family size of 5 persons). This is almost half the size of per capita croplands in SSA (MOA, 2002b). Moreover, both cultivated land and crop yields vary considerably from one year to the other. Figure 3.1 shows the total area of land cultivated with cereals and pulses in the last 10 years. As will be shown in the next section, rainfall is highly variable in its magnitude and distribution in the country. This is one of the main causes of the variation in crop production because it affects both the size of cultivated land and crop yield. The decline in cultivated area in 1999 and 2000 after reaching their peak in 1998 is clearly due to the border war with the neighbouring Ethiopia, which led to the displacement of many rural households in Debub and Gash Barka regions (Figure 1.1). In addition, the mobilization of a large proportion of the population in the army has contributed to the drastic decline in cultivated land in those years. Due to consecutive droughts and the still unresolved border conflict cultivated area remained at low levels.

Table 3.2 Cultivated area (1,000 ha.) and yields (100 kg/ha.) 1994 – 2003

	1994		1995		1996		1997		1998		1999		2000		2001		2002		2003	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Cereals	**330.45**	**7.82**	**296.22**	**4.15**	**225.00**	**3.70**	**223.00**	**4.25**	**464.02**	**9.87**	**440.52**	**7.24**	**296.97**	**4.06**	**318.61**	**6.53**	**307.70**	**2.05**	**349.71**	**2.99**
Sorghum	131.00	9.20	130.07	4.70	100.00	3.92	120.00	4.64	236.23	11.42	236.37	8.77	146.39	4.23	165.82	4.75	166.30	2.02	200.93	3.19
Millet	87.06	6.77	60.24	2.12	50.00	2.48	30.00	2.50	83.00	6.24	80.00	2.90	40.73	1.11	40.42	7.49	40.00	1.45	40.00	4.23
Barley	38.86	7.57	43.32	6.45	25.00	5.13	28.00	5.75	45.55	12.42	43.38	7.34	46.35	5.58	48.38	9.29	40.01	2.43	43.96	1.91
Wheat	18.15	8.26	16.44	6.06	14.00	5.61	10.00	5.13	33.43	5.50	35.70	7.70	23.18	5.94	22.46	11.32	26.16	4.97	20.00	2.38
Maize	24.10	8.24	15.99	3.37	11.00	4.29	15.00	4.28	38.49	7.53	20.07	7.92	20.32	2.00	11.53	7.85	5.23	5.76	13.36	3.34
Others	31.28	4.75	30.16	1.91	25.00	2.53	20.00	2.08	27.32	6.85	25.00	5.26	20.00	5.20	30.00	6.50	30.00	1.06	31.46	2.27
Pulses	**71.71**	**6.03**	**85.80**	**6.58**	**81.20**	**6.26**	**71.30**	**6.41**	**82.87**	**6.60**	**82.69**	**6.16**	**85.65**	**5.58**	**94.07**	**5.87**	**68.03**	**5.78**	**66.30**	**5.61**
Beans	4.96	7.24	6.50	7.69	6.50	7.69	2.00	2.50	2.00	3.48	4.34	7.58	2.85	4.97	4.41	9.12	1.70	2.62	2.00	3.00
Broad beans	4.90	4.12	5.50	5.46	7.00	5.71	4.00	5.00	5.00	6.00	4.00	5.00	4.00	4.50	4.00	4.50	4.00	4.50	4.00	4.50
Peas	1.90	5.02	7.00	4.93	6.50	5.09	2.50	4.84	5.00	4.36	4.50	4.00	4.50	3.64	3.00	3.78	3.80	7.36	3.80	7.36
Chick peas	1.15	9.91	1.30	7.69	1.70	8.82	1.30	7.69	3.37	5.30	6.84	4.08	11.80	2.51	20.16	4.09	4.03	4.39	4.00	4.25
Lentils	2.80	8.93	3.50	8.57	4.50	8.89	3.50	8.57	5.50	9.09	5.00	8.00	4.50	6.67	4.50	6.67	4.50	6.67	4.50	6.67
Vetch	8.00	5.00	10.00	5.00	12.00	5.00	9.00	4.44	11.00	5.46	10.00	5.00	10.00	5.00	10.00	5.00	10.00	4.50	10.00	4.50
Others	48.00	6.04	52.00	6.92	43.00	6.27	49.00	6.94	51.00	7.06	48.00	6.67	48.00	6.67	48.00	6.67	40.00	6.25	40.00	6.25
Oilseeds	**61.70**	**1.37**	**63.30**	**1.69**	**56.90**	**1.26**	**52.50**	**1.19**	**53.45**	**1.41**	**50.69**	**1.46**	**49.59**	**1.35**	**46.25**	**1.29**	**42.70**	**1.30**	**44.84**	**1.76**
Total Area*	**502.30**		**485.40**		**400.4**		**388.4**		**647.90**		**563.40**		**502.00**		**458.93**		**418.43**		**460.85**	

* Total cultivated area includes land cultivated with vegetables and perennials and therefore is greater than the sum of the components.
Source: FAOSTAT

Figure 3.1 Total area cultivated under cereals and pulses in Eritrea: 1994-2004



Source: Based on FAOSTAT

Agricultural productivity is very low because of low and erratic rainfall, poor and shallow soils and little use of modern agricultural practices. Agricultural practices in the Highlands of Eritrea are largely traditional and rain-fed. The same resources and the same type of farming technologies have been used for centuries. The traditional oxen-drawn, simple iron-tipped plough and wooden tools are the major type of farm implements in the region. Improved crop varieties and pesticides are rarely used in the country. It is estimated that only about 10 percent of the farmers use inorganic fertilizers at low rates. The average rate of fertilizer application in 2002 was 22 kg/ha. This is much lower than the recommended rate of 150 kg/ha (FAO, 1994; EarthTrends, 2003). Due to deforestation and the resulting shortage of fuelwood, manure is rarely applied on crops and is primarily used as a source of household fuel. The 30 years war for independence and the recent border war as well as recurrent droughts have also devastated the economic base of the rural people. Table 3.3 shows some parameters that indicate the state of Eritrean agriculture in comparison to the agricultural sector in SSA and the world.

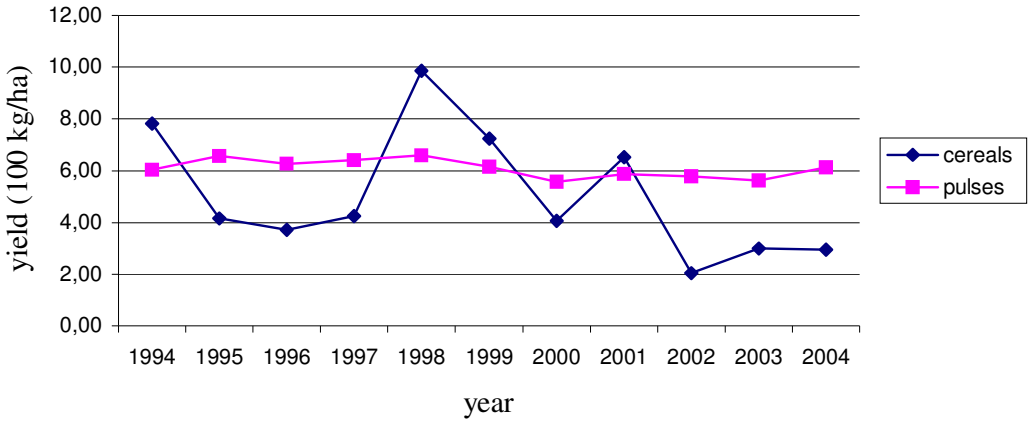
Table 3.3 Indicators of agricultural performance

	Eritrea	Sub-Saharan Africa	World
Cereal production (kg/person), average of 1999-2001	62.0	135.0	343.0
Average yield: cereals (kg/ha)	671.0	1,221.0	3,096.0
Average yield: pulses (kg/ha)	529.0	481.0	808.0
Hectares of land per 1000 population, 1999	142.0	274.0	251.0
Percent of cropland that is irrigated, 1999	4.4	3.8	18.3
Intensity of fertilizer use, (kg/ha) 1999	22.0	12.0	94.0
Number of tractors per 1000 ha Of croplands, 1997	0.9	1.5	17.5

Source: EarthTrends (2003).

Figure 3.2 shows yields of cereals and pulses between 1994 and 2004. As stated earlier crop yields in Eritrea are not only low but are also highly variable. While shortage of rainfall, low levels of input use, and traditional farming practices are the major causes of low levels of crop yields, the high variability in crop yield is mainly a result of fluctuations in rainfall.

Figure 3.2 Yields of cereals and pulses in Eritrea, 1994-2004



Source: Based on FAOSTAT

The Government of Eritrea has introduced a semi-commercial rain-fed agriculture, which it called Integrated Farming Scheme (IFS), in 1997. The objective of the IFS is to replace the low-productivity traditional methods of cultivation by integrating the inputs required to increase crop yield into a package and mechanizing crop production. As the small farm size (less than 1 ha. per family) is not technically and administratively conducive to facilitate IFS, farmers participating in this scheme pool their land resources into large fields and contribute labour. This scheme, which requires farmers to organize themselves into what appeared to be a collective farming system, provides participating farmers chemical fertilizer, seed and tractor services on credit. The total land cultivated under the IFS was 55,000 and 115,000 hectares in 1998 and 1999 respectively. The IFS were concentrated in southern Gash-Barka region, which has the highest potential for rain-fed crop production in the country. While crop yields in the IFS more than doubled, the sustainability of the program was questioned due to low loan repayment rates (Tikabo, 2003).

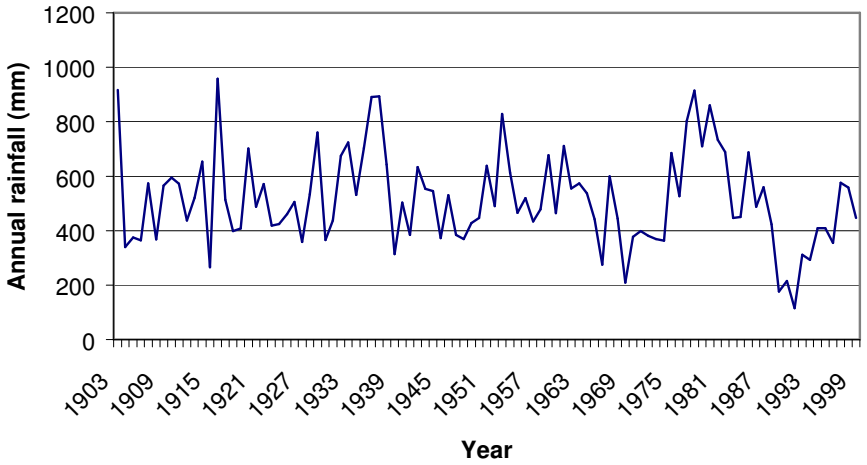
Climate and rain-fed crop production

Based on agro-climatic and soil parameters, Eritrea is classified into six agro-ecological zones: the Central and Northern Highlands Zone; the Western

Escarpment Zone; the South Western Lowland Zone; the Green Belt Zone; the Costal Plains Zone and the North Western Lowland zone. Due to its location and the physical features of its land, the country generally experiences scarce, erratic and unevenly distributed rainfall. Annual rainfall decreases from south to north, from more than 700 mm in some parts of the southern border with Ethiopia to less than 200 mm at the northern border with the Sudan. Rainfall also varies in amount and season between the different regions of Eritrea. The Country has two main rainy seasons: summer and winter rains. Most of the country receives the summer rainfall with the main rainfall period starting in June and reaching its peak in July and August. The Coastal Plains experience the winter rainfall from November to March. The eastern escarpment located in the Green Belt Zone enjoys both the winter and summer rains because of its location.

The scarcity of rainfall in most parts of Eritrea is evident with one third of the country receiving less than 200 mm average annual rainfall and 90 percent receiving less than 600 mm (FAO, 1994). Of the six administrative regions of the country, only two (Debub and Maekel) are classified as dry sub-humid. The rest are classified as semi-arid or arid (MOA, 2002a). Limited and unreliable rainfall is the major constraint to increased crop production in most parts of Eritrea. A study by Cliffe (1992) showed that lack of rainfall was the most important factor limiting crop production in the years 1986 to 1987. An MOA report also showed that crop harvest in 1993 was only 20 percent of the expected crop harvest, inadequate rainfall being the major underlying reason for such a disastrous crop failure. Figure 3.3 shows that there is a high fluctuation in annual rainfall in Eritrea. A statistical analysis of the annual rainfall between 1913 and 2000 has shown that rainfall has not significantly decreased during the last century (Mebrahtu *et al.,* 2004). However, it has been reported that rainfall has shown a decreasing trend over the last decade (FAO, 2005).

Figure 3.3 Annual rainfall in Asmara (Central Highlands Zone)



Irrigation

In addition to the traditional subsistence farming practices that dominate the highlands of Eritrea, small-scale irrigation is practised in some areas of the country. Irrigated agriculture was introduced to Eritrea by the Italians at the end of the nineteenth century. Most irrigation practices make use of diversion of streams (known as spate[5] irrigation) but some depend on boreholes, wells, pond water and dams. The area under horticultural crops in Eritrea in 2004 has been estimated at about 6407 hectares. This mainly includes small pumped irrigation schemes in Debub, Maekel and Anseba regions, where potatoes, tomatoes, carrots and other vegetables and fruits are grown. More than 20,000 hectares are also estimated to be under spate irrigation where, most frequently, sorghum is sown on the escarpments (FAO, 2005). Considerable attention is given by the government and non-government organizations (NGOs) to irrigation in the country. Permanent diversion structures have been constructed and a number of wells and dams have been dug or constructed before and independence for supplying water both for irrigation and drinking. However, only few of the dams are used for irrigation due to various reasons. They include absence of irrigable land below the dams; insufficient capacity to allow use by all members of the villages and absence of institutional capacity to manage water resource; and lack of irrigation experience among the peasants and absence of effective extension on the part of MOA. Moreover, most of the dams were built without irrigation outlet and well-planned irrigation layout for canals (Kiflemariam, 2001).

3.2.3 Livestock

Livestock production is an important component of the farming system in Eritrea. There are two main livestock production systems practised in the country. The agro-pastoral production system, which combines crop farming and livestock rearing, is mainly practised in the highlands and involves raising livestock mainly cattle, sheep, goats, camels and equines for milk, meat, animal power, and for sale. In the pastoral production systems, on the other hand, livestock are mainly kept for the supply of milk, meat and for sale. This is mainly practised in the lowlands with cattle, sheep, goats and camels the main types of livestock.

The livestock population in the different regions of the country in 1997 is presented in Table 3.4. Given that 70 percent of the population live in the rural areas and assuming a an average family size of 4.5 persons per household, the

[5] Spate irrigation is a system of irrigation that makes use of seasonal rivers producing floods of short duration from the highlands. These floods are diverted by structures to irrigate land in the lowlands.

average number of livestock per household is 3.1 cattle, 3.4 sheep, 7.5 goats, 0.5 camels, 0.8 donkeys and 1.8 chickens.

Table 3.4 Livestock population by region, 1997

Region	Cattle	Sheep	Goats	Camels	Equines*	Chickens
Anseba	218,923	124,300	620,023	25,266	61,603	78,247
Debub	490,093	614,069	706,409	19,382	173,703	512,776
Gash Barka	917,344	675,268	1,745,784	113,263	176,139	423,898
Maekel	40,505	149,927	23,556	0	24,676	86,425
Northern Red Sea	178,532	462,333	994,596	107,032	61,140	26,867
Southern Red Sea	82,060	103,047	571,417	53,971	21,198	6,052
Total	1,927,457	2,128,944	4,661,785	318,914	518,459	1,134,265

* Mostly donkeys but include some horses and mules.
Source: MOA (1997)

Livestock productivity is low due to lack of adequate nutrition, poor quality herds and lack of access to veterinary facilities. Since little forage crops are planted in Eritrea, livestock entirely depend on common grazing lands and crop residues. The rangelands in the highlands of the country are generally steep and infertile. Due to the communal land ownership and high population pressure in the highlands of the country, overstocking is a common phenomenon. Deforestation, continuous grazing and the loss of fertile topsoil has substantially reduced the potential productivity of grazing lands. Seasonal migration of livestock (sometimes even across the boarder to Ethiopia and Sudan) in search of feed and water is a common strategy of coping up with shortage of feed both in the highlands and lowlands. In years of extreme droughts, farmers sell their livestock both due to lack of feed and to make up for shortfalls in food production. This often has a negative long-term effect, as livestock, particularly oxen, are key factors in crop production.

3.3 Energy and forestry in Eritrea

Energy and forestry sectors in Eritrea, as in many developing countries, are highly related. This is because of the high dependence of the majority of the population on biomass for their daily energy uses. This over-reliance on biomass as a source of energy is one of the major factors behind the high level of land degradation in the country. An increased tree cover can positively contribute to the problem of land degradation in two ways. First, increased tree cover improves the quality of land directly by decreasing soil erosion and increasing fertility. Second, increased tree cover means rural households will have better access to fuelwood. This will allow dung and crop residues to be used for fertilizer with a positive impact on soil structure and nutrient balance. This

section looks at the structure of energy consumption and the state of forestry in Eritrea.

3.3.1 Energy

Eritrea has one of the world's lowest energy consumption rates. Per capita energy consumption is about 8.12 Giga Joules per year. Commercial energy products (electricity plus oil products) constituting only one third of the total energy consumption (MOEM, 2000). A comprehensive energy database was established by Eritrean Ministry of Energy and Mines (MOEM) in 1995 and was updated in 1998. Table 3.5 shows that about 97 percent of all biomass fuels in 1998 were utilized by the household sector for cooking and heating purposes. Liquefied petroleum gas (LPG) and kerosene are also mainly used in the household sector, about 80 percent of the former and 89 percent of the later being consumed by that sector. While LPG is exclusively utilized in the urban centres (mostly the capital city) for cooking purposes, kerosene is used both in the urban and rural areas of the country.

The transport sector utilizes more than 87 percent of gasoline and about 44 percent of diesel consumed in the country. No electricity is utilized in the transport sector. More than 54 percent of gasoline is consumed in the public /commercial sectors which also use 20 percent of the electricity consumption in the country. The Industrial and household sectors are the major consumers of electricity in Eritrea constituting about 49 percent and 35 percent respectively.

About 80 percent of the Eritrean population has no access to electricity. Electricity is available only in the larger cities and towns and a few villages near them. Few other villages have community diesel generators, which can provide electricity of 30 to 100 Watts in the early hours of the evening. Except in the major cities of the country, electricity in household sector is exclusively used for lighting purpose because most households are too poor to afford the necessary electrical appliances and to pay higher bills.

Different activities are underway by the Ministry of Energy and Mines to diversify sources, increase efficiency and expand access to electricity in the country. To diversify energy sources wind, solar and alternative uses of biomass energy are being actively investigated. Large-scale tree planting activities are being undertaken by mobilizing community labour and students summer programs, which are expected to increase the supply of fuelwood. Major investments are also being made to change the national electricity supply system and to install higher voltage lines to enhance efficiency. The Ministry is also undertaking a research to arrive at affordable and more efficient cooking stoves to reduce the amount of fuelwood required for cooking. Some studies indicate

that improved stoves that use iron plates instead of the traditional clay plates (*Mogogo*) can double the efficiency of the use of fuelwood (Van Buskirk *et al.,* 1998).

In conclusion, biomass fuels and particularly fuelwood is presently the most important source of household energy and the only source of energy for almost all rural households in Eritrea. While the government of Eritrea is making tremendous efforts to increase the supply of energy and improve the efficiency with which fuels are utilized, owing to the distribution of the rural population and the financial constraints of the country, the rural population is likely to continue to heavily depend on biomass energy.

Table 3.5 Energy demand by fuel type and sector in 1998

	Biomass (1,000 tonnes)				Oil Products (1,000 tonnes)				Electricity (GWh)
	Fuel Wood	Dung	Agr. Resi-due	Charcoal	LPG	Kero-sene	Gasoline	Diesel	
Household	800.50	261.47	87.27	70.69	0.65	18.89	0	0	57.06
Public/Comm	30.18	3.90	3.52	2.61	0.17	2.27	2.15	46.62	31.18
Industry	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.92	63.97
Transport	0.00	0.00	0.00	0.00	0.00	0.00	13.88	56.00	0.00
Total	830.68	265.37	90.79	73.3	0.82	21.19	16.03	103.54	152.21

Source: MOEM (2000)

3.3.2 Forests and woodlands

Forest resources in Eritrea are few and highly degraded due to high human and livestock pressure on them from collection of wood for fuel and construction materials, grazing and expansion of agricultural land. Nevertheless, forests and woodlands still contribute considerably to the Eritrean economy and particularly to the rural population. Rural communities, most urban households and some commercial enterprises depend on fuelwood for energy. Forest products also serve for construction materials and as a source of feed for livestock. In addition to the above uses, other non-wood forest products in Eritrea include Gum Arabic, Gum Olibanum and dried Doum Palm leaves (FAO, 1997).

The land use categories in Eritrea were described in Table 3.1. In this section we present the nature of the forests and their distribution in the country in more detail.

Table 3.6 Natural forest vegetation areas of Eritrea by region (km^2)

	Administrative regions						
	Anseba	Maekel	D.K. Bahri	Debub	S.K. Bahri	Gash-Barka	Total
Forest							
Closed to medium closed[6]	14	77	0	37	463	0	591
Open	133	0	0	15	262	0	410
Woodland							
Closed to medium closed	523	8	0	448	832	2722	4533
Open	901	18	1235	1471	1555	4360	9541
Bush							
Grassland/wooded grassland	13,943	52	3,678	907	669	6,327	25,577
Bushland	3,950	282	9,556	1,095	29,416	9,526	53,824
Other Forest							
Riverine forest	341	0	43	99	110	1,272	1,865
Mangroves	0	0	45	0	19	0	64
Other Categories							
Barren soil	1,868	3	10,344	115	4,532	1,403	18,265
Agriculture	527	796	0	3,805	857	2,726	8,712
Other	4	39	116	0	9	67	234
Not classified	581	0	0	0	0	1,591	2,172
Total	22,784	1,274	25,018	7,992	38,724	29,995	125,788

Source: FAO (1997)

As shown in Table 3.6, the FAO (1997) study classifies the natural forest cover in Eritrea into six major vegetation types viz. Highlands Forests, Mixed Woodland, Bush or Shrub land, Grassland and Wooded Grassland, Riverine Forests and Mangrove. The Forests of the country mainly consist of closed and open coniferous and African Olive forests and cover about 1000 km^2 or 0.8 percent of the total land area of the country. In addition, the country has important vegetation composed of woodlands, riverine forests and mangroves of about 16000 km^2 (12.7%), which brings the total forest cover to 13.5 percent of the total surface of the country. The category Bush is the dominant vegetation type covering 63% of the total area. This category is generally open with shallow and rocky soils.

Geographically most of the forests are found in the highlands of the country and the eastern escarpments. More than 72 percent of the open and closed forests of the country are found in Semienawi Keih Bahri and 14.7% are found in Anseba. Of the six regions in Eritrea, Debubawi Keih Bahri and Gash-Barka has none of these forests. On the other hand, 50 percent of the woodlands are found in Gash-Barka. The Mangroves are found in the two coastal regions – Semienawi Keih

[6] Closed and Open (forests or woodlands) refer to vegetation cover of greater than 40% and 10%-40% respectively.

Bahri and Debubawi Keih Bahri. The largest part of the Riverine forests (83.6%) is found in the western lowlands. Gash-Barka and Anseba constitute 65.9 and 17.7 respectively of the riverine forests. A number of activities directed at managing natural forests and woodlands as well as establishing new plantations are underway in Eritrea.

Management of Natural Forests

The government of Eritrea has initiated a closure program in which existing forests and woodlands are brought under full or partial protection by restricting human activity (such as fuel collection, farming and grazing) so that existing forests may be protected and degraded woodlands may get the chance for regeneration. The two types of closures found in the country include 'permanent closure' where the area is restricted from human activity for unlimited period of time and 'temporary closure' where the restriction is carried out for a limited period, from a few months to a few years (FAO, 1997). Generally the permanent closures have relatively more forest cover including tree species with valuable timber quality than the temporary closures. The size and distribution of the closures in the different regions of the country are presented in table 3.7.

Table 3.7 Permanent and temporary closures in Eritrea

	Permanent Closure		Temporary Closure	
Zoba	No.	Area (ha)	No.	Area (ha)
Anseba	17	8,138	2	64
Debub	24	13,843	16	8,650
Debubawi K. Bahri	0	0	0	0
Gash-Barka	10	23,435	10	1,290
Maekel	7	4,990	5	4,500
Semienawi K.Bahri	20	59,932	0	0
Total	**78**	**110,338**	**33**	**14,504**

Source: FAO (1997).

As indicated in table 3.7, there are currently about 125,000 hectares of protected forest and woodland areas in Eritrea of which 110,338 in permanent closure and the rest in temporary closure. Fifty four percent of the total area under permanent closure is found in Semienawi Keih-Bahri region. The next two regions that have the largest area of permanent closures are Gash-Barka and Debub with 21% and 12.5% of the area under permanent closure respectively.

Most of the temporary closures (91%) are located in the Highlands of Eritrea in Debub and Maekel regions. This is because the temporary closure system has been traditionally practised in the highlands for management of grazing lands. Thus, in addition to the closures recorded by the survey, there may be many more temporary closures in the country.

Plantation resources

Afforestation programs have been undertaken in Eritrea for the last two decades. As a result, in addition to the natural forests, some plantations exist in the country. Most of the plantations have been established by the government as part of the hillside catchment planting campaigns with the primary objective of soil and water conservation. The size and distribution of the plantations that existed in 1997 are presented in Table 3.8.

Table 3.8 Summary of plantations

Zoba (region)	No. of Plantations	Gross Area (ha)
Anseba	39	3,986
Debub	44	1,403
Gash-Barka	8	704
Maekel	29	3,344
S.K. Bahri	11	5,305
National	131	14,741

Source FAO (1997)

While the records of the Ministry of Agriculture indicate that over 50,000 hectares of land have been planted, the FAO field survey shows that less than 15,000 hectares of plantations existed in 1997. The discrepancy between the records of the Ministry and the FAO estimates is due to the fact that the records of the Ministry indicate areas planted each year which often includes replanting of previously planted areas to improve the stocking rate. Since soil conservation and not production of wood was the primary objective of the tree planting programs, most plantations were established on inherently low potential hillsides with shallow soils. This, together with defective seedlings and inadequate rainfall, contributed to modest survival rates (60%) and the need for replanting.

As most plantations were undertaken by the government under the FFW (this has been changed to Cash for Work (CFW) in recent years) programs, people participated in the establishment of the plantations. However, the programs did not have any mechanism to ensure community participation beyond that. The communities were not able to identify themselves with the objectives and outputs and therefore their participation continued only as long as they were paid for it. With the exception of a few plantations that have been handed over to the communities after independence, the communities were not allowed to harvest the output.

In addition to the plantations established by the government, there also exist some farm and homestead plantations in the country. Farmers in many parts of

the country exhibit high interest in individual tree planting. This, however, is constrained by the lack of sufficient land around their house. Tree planting on farmlands are not common because the periodic redistribution of land is not conducive for planting perennial crops with long gestation period. In addition, farmlands are used for grazing after harvest. Thus either the community does not allow individual tree planting on croplands or the farmers are not interested because survival of the seedlings is unlikely due to livestock browsing. An innovative solution has been made to these problems in some villages of Zoba Maekel in which the communities have set aside a certain area for tree planting and each farmer who is interested in tree planting is assigned a plot in that area. The participation of the community in such plantations is high. The government can encourage other communities (villages) to undertake similar steps to deal with the tenure constraint in individual tree planting.

3.4 Land degradation

Nature and extent of land degradation

Land degradation is defined as "a loss of land productivity through various processes such as erosion, wind blowing, salinization, water logging, depletion of nutrients, deterioration of soil structure and pollution" (Dudal, 1981: 4). Land Degradation thus involves several processes and can be manifested in many different forms. These include water and wind erosion, biological degradation (loss in humus), physical degradation (increase in bulk density, decrease in permeability), chemical degradation (acidification, toxicity) and excess salts (salinization, alkalization) (Bojo and Cassels, 1995).

The Ethiopian Highlands Reclamation Study (EHRS) found that biological degradation was the most prevalent and most serious feature of all agricultural land in the highlands of Ethiopia.[7] Biological degradation sets in when the soil surface is deprived of the supply of plant residues and is therefore exposed to extremes of heat or wetness. This form of degradation is also the cause of physical degradation and accelerated erosion in the region. Soil erosion is viewed as one of the major environmental problems in the Highlands of Eritrea (FAO, 1994; GOE, 1995). Hawando (1994) underlines that land degradation in Eritrea has reached a very serious level that this has resulted in a dramatic decline in yield levels.

Most of the reports on the extent of land degradation in the country and the impacts on yield are, however, made based on scanty data. Estimates on soil

[7] The study included the highlands of Eritrea.

erosion are based on a single research station (Afdeyu Research Station (ARS) in Zoba Maekel)[8] and/or extrapolations from other countries. Based on these sources, FAO (1994) puts average annual soil erosion for the different and soil conditions in Eritrea between 2 and 25 tons per hectare and the average annual soil loss from croplands at 15 tons per hectare.

The above figures are gross soil losses and do not take into account redeposition of soil from one type of land use to another. By taking into account land use and rainfall conditions in Eritrea, Bojo (1996) has modified the rates of soil loss estimated for the Ethiopian Highlands (Hurni, 1988) and constructed a 'soil transfer matrix' for Eritrea (Table 3.9). The soil transfer matrix shows the transfer of soil between different categories of land use. For example, the gross loss from croplands is 21 tons per hectare per year. The annual rate of deposition from the different types of land use categories to cropland is 9.1 tons per hectare resulting in a net loss from croplands of 11.9 tons per hectare per year. While admitting that some of the assumptions used to derive the soil transfer matrix are questionable, Bojo (1996) emphasized that the major conclusion from the matrix is that the net rate of soil loss from croplands is considerably lower than the gross rate of loss.

Table 3.9 Soil erosion and deposition in Eritrea

	Total area (1,000 ha)	Percent share in total land	Estimated gross annual soil erosion (tons per ha)	Annual soil redeposition, by land use ((tons per ha)					Total eroded soil which is lost to the system (tons per ha)
				Grazing	Barren	Woodland	Cropland	Forest	
Grazing	6,967	57.2	2.5	2.0	0.3	0.3	0.3	0.3	0.3
Barren	4,047	33.2	35.0	7.6	16.3	7.6	7.6	7.6	3.5
Woodland	673	5.5	2.5	0.1	0.1	0.2	0.1	0.1	0.3
Cropland	439	3.6	21.0	0.7	0.7	0.7	1.1	0.7	2.1
Forest	63	0.5	1.0	0.005	0.005	0.005	0.005	0.007	0.1
Total	12,189	100.0		10.4	17.4	8.8	9.1	8.7	
Net loss (gain)				(7.9)	17.6	(6.3)	11.9	(7.7)	1.5

Source: Bojo (1996).

Effects of land degradation

The impact of soil loss on agricultural production is even more difficult to estimate with any degree of reliability. The relationship between soil erosion and crop yield is very complex because soil erosion reduces crop yield by, among other things, decreasing the water-holding capacity of the land, reducing the rooting zone and decreasing nutrients available for plants. In addition, the

[8] Results from ARS are discussed in more detail in Chapter seven.

relationship between soil loss and crop yield is non-linear. While soil loss may not have any effect on yield in deep soils, it may reduce yield in shallow soils considerably (Eaton, 1996).

Estimations of yield decline due to soil erosion in Eritrea are based on a similar study in Ethiopia. Hurni (1988) estimated crop yields in the Ethiopian Highlands were declining at a rate of 2 percent per year. Bojo and Cassels (1995) considered lower rates of soil loss (due to redeposition) and arrived at a much lower rate of yield decline. Modifying these calculations for Eritrean conditions, annual yield losses for Eritrea are estimated between 0.6 and 0.3 percent per year (World Bank, 1996a).

The depletion of nutrients for African countries is generally very high (Stoorvogel and Smaling, 1990). Evidence on the extent of nutrient loss and its impact on agricultural production, however, do not exist for Eritrea. The use of cow dung for household fuel is believed to have much more impact on agricultural production than soil loss. Estimations of the value of agricultural output foregone due to burning dung vary from 2.2 percent (MOA, 2002a) to 6 – 18 percent of the value of total annual cereal production in the country (World Bank, 1996a; MOA, 2002a).

3.5 The causes of land degradation in Eritrea

Understanding the process of land degradation and identifying the major factors that give rise to it are important preconditions for policy making in respect to NRM. The factors that directly cause or accelerate soil erosion in the highlands of Eritrea include deforestation, inappropriate land management practices, overgrazing and the use of dung and crop residue for fuel. Other factors that indirectly contribute to land degradation include high population pressure, insecure land tenure, poverty and war. These factors will be discussed below.

3.5.1 Direct causes of land degradation

Deforestation

Forest cover provides land with protection from the direct impact of rainfall. It enhances the availability of organic matter in the soil, and contributes to soil strength by providing additional cohesion (Cassels *et al.,* 1987). Thus, deforestation does not only expose soils to the direct impact of rainfall but makes soils easily erodible by reducing organic matter content and water

holding capacity. This reduces infiltration rate and increases run-off and soil erosion.

Massive removal of vegetative cover is the major driving force behind Eritrea's land degradation in general and soil erosion in particular. In the mid nineteenth century about 30 percent of the country was covered by forests. However, by 1951, the forest cover had declined to 11 percent of the total land area of the country. Today, most parts of the country are almost devoid of trees, with forests covering only 0.8 percent of the total land area (FAO, 1994).

Population growth has increased the demand for cropland, grazing land and wood for construction and fuel. These factors have been instrumental in causing massive deforestation in Eritrea. As shown in Table 3.9 soil loss from croplands in Eritrea is 21 tons per hectares per year, while soil loss from forested areas is only 1 ton per hectare. The considerably higher rates of soil loss from non-forested land use systems relative to those from forest area clearly shows the negative effect of deforestation on land degradation in general and soil erosion in particular.

Inappropriate land management practices

Farmers' land management practices such as the kind of tools used, crops grown, timing of sowing, crop rotation, the use of fertilizer and expansion of croplands with increasing demand for food crops have all had some effect on land degradation.

Crop production in the highlands of Eritrea is characterized by the dominance of annual crops, mainly cereals. The major crops grown in the country are sorghum, barley, wheat, taff and maize. Although some perennial crops such as fruit trees are also produced in the highlands of the country, these crops constitute for a small proportion of the total area cultivated. The dominance of annual crops rather than perennial crops in the highlands of Eritrea implies the presence of very little land cover for the croplands during most periods of the year.

Expansion of agricultural land into marginal lands is usually induced by population pressure. Such expansion is often cited as a major cause of land degradation, particularly soil erosion, but available statistics show that Eritrea's harvested area increased from 1950 to the early 1960s and then declined considerably (MOA, 1993). The country's 30-year war of independence, which started in 1961, is the main reason in fluctuation in the cultivated area. However, despite the absence of evidence of recent expansion of croplands to marginal lands, the fact that steep slopes are currently cultivated in many parts of the

highlands of the country suggest that agriculture has already been extended to marginal lands.

Eritrean farmers use farming practices that help reduce land degradation. These practices include fallowing, crop rotation, intercropping, application of manure and rotational grazing. In addition, they use practices such as terracing with the specific objective of soil and moisture conservation. However, due to increasing population pressure and the consequent acute shortages of croplands and firewood, fallows have become shorter and the amount of manure is inadequate.

Burning of dung and crop residues

The use of dung and crop residues as fuel means that Eritrea's soil is deprived of its traditional sources of nutrients. In addition, as their organic matter content decreases, soils become easily erodible. With the decline in the availability of firewood, the burning of dung and crop residue has become more common, particularly in the rural areas. Almost all the domestically produced dung is used for fuel. In addition, a considerable proportion of the dung that falls directly on croplands as well as crop residues, particularly those of maize and sorghum, is collected for the same purpose.

There is no reliable estimate of the extent of the use of dung and crop residues as a substitute for firewood in Eritrea. Newcombe (1989) estimated that about 90 percent of the total dung production in Eritrea is used as fuel. However, the approach he used required restrictive assumptions and hence his figures should be considered only as a rough approximation. He estimated the extent of the use of dung and crop residues for different regions of Ethiopia (including Eritrea) indirectly from estimates of fuelwood deficits in respective areas. He then used hypothetical fuel mixes of dung and crop residues for different regions, which, in turn, were used as a substitute for the estimated fuelwood deficit in the respective regions (Bojo and Cassels, 1995).

Based on the assumption that per capita consumption of dung for fuel in Eritrea is the same as in neighbouring Ethiopia, Bojo (1996) estimated that about 20 percent of the total dung production in the country was used as a substitute for fuelwood. However, the figure is likely to understate the extent of dung use in Eritrea as per capita dung consumption is likely to be higher than in Ethiopia where firewood is less scarce.

FAO (1997) estimates that dung and crop residues respectively constitute for 8.3 percent and 1.6 percent of the total energy demand in the country. Despite the lack of precise data, the use of dung and crop residue for fuel in Eritrea is very high and one of the major factors underlying the problem of land degradation.

Overgrazing

Crop production in Eritrea is almost entirely dependent on the use of oxen for ploughing. Moreover, Eritrean farmers are not self-sufficient even in good years (MOA, 1993; Riely, 1995) and face a high risk of crop failure due to lack of rainfall or crop infestation. Thus, they tend to keep as many livestock as possible to supplement their income and as security against crop failure. Besides economic considerations, ownership of a large number of livestock is considered as a sign of wealth and prestige.

The number of livestock is much higher in the lowlands of Eritrea than in the highlands with the former accounting for more than 60 percent of the total livestock population. The average tropical livestock unit (TLU) per household varies from a minimum of 1.45 in some areas of the highlands to about 7.85 in the lowlands[9] (FAO, 1994). Table 3.10 shows that the total number of livestock in the country is considerably higher than the carrying capacity of the land in five of the six regions. The difference between the carrying capacity and current levels of livestock is much higher in the Central Highlands than in the other regions.

Table 3.10 TLU and carrying capacity by region in Eritrea in 1997

Region	Total Area* Km^2	TLU**	TLU/km^2	Carrying Capacity*** TLU/ km^2
Anseba	23,200	283,746	12.23	8
Debub	9,300	581,346	62.64	16
Gash Barka	33,200	1,085,579	32.70	16
Maekel	1,080	58,040	53.79	16
Northern Red Sea	27,800	408,267	14.68	8
Southern Red Sea	27,600	189,458	6.86	8
Total	122,180	2,606,436	20.9	

*Reliable land areas are not as yet available for Eritrea and the total differs from the often quoted figure presented in Chapter One.
** based on a conversion factor of 1, 0.7, 0.1, 0.5, and 1 for oxen, cattle, sheep/goats, donkeys and camel respectively.
*** The carrying capacity is estimated based on 6 and 12 hectares per TLU in the higher and lower rainfall regions respectively.
Source: Based on Table 3.4, Table 5.1, and FAO (1997)

Overgrazing is, therefore, a serious problem in the Central Highlands of Eritrea; and a shortage of animal feed, particularly in the dry season, forces the migration of livestock to the eastern escarpments or the south western lowlands. Inadequate nutrition ranks next to endemic diseases as the second major constraint to livestock production in the country (FAO, 1994). The production of dry matter from most grazing land is lower than what rainfall and climate permit

[9] One TLU is equivalent to one 250 kg cow or four 50 kg goats.

mainly due to poor management of grazing land. Many areas are reported to have lost their original vegetation and to have been invaded by nutritionally inferior grasses (FAO, 1994). The compaction of soil from trampling by livestock also increases the risk of soil erosion by reducing the rate of infiltration destroying the aggregate stability of the soil and reducing its water holding capacity (Jahnke, 1984). The qualitative assessment that overgrazing is the major cause of land degradation in the region (Catterson, 1995; FAO, 1994), has not been tested by quantitative estimation of the extent of the problem nor a measurement of the actual loss of productivity from it are available for Eritrea.

3.5.2 Indirect causes of land degradation

In addition to the factors that directly cause land degradation, other factors also cause or accelerate land degradation indirectly by influencing land use and land management practices of farmers. Factors that influence farmers' land use decisions and their willingness and ability to invest on fertilizer, soil conservation and tree planting include land tenure, population growth, poverty and war. Lack of credit, extension and other services may also be important factors that influence farmers' land management practices. The relationships between land tenure, population growth and poverty on the one hand and land degradation on the other are discussed in Chapter two. In this section we will describe the land tenure system in Eritrea, the size and distribution of the population, and the nature and magnitude of poverty in the country. Finally, we will briefly discuss the effects of war on land degradation.

Land tenure

Land ownership and property relationships in the highlands of Eritrea are varied and complex. They encompass state, individual, family and communal (village) ownership. With the new land policy, all land and natural resources in Eritrea belong to the state and all citizens of the country are entitled to usufruct rights to agricultural and/or residential land (proclamation No. 58/1994). However, the new land policy has not yet been implemented and the traditional land tenure systems are still in practice. The three main types of land tenure – the *Diesa* system, family ownership and state ownership – are briefly discussed below.

The diesa system

This is the predominant system of land tenure in the highlands of Eritrea. In the *diesa* system of land ownership residents of a village, not necessarily related to each other by family ties, collectively own the land surrounding the village. While grazing land is used communally, croplands are redistributed periodically among married adult residents of the village by drawing of lots. The period of

redistribution varies from village to village or sometimes within a given village depending on the crop rotation system practised in the village.

To ensure equity, the village cropland is classified into three grades: good medium and low quality. Every member of the community who qualifies for an allocation receives land from each category. To qualify for the allocation, the applicant must be a married male member of the village[10]. Widowed women can retain their husband's rights and divorced women take half of their husband's share. With the traditional *diesa* system land is distributed in such a way that all households (except a one person household which gets half the full share) receive the same size of land. However, in some villages, the Derg (the former Government of Ethiopia) introduced a system of land distribution where land is distributed according to family size. Once land is allotted, the household has the right to cultivate or lease it until the next redistribution. The holder, however, cannot sell or transfer his land and should he or she abandon the land for any reason the land is brought back to the pool from which individuals who qualify for land before the next redistribution are given temporary plots to cultivate (see Chapter Five)

Family ownership

This is believed to be the earliest form of land tenure system practised by the original settlers of the highlands of the country. This is a system of land ownership where all the landowners are descendants of a common ancestor who once owned the land. This system of land ownership is referred to as *risti*. Two types of *risti* exist. The first type refers to the system where members of the family are given only a usufruct right while the land is kept as their collective property. The second type refers to hereditary ownership where land is continuously divided and subdivided among the sons, and some times the daughters. This type of *risti* is known as *tslmi* and gives absolute ownership. Due to land reform programs by the former Ethiopian government as well as the two liberation fronts (ELF and EPLF), which converted the *risti* and *tsilmi* land tenure system in many villages into *diesa*, the former systems are not common these days.

State ownership

As the name indicates this type of land tenure system refers to land that belongs to the state. Such lands, also referred to as *dominale*, are lands where no one has a clear claim of ownership or lands where ownership or entitlement has been

[10] Currently there are some changes in eligibility for land. Some villages allow members who completed their national service to get land even before they get married.

abrogated for political or public utility purposes. These lands include forest, grazing and crop lands in all of the coastal and western lowlands and some areas in the highlands. They are also found in the southern areas of southern highlands around Asmara (the capital city) and the eastern escarpments. State lands are given as concessions to individuals who have the resources to develop them. The terms of the concessions, while renewable vary from 20 to 50 years (FAO, 1994).

Land tenure and land degradation

As noted already, the Eritrean highlands are dominated by communal ownership of land through the *diesa* system. This type of land tenure is considered as the major factor discouraging investment in land improvements thereby leading to land degradation (GOE, 1994). It is argued that the length of period of land redistribution (5 to 7 years) is too short to justify investments in land improvements such as terracing and tree planting that have a long gestation period. In addition, as croplands are open to common grazing during the post-harvest period, farmers cannot plant trees on their croplands. Crop residues that could otherwise provide ground cover and nutrient recycling are also completely removed. Communal ownership also precludes the possibility of using land as collateral. This makes it difficult for farmers to obtain credit to improve their farming activities. Finally, young members of a village who qualify for land (as they get married) have to be accommodated. This leads to a continuous reduction in household farm sizes as the village land has to be shared by a larger number of households. As a result farmers are forced to look for off-farm jobs to supplement their income, which leaves them with little time to invest in land improvement.

On the other hand, despite the belief that a communal land tenure system hinders investment in land improvement, land management practices in the highlands of Eritrea where communal land tenure is practised reflect a concern for natural resources. Traditionally arranged fallow periods are also in use in Eritrea's highlands and individuals cannot cultivate in areas declared fallow. Crop rotation, which is an environmentally friendly way of controlling pests and re-establishing soil fertility and thereby reducing soil erosion, is also widely practised by these communities. Cutting of live trees is totally restricted and a forestry guard is appointed to safeguard forest and grazing areas. Nadel (1946) remarked that Eritrean farmers made extensive use of terracing where their farms were located on sloping ground and that the terraces were well built and maintained. He disputed the argument that farmers on communally owned land could not show any interest in developing their land because of frequent changes in ownership. He stated that "the spirit of communal responsibility in these communities makes the temporary land holder work in the interest of his

successors as well, since they belong to a closely knit social unit. The rules of fallow lying and the building and upkeep of terraces which outlive individual tenure, prove this communal spirit convincingly" (Nadel, 1946:4).

There are only few empirical studies that analyze the effect of private ownership of land on the management of natural resources in Eritrea. Tikabo (2003) analysed the effect of length of rental contract between landowner and tenant (which he used as a proxy for tenure security) on the probability of manure application (considered as long-term investment) and the extent of manure application. He found that the probability of manure application was higher on longer duration rental agreements than on a shorter duration rental agreements. On the other hand, the intensity of manure application was not different between short and long duration tenure arrangements. Interestingly, he found that the intensity of manure application was highest in medium duration tenure arrangements. This, the author argues, shows that tenure insecurity may even be a motive for higher application of manure because tenants may want to ensure continuity of operating the rented land by investing on the land.

Araya (1997) also analysed the effect of land tenure on soil conservation activities of farmers in the highlands of Eritrea. The study shows that farmers in areas where land is communally owned spend less time on soil conservation compared to those in areas where land is privately owned. However, time spent on undertaking soil conservation activities on owner operated land and rented land (a proxy for tenure security) do not differ significantly. While private ownership of land (*tslmi* and risti) is free of most of the problems associated with communal ownership discussed above, there is no clear evidence that land degradation is less severe in areas of private ownership. Steep farms with high risk of soil erosion are cultivated in these areas without any conservation measures. Disputes on land rights and boundary conflicts are also more common in areas where land is privately owned than where it is communally owned.

Population growth and distribution

As discussed in Section 2.2, population density varies considerably in the highlands and lowlands of Eritrea. The average population density for the highlands of Eritrea is 131 persons/km^2 compared to an average population density of 13 persons/km^2 for the lowlands. Average rural population density for the highland areas of the country is 73 persons/km^2 compared to a national average of 23 persons/km^2. Within the highlands, as well, population density varies substantially from one region to the other. Areas with higher agricultural potential generally have higher population density. Population densities for the different subregions of the highlands are discussed in Chapter five.

There are no current census figures for Eritrea. Despite questions about exact population size and growth over time, however, it is clear that population has dramatically increased in the last 50 years of the past century. The average rate of population growth is estimated to be 2.9 percent per year. FAO (1994) suggested that population growth in Eritrea could be even higher because of a possible post-war baby boom.

Rapid population growth and high population density are mentioned as factors that contribute to land degradation problems particularly in the highlands of the country. Population increase has led to expansion of agricultural lands to marginal areas and fallow periods got shorter leading to deforestation and soil erosion (MOA, 2002b). The theoretical links between population growth and land degradation are not always straightforward and are discussed in Chapter two.

Poverty and land degradation

The majority of Eritrea's rural people is poor. The nature and magnitude of poverty vary between rural and urban areas as well as among the various regions of the country. Poverty is generally concentrated in rural areas with about 67 percent of the poor living in rural areas. This group of people is highly dependent on low input agriculture and animal herding for their livelihoods. Due to lack of diversification in their incomes they face high-income risk and high frequency of food insecurity. They also lack access to most physical and social infrastructures. Urban poor on the other hand mainly depend on wage labour and petty trade. They have relatively better access to physical and social infrastructures (World Bank, 1996b; GOE, 2004b).

Table 3.11 Population below the poverty line in Eritrea*

Poverty incidence (head count)						
Location	Population		Poor		Extremely poor	
	Million	(%)	Million	(%)	Million	(%)
Rural	2.45	68.8	1.58	64.64	0.95	38.90
Urban	1.11	31.2	0.78	70.32	0.36	32.65
Overall	3.56	100.0	2.36	66.40	1.31	36.97

* The poverty line is Nakfa 240 per capita/month; Extreme poverty line is Nakfa 150 Nakfa per capita/month.
Source: After GOE (2004b)

Agricultural potential in general and climatic conditions in particular largely contribute to regional distribution of poverty. Poverty is more pervasive in the semi-arid lowlands where about 36 percent of the population live. However, the majority of the poor people live in the highlands of the country. The rural population in arid areas of the country mainly depends on livestock herding and

where rainfall is adequate they grow some crops. However due to frequent droughts they are forced to sell livestock to buy food crops. The fact that many of the poor in this region are nomads also limits their access to health care and educational services. In the highlands, shortage of land and poor access to farm inputs such as seed and animal power are the major factors to high levels of poverty. Access to off-farm jobs is limited both in the highlands and lowlands (GOE, 2004b).

The theoretical links between poverty and land degradation are very complex and are discussed in Chapter two. It has already been mentioned that high dependence of rural population on the natural resources in their surrounding has led to land degradation such as soil erosion and deforestation. But it is not clear if poorer households do cause more damage to the environment than better-off households. There is no study that relates poverty and land degradation in the country. However, it is clear that the generally poor condition of the rural population contributes to land degradation because the rural population lack resources to invest on land, and do not have access to alternative sources of energy.

War and land degradation

The extended war for Eritrea's independence has had a considerable direct and indirect impact on the country's agrarian systems and thereby on the country's environment. The direct impact on land degradation in Eritrea includes the clearing of forests to supply the army with firewood and fortification materials as well as to improve visibility in war operations.

The war's indirect impact on land degradation includes its effects on the lives of the people, their property and their farming activities. Although no hard data are available on the change in the economic status of the rural population as a result of the 30 years war, there is no doubt that it has worsened. The country's labour force decreased significantly as many of the adult population joined the freedom fighters or migrated. The general threat to movement such as harassment, mines and aerial attacks also had a serious impact on economic activities to the extent that considerable proportion of the land was left idle. The war has also contributed to a high proportion of female-headed households in the country with most rural families having insufficient labour and other resources to undertake basic farming practices, let alone conservation activities.

In some areas, the war could have helped to reduce the problem of land degradation. The pressure on land was alleviated as the number of livestock decreased and the land was left idle. It has been observed that in many areas,

where movement of livestock and people was restricted or unsafe, the natural vegetation has regenerated to form sufficient cover for the land.

Generally, however, the protracted war in Eritrea had an adverse impact on the environment. The apparently reduced pressure on resources in some areas was more than offset by increased pressure in other areas as people and livestock had to migrate to the relatively safer areas. Moreover, while the harmful effects of the war on the environment were direct and immediate, the factors that have a beneficial conservation effect were indirect and long-term in nature.

3.6 Summary

This chapter describes the precarious conditions of the rural population in Eritrea in general and in the Central Highlands in particular. The present conditions of the agricultural and energy sectors are described and the linkages between these sectors and the problem of land degradation are highlighted. High population density, rugged topography, erratic rainfall, traditional farming practices that make little use of external inputs and land degradation result in a low and declining agricultural productivity. Farmers in the Central Highlands of Eritrea try to meet the subsistence requirements of the growing population by expansion of cultivated land to fragile steep-slope areas and by shortening of fallow periods – a traditional method of restoring land productivity. As a result of this and the topographic and climatic conditions, the Central Highlands suffer from a severe land degradation problem. The energy sector also constitutes another key link between the economy and the environment. Biomass fuels such as fuelwood, dung and crop residues are the major sources of domestic energy in Eritrea. The use of wood for fuel and construction of traditional houses as well as the expansion of croplands has made most parts of the Cetral Highlands devoid of any vegetation. Dung and crop residues are almost exclusively used for fuel and animal feed depriving croplands from traditional sources of nutrients.

Soil erosion, nutrient depletion and deforestation are the major types of land degradation in the country. Various public projects in the form of Food for Work and Cash for Work programs, mobilization of students and other extension activities are underway to restore and/or prevent further deterioration of the environment. The government is also making efforts to increase agricultural productivity, among other things, by distributing seeds and chemical fertilizers at highly subsidized prices and often on credit, as well as by provision of tractor and extension services. Socio-economic, institutional and political conditions, however, hinder the adoption of new technologies by farmers and the success of the public projects.