Poverty and natural resource management in the Central Highlands of Eritrea

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Chapter 5

The Field Research

5.1 Introduction

The use of mathematical modelling to understand farmers' decisions and to explore the impacts of technological and policy changes on rural income and the environment involves the identification and estimation of a large number of socio-economic and biophysical parameters. Unfortunately, most of the data required are either not available or, when available, not at the desired scale. For example, an estimate of the average size of farm is available for the highlands of Eritrea, but not at the village level. As much as possible effort was made to collect data from secondary sources. However, due to decades of war no systematic and coherent set of data required to undertake a study of farmers' strategies was available.

Field research was undertaken to obtain parameters relating to household resource endowments and labour and oxen requirements for various activities as well as to explore cultural and institutional conditions that influence their decisions. Moreover, farmers' awareness of the risks of land degradation on their farms and their perception of the impacts of new technologies and land management practices such as the application of fertilizer and stone bunds is explored.

Field research for this study took place from April 2002 to March 2003 in various villages in the Central Highlands of Eritrea. The fieldwork involved household surveys, field measurements of the size of croplands, land type and land use classification of study villages, as well as estimation of biomass production from Eucalyptus plantations in the study area.

5.2 Methodology of the field research

Three subregions were first identified in the Central Highlands based on characteristics such as topography, market access and the availability of off-farm job opportunity. We refer to these three subregions as Zoba Debub East

(ZDE), Zoba Debub West (ZDW) and Zoba Maekel (ZM) based on their relative location in the Central Highlands of the country[12]. Then out of a list of all villages in the country prepared by the Ministry of Local Government (2000) three villages were randomly selected in each of the above mentioned subregions. In each village thirty farm households were, then, randomly selected for the general survey. So, in total 9 villages and 270 farm households were included in the general survey. In addition, three villages - one village in each of the three subregions - were again selected where in-depth interviews were undertaken with ten households. The objectives of the general and in-depth surveys as well as the type of information collected are described in the following sub-sections.

Three interviewers, two graduate assistants from the College of Business and Economics, of the University of Asmara, and one third-year student from the same university participated in conducting the surveys. Prior to a pilot testing of the questionnaire, the interviewers were given some training. All the questions were discussed in detail with the interviewers to ensure that they understand the questions properly. Then a pilot survey involving 20 farmers was carried out in two villages. This helped to test and adjust the questionnaire and to further train the enumerators. In total 270 questionnaires were completed.

5.2.1 General farm household survey

In the general household survey which was conducted in the 9 villages (three villages in each of Zoba Debub East, Zoba Debub West and Zoba Maekel)[13] information was collected on farm resources, the activities performed by members of the rural households, household consumption habits particularly with regard to food and use of energy, households' perception of the quality of their farms and erosion risk etc. Such information is to be used to determine the quantity and quality of resources households are endowed with, to describe the present production and consumption situations, which are important to deduce household objectives and factors constraining their decisions.

Whenever possible, we tried to contact the head of the household for an interview. However, due to the fact that a large part of the population were mobilized due to the border conflict with Ethiopia, this was difficult. Thus, when it was not possible to meet the head of the household, any adult member of the household was interviewed. If both the head of the household and his spouse

[12] As the subregions cover large areas, the topography, market access and off-farm job opportunities vary within a given sub-region as well.

[13] The villages where the general survey has been undertaken are Mai Harasat, Hadida, Awlietsoru, Adi Baro, Adi Merkeja, Biet Gebriel, Ametsi, Zigb and Adi Qontsi.

(or any other adult member) were present, both of them were made to listen to the questions and both could respond.

5.2.2 In-depth farm household survey

Three villages, Maiaha, Zibanuna and Embaderho representing the three regions of ZDE, ZDW and ZM respectively have been selected for an in-depth study. Ten farm households from each village were included in this survey. The survey involved a physical measurement of the size of each and every plot cultivated by the respondents as well as detailed interview with the heads of the households. As the farmers had to guide the enumerators to all their crop fields, sometimes up to 6 kilometres apart, they were given a small financial incentive.

The detailed questions in this survey dealt particularly with inputs and outputs in crop production. Each household was asked to give a detailed description of each plot of cultivated land, including the frequencies of ploughing and weeding, the length of time each activity took, the amount of seed and fertilizer used and the production from each plot. This information was then combined with physical measurements of the size of each plot to determine the input-output coefficients (yields, labour input per hectare etc.) needed in the mathematical model developed in the next chapter. More detailed information was also asked on time allocation of households as well as cash expenditures made on crop and livestock activities.

5.2.3 Field measurements

In addition to the household surveys, the field research included some field measurements. The field measurements included the classification of land into various categories of land use and land capability, which was carried out by land use experts in the Ministry of Land Water and Environment and estimation of biomass production from eucalyptus plantations and natural woodland, which were carried out by senior students in the Department of Forestry, University of Asmara.

While secondary data on slope of land, soil depth and soil type, which determine the suitability of land for various kinds of activities, are available at a regional levels, such data are not available for most villages in Eritrea. Thus land use experts from the Ministry of Land Water and Environment helped to prepare land use and land-capability classification of two of the three villages (Maiaha and Zibanuna). Similar land classification was already available from the above ministry for Embaderho. The land capability classification is based on a widely used system of land evaluation developed by the United States Department of Agriculture. The classification is mainly based on soil depth and slope and indicates the extent of physical limitations of a given land to crop growth.

According to this system, land is classified into eight classes. For the purpose of our analysis, however, the number of land categories is reduced into four classes (Section 7.2).

Despite the fact that projects of afforestation have been undertaken in the highlands of Eritrea for decades, the rate of growth of various species of trees (or volume of wood produced per hectare) has never been monitored. This is mainly because the projects' objective was largely soil conservation and not production of wood (FAO, 1997). Thus, after consultations with the head of the Department of Forestry at the University of Asmara, we agreed that three senior students from the department would undertake their senior project on biomass yield of Eucalyptus plantations in the Central Highlands of the country under his supervision. The results are used to compare data obtained from secondary sources (Section 7.7).

The students took two sites in the Central Region (Zoba Maekel), which had been afforested since 1992 and 1993. The whole forest plantation areas in the two sites were divided into six plantation stands based on age. From each stand two representative blocks were selected. In each block the students took two sample areas of 300 m^2 and the number of eucalyptus trees in each sample area were counted. The diameter at breast height (dbh), total height and bole height of each tree were measured using diameter tape and telescopic stick. In addition, the physical condition of each block (slope and conservation measure applied) was recorded. Based on the above information the students could estimate, among other things, the mean annual increment of eucalyptus trees (Ermias *et al.,* 2003). The same students have also taken a case study of a certain permanent closure in the Zoba Maekel 16 km south of Asmara to estimate the biomass production of acacia woodlands in the Central Highlands of Eritrea. Research results from this study together with estimates from similar environments in the region will be used to estimate biomass production from eucalyptus plantations and natural woodlands.

5.3 The research area and the research villages

5.3.1 The Central Highlands of Eritrea

The Central Highlands of Eritrea cover areas with an altitude of 1500 meters and higher above sea level and average annual rainfall of 500 mm. This zone enjoys for the most part a warm to cool semi-arid climate and comprises a number of sub-zones that have common major crops but differ in altitude, annual precipitation, relief, soils, population pressure and degree of environmental degradation. According to past administrative classification, this zone comprises the three provinces of Akelguzai, Hamasen, and Seraye or according to the

current administrative classification of the country, Zoba Debub and Zoba Maekel (which literally mean southern region and central region respectively) and a small part of Zoba Anseba. When we refer to the Central Highlands in this area we refer to the Central and Southern Zones only.

The number of households, the total land area per household and the cropland per household in the various sub-zones of the Central and Southern Zones are presented in Table 5.1. Zoba Debub consists of 12 sub-zones and 894 villages and Zoba Maekel consists of four sub-zones and 98 villages.

The Central Highlands cover a total area of approximately 1.01 million ha, which is 8.38% of the total land area of the country. The area under cultivation is 240,112 ha or 23.7% of the total. The total rural population is about 740,000 resulting in a population density of 73 persons per square km. This is much higher than the national average of 32 persons per square kilometre. The average total land and average cultivated land are 5.47 and 1.32 ha per household respectively.

Table 5.1 Land and rural population in the Central Highlands, 2000**.**

Sub-Zoba	Total area (ha)	Agr'l[14] land (ha)	Total population	Total number of households	Total land /hh (ha)	Agr'l land /hh (ha)
Zoba Debub	**928130**	**186150**	**598332**	**149752**	**6.05**	**1.24**
Adi Keih	57118	5903	42279	10414	5.48	0.57
Segeneiti	75226	9050	36663	9520	7.90	0.95
Tsorona	74600	8204	30352	7275	10.25	1.13
Dekemhara	42542	9600	44500	11118	3.83	0.86
Mai Aini	82300	11081	30713	7508	10.96	1.48
Senafe	121044	10601	84322	24604	4.91	0.43
Areza	135751	27885	62563	15043	9.02	1.85
Emni Haili	44166	17867	45757	12082	3.66	1.48
Adi Quala	102350	22200	61449	14855	6.89	1.49
Mendefera	28297	11095	42906	10477	2.70	1.06
Mai Mine	68264	25930	49861	11576	5.89	2.24
Dibaruwa	96472	26734	66967	15280	6.31	1.75
Zoba Maekel	**107907**	**53962**	**140967**	**31893**	**3.38**	**1.69**
Berik	27219	17631	32808	6609	4.12	2.67
Serejeka	27254	10138	43989	10456	2.61	0.97
Gala Nefhi	40414	23011	40754	8974	4.50	2.56
Asmara	13020	3182	23416	5854	2.22	0.54
Total	**1013171**	**240112**	**739299**	**181645**	**5.47**	**1.32**

Source: MOA, (2000a); MOA, (2000b).

[14] We use the terms agricultural land, cultivated land, and cropland interchangeably to refer to the total are of land allotted to farmers for cultivation. This includes both the land cultivated in the current period as well as land, which is left fallow for a year or two.

The topography, land use and population density vary considerably from one sub-zone to another. The proportion of total cultivated land as a percentage of total land varies from 10% in Adi Keih to 64% in Sub Zone Berik. The total area of land per household varies from 2.22 ha in Asmara Sub Zone to 10.96 ha in Mai Aini. The respective average total and agricultural lands are 6.05 and 1.24 in Zoba Debub and 3.38 and 1.69 in the Zoba Maekel.

5.3.2 The research villages

As discussed in section 5.2 we have taken three subregions in the Central Highlands each representing different biophysical and/or socio-economic situations – ZDE, ZDW and ZM. We have also selected three villages for an in-depth study representing the three subregions - Maiaha, Zibanuna, and Embaderho. In this section we will provide a brief description of the three villages.

Maiaha – This village is one of the 41 villages in the sub-zone of Segeneiti and it is located at 15^0 03' North latitude and 39^0 06' East longitude about 60 km southeast of Asmara. The total land area is 1037 ha of which 249.27 ha (24%) is currently cultivated. The rest is grazing land with scattered trees (bushes) mostly dominated by acacia. The topography of the land is highly rugged with most of the land not suitable for crop production (see Annex 1). The total number of households in the village is 190 of which 35 are female-headed. The average land and average cropland per household are 5.46 and 1.31 hectares respectively.

In terms of infrastructure, Maiaha is a typical village in the Central Highlands of the country with no access to electricity, current water, schools, health centres, grinding mills and postal and telecommunication services. There are neither dams nor wells in the village. People, therefore, fetch water from a stream at a five-to-ten minutes walking distance. Fetching water remains mostly women's task. When ever available, donkeys are used to transport water; otherwise women use a 20-litre jerrican, which they carry on their back. Both humans and livestock use the stream. Shortage of water for drinking and other household uses is not a problem in the village. However, the fact that both livestock and humans use the stream, and that the same river is used for cleaning, may expose the people to water-related health problems. In addition, as the river is the only source of water throughout the year, livestock have to be trekked to the river at noon and back to the grazing lands which can sometimes be a long distance contributing negatively to their weight. Whether there is sufficient water that can allow irrigation in the village is not known yet. Recently, one person has started irrigating a small plot of land by pumping water from the stream.

Residents of the village have to travel to a health centre in Hadida – a village about 8 km south of Asmara - for health service. When people have more serious health problems, people are referred to a hospital in Segeneiti town, which is at a distance of 20 km from the village. Similarly, pupils from this village have to travel a long distance for schooling. There is not even an elementary school in the village so children have to travel more than six kilometres to Halibo Elementary School. There is no transport facility connecting Halibo and Maiaha villages. As children at early age cannot make a round trip of 12 kilometres every day, they are obliged to start schooling late. For junior high school education youngsters have to go to Hadida village and for a high-school they have to go to Segeneiti or Dekemhare towns, which are about 20 kilometres away. As making a round trip walking of 40 km per day is very difficult, students have often to depend on relatives living in those towns or organize themselves in groups and rent a room together, which involves expenses that only few can afford to incur.

A new all-weather gravel top road has been built after independence, which passes through Maiaha. As a result there is now a bus making a daily (some times two to three round) tour to Dekemhare – the major market centre in the region. However, due to the long waiting time and to spare transport fee many people still walk on foot to the market centre as well as to the neighbouring villages. The distance from the nearest paved (asphalted) road is about 10 kilometres.

Land is communally owned in Maiaha. There is a land committee, which is responsible for classifying the village land among different uses (cropland, grazing land etc.) and allocation of cropland to the households in the village. There are also sub-committees responsible for specific activities in the process of allocation of croplands. These sub-committees include the screening committee which is responsible for the identification of households eligible for a full or half share (*gibri*)[15], and the distributing committee which are responsible for classifying the total village cropland according to soil quality (taking soil type and slope into account). The land distributing committee divides the total agricultural land into blocks of land to be distributed to groups of households. For example, the total number of household in the village (about 200 households) is divided into 10 groups each group containing 20 households. The total cropland in the village is also divided into ten blocks – one for each group of household. Finally each group of households selects their own distributors to divide each block into equal units of land and makes it ready for final drawing of lots. This way each household gets its share of cropland in the village.

[15] As discussed in chapter two, all households with more than one member get the same size of land (full share or gibri) but households with only one member get only half of that size.

Maiaha, as most villages in the Central Highlands of Eritrea, has well established community rules and regulations for the use of woodlands and grazing lands. A watchman (known as *Nebera*) is appointed to see that the rules and regulations are respected. To allow regeneration of grasses, grazing lands are open for grazing in rotations in different periods of the year i.e. different parts of the grazing land are restricted and then opened for grazing in different months of the year. Some grazing land (known as *Hizaeti B'eray*), after being restricted for grazing for about eight months, is open for grazing exclusively for oxen, for some time before it is open to other types of livestock. Livestock are not allowed to graze around croplands during the growing season and livestock from neighbouring villages are not allowed to graze in the village territory. The *Nebera* (also known as *Zer'ay* in other parts of the Central Highlands) is responsible to see to it that all the above guidelines are respected. Trespassers, if found, are fined in kind (usually 2 to 4 kg of grain), which the watchman can keep for personal use. In addition, each farming household in the village pays in kind for the services of the watchman at the time of the harvest.

Maiaha has a relatively vast area of degraded woodland mainly dominated by acacia. In the past cutting of live trees was allowed with permission from village elders on occasions of wedding ceremonies, memorial of the dead, construction of houses for newly formed families and maintenance of the traditional houses called *Hidmo*[16]. Without such permissions, the cutting of live trees was forbidden but people can collect dry wood (or cut dead trees) for fuel. However, people who do not belong to the village were not allowed to cut trees or to collect dead wood in the village's territory. The watchman was expected to make a frequent tour of the woodlands and ensure that the rules were not breached.

After independence, the government, in its effort to control land degradation, has taken over the responsibility of managing the woodlands by appointing a watchman who is paid by the government. It is now illegal to cut live trees for whatever purpose. Trespassers are fined in cash and the regional office of the Department of Forestry and Wildlife in the Ministry of Agriculture collects the fine.

Zibanuna – This is a village located at 14^0 54' North latitude and 38^0 48' East longitude in the Mendefera sub-zone 63 km south of Asmara. Zibanuna is located in the most fertile areas of the Central Highlands of Eritrea where the topography is mostly flat and soils very deep. The total land area is 829.28 ha

[16] Hidmo is a typical traditional house in the Central Highlands where the walls are mostly built of stones but requires considerable amount of woods for the roof and the poles supporting it. This is often considered among the major factors causing deforestation in Eritrea (Atzbaha et al, 1998)

more than 40 % of which is currently cultivated. The area is almost entirely devoid of natural vegetation but plantations cover about 2.6 percent of the land. Grazing land covers for 8.65 percent of the total land area. The village has 278 households. Female-headed households constitute 33 % of the total households. The average land and average cropland in the village is 2.98 and 2.34 ha per household respectively.

In terms of infrastructure, the village being located close to Mendefera (the capital of Zoba Debub), is in a better position than most other villages in the study area. An asphalted road connecting Asmara and Adi Quala passes only half a kilometre from the village. The village has one elementary school, and the famous San Georgo high school of Mendefera is located on this village's land only two and half kilometres from the village. Similarly, although the village does not have its own health centre, grinding mills, telecommunication and postal services, etc. the residents of the village need only to travel less than 6 kilometres to get such services in Mendefera.

There is no current water in the village, but there are some wells and one dam and there is no acute shortage of water. An attempt to use the dam for irrigation purposes in the past caused the reservoir to dry before the arrival of the rainy season. Since then the water of the reservoir is exclusively used for drinking (humans and livestock) and other household uses, the wells are used for irrigation purposes. Those who engage in irrigation have to dig their own wells or to share the wells with others. Zibanuna is one of the villages were irrigation is relatively much practised in the Central Highlands of the country.

Three decades back land was privately (family) owned in Zibanuna. However with the coming to power of the socialist government of the Ethiopian Military regime in 1974, the communal land ownership system known as *diessa* was introduced. The way now land is distributed among members of the village in Zibanuna is similar to what we have discussed for Maiaha above.

Embaderho – This village is located at 15^0 23' North latitude, and 38^0 53' East longitude 12 km north of Asmara. The village is found in the Central Zone, Serejeka sub-zone. The topography is rugged with considerable part of the land marginally suitable for cultivation. The land is totally devoid of natural woodlands apart from 46 ha of eucalyptus plantations. The total cultivated land is about 1052 ha which is about 44 % of the total area (2404.69 ha). Embaderho is one of the largest villages in the Central Highlands of Eritrea with 1400 farming households. Female-headed households constitute about 30 percent of the households.

Embaderho has relatively better infrastructure compared to most villages in the Central Highlands. An asphalted road that connects Asmara and Keren passes through the village; a public transport as well as private busses passing through the village to Serejeka provides a relatively continuous transport service to the village. The village has been connected to electricity since mid 1980s. However, with the exception of few small businesses, electricity in this village is still used solely for lightening purposes. There are few small businesses in the village including groceries, bars and a small firm producing sand bricks.

Despite the fact that Embaderho is a large village with about 5600 inhabitants, it has only one elementary school and no junior or high school. Thus students have to travel to Beleza, a neighbouring village 6 kilometres away, for a junior high school and to Asmara for high school education. Other essential services such as health centre and a grinding mill are not available in the village.

Although there is no shortage of water in the village, there is no pipe water. There is one large reservoir, covering an area of 15.3 ha, and two small reservoirs covering a total area of 8.1 ha in the village. In addition, there is one stream and one well. The large dam is in a restricted area and is not used for any purpose. The two small dams are used as a source of drinking water for livestock and humans, other household uses as well as for irrigation. Irrigated farming is relatively a common practice in Embaderho mainly due to the relative abundance of water and the proximity of the village to the Asmara market. Shortage of motor pumps and shortage of labour are the major current constraints to irrigation in the village.

Land is communally owned and managed in Embaderho as in most parts of the Central Highlands. The Diesa system of land distribution is similar to what has been described above for Maiaha village.

5.4 Household resources

5.4.1 Labour

In the Central Highlands of Eritrea, where members of the household do almost all farming activities, the supply of labour for agricultural and other activities is determined by the size of the family and its composition. Men, women and children engage in most economic activities as weeding, harvesting, transporting crops and straw, tending and milking livestock, collecting fuel wood, marketing etc. However there are few activities that require particularly adult male labour such as ploughing and tending livestock when they migrate outside the village. There are also some activities that are traditionally women's tasks such as

childcare and food preparation. Table 5.2 shows average family size and the age distribution of the population in the study area.

Table 5.2 Family size and household composition (2002)

	Sample size	Female-headed (%)	Family Size			Age groups (%)			
			Average	Min	Max	0-10	10-18	18-75	>75
ZDE	90	16	5.17	1	14	30	27	35	8
ZDW	90	21	5.98	1	12	28	30	40	2
ZM	90	12	6.27	1	13	29	28	39	4
Mean		16	5.74			29	28.3	38	4.7

Source: Own General Survey (2002)

The average family size is 5.74 ranging from 5.17 in ZDE to 6.27 in ZM. These figures are higher than the average family size in various regions of the Central Highlands, which ranges between 4 and 5 persons per household (FAO, 1994; KHC, 1996; MOA, 2000b). This is most probably a result of a lower proportion of female-headed households included in the sample. While female-headed households constitute 32 percent of all households in the survey villages, only 16 percent of the respondents were female-headed in our survey. The average family size for the female-headed households included in the general survey was 2.64. Similarly, a study by Kale Hiwet Church (1996) in four sub-zones in Zoba Debub shows that the average household size differs substantially between the male-headed households (5.9 members) and female-headed households (3.3 members). The major reason for the high proportion of female-headed households in the study area is the long war for independence and the recent border war, which costed the country tens of thousands lives.

The last four columns of Table 5.2 show the distribution of the population by age groups. The classification is made in such a way that it can help to determine the supply of labour for agricultural activities. The first and the last age groups, i.e. those below 10 years of age and those above 75 are considered to be economically non-active. This constitutes about 34 percent of the total population. The range of age for economically active population, 10 to 75, is based on the fact that children help with farming and other activities from early ages. This constitutes 66 percent of the population. Economically active adults, 18 to 75 years of age, constitute only 38 percent of the population.

Shortage of labour is a serious constraint both to crop as well as livestock production in the Central Highlands of Eritrea. The major cause shortage of labour is the thirty-year war of independence and the two year border conflict with Ethiopia that claimed tens of thousands of lives at the productive age group. This is reflected in the high proportion of female-headed households. The war has also made many more people to migrate. The shortage of labour is

exacerbated by the large number of religious holidays observed by the followers of the Orthodox Church, the dominant church in the Central Highlands, during which no major agricultural activity could be undertaken.

Rural households in the study area practise various ways to overcome this problem. Collaboration between family members and close relatives is the most important one. Various forms of labour-labour, labour-oxen, oxen-straw and sharecropping arrangements are also practised. For example, a female-headed household with no adult male may depend on a close relative who would cultivate her land for free, spend some days weeding or harvesting the farm of another household who would supply adult male labour to cultivate her land in exchange, or she would rent the land and get a share of the harvest. The share of harvest may vary from half to one quarter depending on whether she is sharing the cost of production such as labour, seeds and fertilizer. The rural labour market in most parts of the Central Highlands is not well developed. Very few farmers (except those engaged in irrigated agricultural activities) employ paid labour even during the peak agricultural season. However, in villages close to the major urban centres, a large number of farmers are engaged in off-farm employment.

5.4.2 Land

Land is an important resource for rural livelihoods in the Central Highlands of Eritrea. Generally croplands are very small and fragmented. Both the size and quality of land vary considerably from one region to the other. Table 5.3 shows the average size of cropland households own, the number of plots, the average distance from home to the plots, the overall quality of the croplands, the need for soil conservation structures (terracing) and the extent to which such structures are already applied in ZDE, ZDW and ZM.

Table 5.3 Croplands in the Central Highlands, 2002

	Zoba Debub East	Zoba Debub East	Zoba Maekel
Average Farm Size (t*simdi** per household)	3.7	3.8	3.2
Average Number of Plots per household	3.5	4.4	3.3
Average Distance from the village (km)	1.8	1.5	2.5
Fertile Soil type (% of all plots)	50.0	56.0	57.0
Moderate to Steep Slope (% of all plots)	33.0	28.0	31.0
Need for Conservation (% of all plots)	84.0	56.0	71.0
Conserved Land (% of all plots)	57.0	35.0	53.0

* *Tsimdi* (literally pair) is a traditional measure of the size of cropland which is approximately 0.25 ha.
Source: Own General Survey (2002).

The average cropland in all the three regions (ZDE, ZDW and ZM) is less than one hectare per household. This is lower than the average cropland in the Central Highlands (about 1.32 ha per household) presented in table 5.1. As the size of land varies from one village to the other, the discrepancy can be due to small number of villages included in the General survey (only 9 villages were included in the survey out of a total of 967 villages in the Central Highlands). Another reason can be that *tsimdi* is a subjective measure. Defined as the area of land a pair of oxen can plough in a day, *tsimdi* can vary depending on the strength of the oxen, the type of land, the length of working time in a day etc. In the in-depth survey, all plots of croplands of ten farmers each in Maiaha, Zibanuna and Embaderho were measured. The average croplands in the three villages were 1.23, 1.04 and 0.48 ha per household respectively.

Land fragmentation is often considered as a problem in agricultural production in many developing countries. The arguments against land fragmentation are based on the wastage of time travelling from one plot to the next and the loss of agricultural land to crop production due to large number of borders between plots. Land fragmentation is common throughout the Central Highlands. This is because in the Diesa system of communal land ownership each farmer is allotted land in different locations to ensure equity. The average number of plots reported varies from 3.3 in Zoba Maekel to 4.43 in Zoba Debub. In fact, farmers may have more plots of croplands because they often report all plots in a single block as one[17].

The last four rows in table 5.3 refer to farmers' perceptions regarding the quality of their land, the extent to which croplands are exposed to erosion, the need for soil conservation and whether croplands have the necessary conservation structures or not. Of all the plots of cropland 50 to 60 percent were reported to be fertile. Although land is generally more fertile in ZDW, the farmers' classification does not show significant differences on the proportion of fertile and non-fertile plots in the three regions. This is probably because farmers classify a given plot of land as fertile or otherwise relative to the other plots in the same village.

While farmers believe that less than one third of their farms have moderate to steep slopes, they still believe that a large proportion of their croplands need soil conservation structures. More than half of the croplands in ZDE and ZM and more than one third of those in ZDW were reported to be terraced already.

[17] The way croplands in a village are first divided into blocks, which are then, further sub divided into individual farms is described in 5.3.2.

Table 5.4 shows farmers' soil fertility classification of croplands in the three study villages of Maiaha, Zibanuna and Embaderho. The farmers classified their farms into different categories of fertility based on the colour and texture of the soils. These categories include highly fertile soils (*Walakha*), moderately fertile (*Dukha, Shiebet* or *Sibuh*) and poor soils (*Tsebaria, Rekik*, or *Fequis*)[18].

Table 5.4 Soil quality on croplands in Maiaha, Zibanuna and Embaderho (%), 2002

	Maiaha	Zibanuna	Embaderho
Walakha (fertile)	-	48	-
Dukha (moderately fertile)	32	21	65
Tsebaria (poor soil)	68	31	35

Source: Own In-depth Survey (2002).

As shown in Table 5.4 Maiaha has the poorest soils with 68 percent of all plots included in the survey being classified as Tsebaria and none as Walakha. On the other hand Zibanuna has the most fertile soils with 48 percent of the soils classified as Walakha and 31 percent as Tsebaria. Sixty five percent of the soils were Dukha and the rest Tsebaria.

5.5 Crop production

The types of crops grown vary from one region to another mainly due to variations in altitude and soil type. Even in a given region and village the types of crops grown vary from one year to the other due to the practice of crop rotation as well as the onset of rains. Land that is planned to be used for finger millet (which has a long growing period) may be used for maize or sorghum if rains start later and for taff, barley or wheat if the rain starts even later in the rainy season. Cereal crops such as barley, wheat, sorghum and millet and pulses such as beans and chickpeas are the dominant crops in ZDE and ZM. In ZDW, on the other hand, cereals such as barley, sorghum and taff and pulses such as chickpeas and field peas are the major crops. In addition to these crops, which are mainly dependent on rainfall, a small scale of irrigated vegetables production is practised in some villages of the Central Highlands particularly in ZDW and ZM.

Although the choice of crops is dictated by factors such as altitude, soil type and the onset of rains, generally farmers in the Central Highlands choose to grow more than one crop at a given year. This is mainly a strategy of spreading risk as the susceptibility to drought and the outbreak of pests vary for different crops. In

[18] Walakha refers to the most fertile soils with dark brown colour and a clay loamy texture. Dukha, is the next fertile soil with lighter red brown colour and loamy texture and Tsebaria is the least fertile land with high percentage of coarse gravel (FAO, 1994).

areas where maize can grow and the rains start early enough, farmers prefer to have at least one plot cultivated with maize. This is because maize can be ready for consumption at the end of August when the household is in a serious shortage of food and the other crops are not yet ready for harvest. Farmers also prefer to produce some crops that have a relatively higher market value. Whenever climatic and soil conditions, such as soil quality and altitude are suitable taff is the most important crop in this respect. Pulses and finger millet, the best crop for the local beer called *Siwa*, also have a strong market demand and a relatively higher price compared to many rain-fed crops grown in the Central Highlands.

5.5.1 Crop yield

Crop yields vary considerably from one region to another and even within a given region due to variations in rainfall, soil quality, use of fertilizer and other land management techniques. Table 5.5 shows a summary of crop yield from the in-depth survey in the three villages of Maiaha, Zibanuna and Embaderho. Although differences in the types of crops grown in the three villages makes yield comparison difficult for all crops, A comparison of the yields of crops grown in the study villages shows that Embaderho has the highest yield. For example, the yield of barley in 2001 was 648, 1052 and 2294 kg/ha in Maiaha, Zibanuna and Embaderho respectively. The comparison of yields of wheat and potatoes in Zibanuna and Embaderho also shows similar results. Wheat and potatoes had a yield of 1271 and 7290 kg/ha respectively in Embaderho compared to 995 and 5529 kg/ha respectively in Zibanuna. This is surprising given the generally more fertile land of Zibanuna. The explanation is the higher rates of fertilizer use in Embaderho (see Section 5.5.3). The higher altitude of Embaderho, which results in a cooler temperature and hence lower evapotranspiration, also contributes to the relatively higher yields.

Table 5.5 Crop yield (kg/ha), 2001

Crops	Maiaha	Zibanuna	Embaderho
Sorghum	680.8	836.1	
Maize	1064.2		
Barley	649.3	1052.1	2294.2
Millet	501.0		
Beans	606.0		1562.2
Wheat		995.9	1271.3
Taff		786.0	
Chick pea		790.0	
Potatoes		5529.0	7290.7

Source: Own In-depth Survey (2002).

A number of studies show that basic food requirement was not met in Eritrea in the last three decades. Cliffe (1992) estimates that food production in a normal year covers only 55-60 percent of the annual food requirement in the country (see chapter two). Households in the survey were asked whether there is a change in crop yield and crop production in the last 20 years and what factors were responsible for such changes. To determine the changes in crop yield and production, respondents were asked what the crop yields (per *tsimdi*) were and for how many months the total production used to feed the family 20 years back. The same questions were also asked for the present time. Table 5.6 shows farmers' perception of the changes in crop yield and changes in the number of months covered by farmers' own production.

Table 5.6 Farmers' perception of changes in cereal production and productivity

	Crop yield (100 kg/*tsimdi*)			Months covered by own production		
	Past (20 year ago)	Present	% Change	Past (20 year ago)	Present	% Change
ZDE	6.8	2.5	-62.6	10.3	4.5	-56.6
ZDW	4.8	1.9	-60.8	10.8	4.5	-58.3
ZM	7.1	4.0	-43.1	9.7	5.9	-38.8
Mean	6.3	2.8	-56.1	10.3	4.9	-51.9

Source: Own General Survey (2002).

The total production of crops per household could change because of changes in yield as well as changes in farm size. As shown in table 5.6 farmers believe that crop yield in the Central Highlands has declined by on average 56.1 percent in the last two decades. The change in crop yield varies from 43.1 percent in ZM (from 7.1 to 4.0 quintals/ha) to 62.6 percent in ZDE (from 6.8 to 2.5 quintals/ha). Similarly the number of months covered by farmers' own production has declined by about 52 percent in the Central Highlands ranging from 38.8 percent in ZM to 58.3 percent in ZDW. It is important to note that farmers in this region have never been self-sufficient but the gap between food production and food requirement has been getting wider through time. Currently farmers on average can cover only about five months of their food requirements from their own production.

The results of the survey indicate that farmers believe that the major factor contributing to the decline in crop yield is shortage of rain (mentioned by 57 percent of all respondents) followed by shortage of labour (mentioned by 27 percent of the respondents). Declining land productivity due to soil erosion, reduced fallow and nutrient depletion is often cited as a cause of declining yields in the Central Highlands of Eritrea (see Chapter two). A significant number of the respondents referred directly or indirectly to a decline in land productivity as a cause for the declining yields. A decline in land productivity, lack of manure, soil erosion and reduced fallow together were mentioned by 28 percent of the

respondents. A decline in land productivity was a relatively important factor for yield decline in ZDE, where it was mentioned by 30 percent of the respondents, followed by ZM and ZDW where 28 and 22 percent of all respondents mentioned it respectively. This is understandable given the fact that ZDE has the most rugged topography and the least use of fertilizer to make up for the nutrients lost through soil erosion and nutrient depletion.
Another important observation from Table 5.7 is that a large number of (31 percent) respondents in ZM reported that there was no decline in crop yield during the last two decades. With this finding and the relatively higher yields (Table 5.6), it seems that farmers in this region have managed to reduce the decline in crop yields by relatively better management of their land such as a higher use of fertilizer and longer fallow period as reported from Embaderho (a village representing ZM).

Table 5.7 Reasons for yield decline over the past 20 years

Factor	ZDE		ZDW		ZM		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Shortage of rain	43	48	52	58	43	48	153	57
Shortage of labour	32	36	12	13	17	19	72	27
Decline in land productivity	8	9	5	5.5	6	6.7	24	9
Lack of manure	6	6.7	5	5.5	7	7.7	20	7
Erosion	5	5.5	5	5.5	1	1	11	4
Less fallowing	8	9	5	5.5	8	9	21	8
Other (lack of oxen, weeds, pests etc)	3	3.3	7	8.0	2	2	12	5
No decline	3	3.3	11	12	28	31	33	18

Source: Own General Survey (2002).

5.5.2 Labour and oxen requirement

Almost all crop production activities in the highlands of Eritrea are labour intensive, which are performed with the help of animal power and simple tools. The availability of labour and oxen determines the success of crop production because as the rainy season is very short in Eritrea the timeliness of the various farming activities and particularly sowing is critical. Since most of the farmers in the Central Highlands of Eritrea are followers of the Orthodox Church, they observe a number of days dedicated to the saints including Saturday and Sunday. No major farming activity such as ploughing, weeding, harvesting and threshing can be performed on these days. This considerably reduces the number of days farmers can work and thereby increasing the number of people and oxen required to do the jobs at the right time.

The average amount of labour required to cultivate one hectare of land is calculated based on the number of times each activity is done on every plot of cropland of the farmers included in the intensive survey and the amount of time that activity took. Table 5.8 shows labour requirement for the various farming activities. The frequencies of weeding and ploughing do not considerably differ

in the three villages. The average number of times of ploughing (which includes land preparation and sowing) is approximately three. The number of ploughings required varies from one crop to the other. Generally taff requires a finer seed preparation and hence a larger number of times of ploughings. On the other hand, sorghum and pulses are reported to need the least number of ploughings.

The number of mandays required to do each farming activity per ha varies considerably from one village to the other. For example, Zibanuna has the lowest number of days needed to plough one hectare of land, probably because of the more fertile deeper soils. The lowest number of days to weed a hectare of land, on the other hand, was in Maiaha. This may probably be due to different level of weed infestation or the thoroughness of weeding done in the three villages. Finally, the mandays required for harvesting, threshing and transporting were the highest in Embaderho followed by Zibanuna. This is most probably due to the higher yields in those villages.

Table 5.8 Labour requirements for crop production

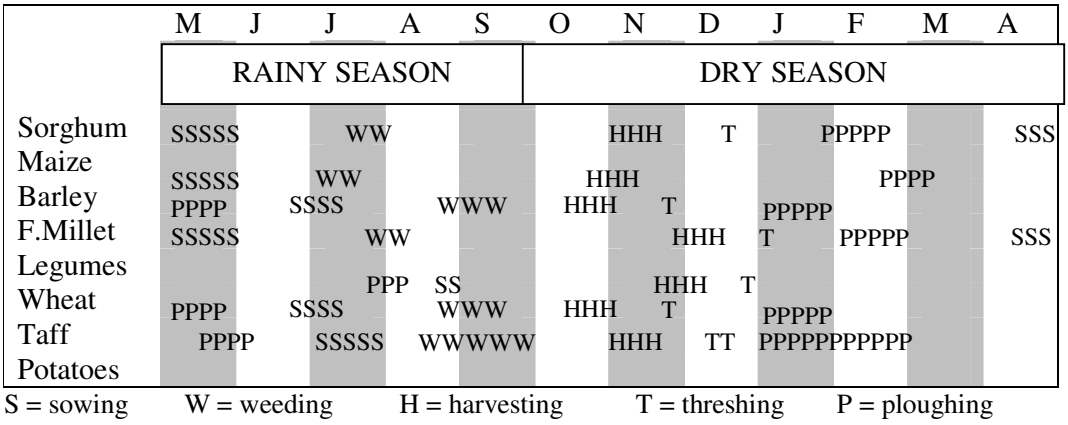
	Ploughing md/ha (a)	Av. No. ploughing (b)	Weeding md/ha (c)	Av. No weeding (d)	Harvesting md/ha (e)	Threshing & Transport md/ha (f)	Total* md/ha (g)
Maiaha	6.79	2.97	17.49	1.45	13.27	12.40	71.60
Zibanuna	3.55	3.20	32.85	1.42	29.93	16.95	104.89
Embaderho	6.91	2.79	34.86	1.13	30.13	31.99	120.79

g = (a*b) + (c*d) + e + f

Source: Own In-depth Survey (2002)

Both ploughing and threshing involve oxen power besides labour. For every manday of ploughing a pair of oxen is involved. The ratio between labour and oxen is not so definite for threshing as for ploughing, because for threshing three to five or even more oxen may be involved. But on average two people and about four oxen are involved in threshing and the ratio of two oxen for one person is a reasonable approximation for threshing as well. In addition to the amount of labour and oxen required to work one hectare of land, the length of period in which the job has to be done is also important to determine the extent to which the availability of these resources constrain crop production. While some activities such as land preparation can be done in an extended period of time (during the dry season), other activities such as sowing, weeding and harvesting have to be done in a relatively short period of time. The cropping calendar presented in Figure 5.1 shows the period in which different farming activities are undertaken in the Central Highlands of Eritrea.

Figure 5.1 Cropping calendar in the Central Highlands



5.5.3 Land management practices

Farmers in the Central Highlands of Eritrea practise various land management techniques to maintain and improve crop yield. These practices include fallowing, crop rotation, applying manure and chemical fertilizers as well as undertaking soil conservation activities. The extent and frequency of the above activities vary considerably from one region to another.

Fallowing

This practice is a widely used means of restoring land productivity in most parts of the highlands of Eritrea. In fact, when sufficient period of fallow is adopted this strategy also allows the regeneration of vegetation cover. Two methods of fallowing are practised in the Central Highlands of Eritrea. The first is a situation where land is left without any crop for one year. At the end of the rainy season in the fallow year (end of August or early September), the land is ploughed to increase water infiltration and to incorporate the grass as green manure. In the second case of fallowing, after staying idle for the most part of the rainy season, the land is used to grow chickpeas, which is believed to improve soil fertility. Although, due to the shortage of land the second type of fallowing is becoming common, farmers believe that the former one is more effective in restoring soil fertility.

When land is left fallow, it is used as grazing area for livestock. Thus, the decision whether and which parts of the croplands should remain fallow is made at a village level and not at the farm household level. In order to avoid the damage of crops by livestock, all croplands in a certain location are left fallow at the same year and once that location is declared fallow for the year, no farmer is allowed to cultivate his farm located in that area.

The frequency of fallowing and the number of years the land remains fallow vary from one village to another as well as between various croplands in the same village. In most villages land is cultivated two to three years before it is left fallow for one year. In many villages in ZDW, where land is relatively more fertile, fallowing is not practised at all. All croplands are cultivated continuously. In the other two regions, ZDE and ZM, fallowing is practised on most of the croplands except on the plots adjacent to the village (dwelling area) known as *Gedena*. These parts of the croplands are relatively more fertile because household waste and manure that are washed away from the village surroundings rest on them. In addition, if farmers have some manure, they first apply it on these plots because of their proximity to the village. When rains start early, *Gedena* is used to cultivate maize (and potatoes in some villages in ZM).

In only two of the nine villages included in the general survey longer fallow periods (up to six years) were used until recently. In fact, in one village (Awlie Tseru) in ZDE farmers complained that the Ministry of Agriculture prohibited them to cultivate their former cropland which they fallowed for six years. This is because the land is now covered with bushes and it is not allowed to cut trees.

In Embaderho croplands are cultivated for two to three years and then left fallow for the next two years. Farmers in Embaderho reported that they used to cultivate their land for three years before leaving it fallow for one year in the past but this has changed recently. The reason for leaving the land fallow for a second year, which was not observed in other villages, was shortage of grazing land. This is an interesting phenomenon because with higher population pressure it is expected that land is cultivated more frequently such that the length of the fallow period gets shorter and shorter. Asked if farmers noticed any change in the frequency and length of the fallow period, farmers in the remaining villages included in the general survey did not remember such change.

Crop Rotation

Crop rotation is another widely used practice in the highlands of Eritrea. All farmers in all villages and regions reported that they use crop rotation. However the type of crop cultivated is dictated very much by the onset of the rainy season as well as seed availability that farmers do not always stick to the sequence of crops. They often grow the same crop year after year. The major types of crop rotation in the three regions include:

ZDE	Barley – Sorghum or Finger Millet – Barley or Sorghum – Fallow
ZDW	Sorghum – Chickpeas or Taff – Barley and/or Wheat - Sorghum
ZM	Barley – Wheat or Beans – Fallow - Fallow

Crop rotation and fallowing practices are arranged in such a way that land redistribution will take place during the second fallow period. That is once farmers obtain a cropland they cultivate it for three years, leave it fallow for one year, and then cultivate it for the next three years. During the 8th year the land is left fallow again and land redistribution takes place during this year.

Intercropping is not a common practice in the Central Highlands of Eritrea except for barley and wheat.[19] The main reason for mixing the two crops is the better quality of bread the mixed crop makes than barley alone and the higher yield it gives than wheat alone. In fewer cases mixed cropping of Finger millet and sorghum is practised as well.

Fertilizers

Application of manure on croplands is one of the commonly used practices of restoring soil fertility in the Central Highlands of Eritrea. However, the amount of manure farmers apply on their croplands is very limited mainly due to the limited number of livestock they keep and the use of manure for fuel. Farm households often collect the manure, particularly from cattle, dropped on croplands and grazing areas for use as a fuel. Manure from cattle that is dropped at home at night is also dried and carefully stored for use as fuel in the dry season. In addition, farmers do not make serious effort to maintain the quality of manure by applying storage and utilization practices that would minimize nutrient losses and make the nutrients readily available to the plants. The manure is collected from the house compound (where livestock are usually kept overnight) and piled just outside the compound for months until they are taken to the field. This manure together with other household waste, ashes and leftovers of crop residues from livestock are transported to the field before the onset of the rainy season and ploughed into the soil.

The use of chemical fertilizers is very low in Eritrea. The average rate of chemical fertilizer applied was 20 kg per ha in 2001 (10,200 tons on 497,530 ha cultivated in 2001). This is very low even by Sub-Sahara African standards. Table 5.9 shows the type and extent of fertilizer use in the three study villages. The use of manure is generally low in all the villages but farmers in Zibanuna used even less manure with only 12 percent of all plots cultivated with the application of manure. This due to the fact that most of the land in this village is suitable for cultivation and hence, there is acute shortage of grazing land. As a result farmers in this village own smaller number of livestock (particularly sheep and goats) and therefore less manure is available. The application of chemical fertilizer, on the other hand, is relatively higher in Embaderho and Zibanuna.

[19] The mixed crop from barley and wheat is known as *Hanfets*.

The average amount of chemical fertilizer applied on fertilized plots in Embaderho and Zibanuna is 84 and 65 kg per ha respectively. The recommended rate of application of chemical fertilizer in the Central Highlands of Eritrea is 100 to 150 kg per ha (Barbier 2001). The use of chemical fertilizer is very low in Maiaha where it was applied only on 9 percent of all plots cultivated in 2001.

Table 5.9 The use of manure and chemical fertilizers

	Manure		Chemical Fertilizer		
	% of farmers	% of plots	% of farmers	% of plots	Average Qty applied Kg/ha
Embaderho	80	29	90	60	84
Maiaha	80	33	30	9	50
Zibanuna	40	12	100	58	65

Source: Own In-depth Survey (2002).

According to the farmers in the study areas the impact of manure and chemical fertilizers on crop yield is not very different. Farmers believe that the application of fertilizer (organic or inorganic) could increase yields by 125 to 150 percent. However, farmers said that manure is preferred to chemical fertilizer because while chemical fertilizer needs to be applied every year, manure once applied serves for two to three years. They also emphasized that the application of chemical fertilizer results in a higher yield only when there is sufficient rain.

In addition to manure and chemical fertilizer the use of municipal waste as fertilizer was reported in Embaderho. In this village, while chemical fertilizer is applied to most plots, manure and municipal wastes are particularly applied to the irrigated fields. The application of manure in all the study villages is done by donkey and camel loads and sometimes by renting trucks.

Soil Conservation Practices

Most of the soil conservation structures established with food-for-work programs is done on non-cropland hillsides. However, there exist some well-developed terraces on moderate to steep slope croplands that have been developed through time. It is common in many villages to find almost flat croplands in areas that have generally moderate slopes. This shows that farmers were very much aware of the erosion problem and used to take measures to prevent soil loss and conserve moisture. This is supported by a study in the Central Highlands of Eritrea that showed that about 70 percent of a total 300 respondents believed that their croplands suffer from moderate to high rates of soil erosion (Araya 1997). The same study also shows that more than 70 percent of the farmers believe that erosion considerably reduces yield. However, it has

been observed in the field study that croplands with very steep slopes have been cultivated without any physical soil conservation structures in ZDE and ZM.

Farmers in the study area generally believe that most of their croplands need some conservation measures. Table 5.10 summarizes farmers' perception on which of plots need soil conservation structure and which of the plots already have sufficient conservation structure in ZDE, ZDW and ZM.

Table 5.10 Farmers' perception on the need and extent of terracing on own croplands

	Plots that need soil conservation (%)	Plots that already have sufficient conservation structure (%)
ZDE	84	57
ZDW	56	35
ZM	71	53

Source: Own General Survey (2002).

Households in the survey have been questioned about the major constraints to undertake activities that improve lands productivity such as the use of fallowing, crop rotation, the application of manure and chemical fertilizers and terracing. Shortage of labour was the major constraint for the application of soil conservation structures and, next to the availability of manure, the second most important factor that hinders the application of manure. Lack of finance was the most important constraint to the application of chemical fertilizers. But lack of finance as a constraint for the application of chemical fertilizer is more pronounced in ZDE where it was mentioned by 62% percent of the respondents than in region two or three where only 38 and 18 percent respectively mentioned it as a constraint.

5.6 Livestock

Livestock production is very important to rural income and food security in Eritrea. The main species found in the study area are cattle, donkeys, sheep, goats and poultry. Farmers also keep some bees. Oxen and donkeys are important sources of draught power and transport. The other types of livestock are important sources of milk and meat for household consumption, as a source of cash, as well as security and investment. Another highly valuable animal product is dung, which is used as fuel and fertilizer.

Most farmers keep oxen and donkeys because of their importance in crop production and other activities. Table 5.11 shows that only 29.6 and 28.8 percent of the respondents owned no ox and no donkey respectively compared to 74.6 and 75.3 percent who did not own any cow or no sheep/goat respectively. This shows that when households, due to financial, labour or feed constraints, can not

keep more livestock, they prefer to keep working animals such as oxen and donkeys to other types of livestock.

Table 5.11 Ownership of Livestock in the Central Highlands, 2002

	Percentage of households who own		
	Zero	One	Two or more
Oxen	29.6	27.2	43.2
Donkeys	28.8	61.7	9.5
Cows	74.6	14.9	10.5
Sheep/goat	75.3	1.0	23.7

Source: Own General Survey (2002).

Both the composition and number of livestock are slightly different in ZDW compared to the other two regions. As this region has flat topography and fertile soils most of the land is used for crop cultivation. This means there is less grazing land and therefore lower number of livestock. The average number of tropical livestock unit for all regions is 2.18 ranging from 2.0 in ZDW to 2.3 in ZM. While ZDW has less of all types of livestock, the difference is more pronounced in the case of sheep and goat (Table 5.12).

Table 5.12 Ownership of livestock in the Central Highlands, by region 2002

	Oxen/ hh	Cow/hh	Donkey/ hh	Sheep/ Goat/hh	TLU/hh	Percentage of households with		
						No oxen	One oxen	Two or more
ZDE	1.25	0.46	0.72	2.68	2.20	30.0	31.1	38.9
ZDW	1.17	0.41	0.78	1.86	2.00	36.4	19.3	44.3
ZM	1.23	0.46	0.98	2.54	2.30	25.6	32.2	42.2
Mean	1.22	0.45	0.82	2.39	2.18	30.6	27.6	41.8

Source: Own General Survey (2002).

Table 5.13 shows the number of livestock in Maiaha, Zibanuna and Embaderho. As shown in the last column of the table, the existing number of livestock far exceeds the carrying capacity of the villages. The gap between the carrying capacity and the existing livestock is the largest in Embaderho followed by Maiaha and Zibanuna respectively. This clearly shows that shortage of animal feed is the most serious constraint for livestock production in the study villages.

The communal grazing land and crop residues are the major sources of animal feed in the study villages. Livestock are taken together to the communal grazing areas during the day and return to the homestead during the night where they are fed straw, which has been conserved after the harvest. The arable lands become an important grazing area for two to three months after harvest. The most difficult period is the end of the dry season, just before the arrival of the rains. Farmers try to keep enough straw for this period. Animal feed in most cases

must be supplemented by straw of barley wheat and taff for the months between March and August.

Table 5.13 Number of livestock and carrying capacity in Maiaha, Zibanuna and Embaderho, 2002

	Number of livestock				TLU	Carrying Capacity* TLU/village	TLU/carrying capacity
	Ox	Cow	Donkey	Sheep /goat			
Maiaha	300	405	100	500	683	170	4.02
Zibanuna	168	99	122	46	303	126	2.40
Embaderho	2500	400	800	2000	3380	385	8.78

* Carrying capacity is determined at 6 ha per TLU
Source: Respective village administration, (FAO, 1997).

Migration of livestock is a common strategy of alleviating feed shortage practised in most villages in the Central Highlands of Eritrea. Cattle are the main types of livestock that move from one place to another in different seasons although sheep and goats also sometimes move with the cattle. Livestock from Maiaha and Embaderho migrate to Semienawi Bahri[20] from December to June and to Barka and Gash basins in the western lowlands from July to August. The duration of the migration varies from one village to another and from one household to another household. But in some villages in ZM (including Embaderho) all livestock except oxen are required to migrate at least for one month (August). Households whose cattle migrate may either send one or more of the household members with the livestock[21] or find someone who would keep their livestock in return for the milk and manure from the cattle (if there are sufficient milking cows) or in return for a cash payment. Seasonal migration of livestock is not practised in Zibanuna. Farmers in Zibanuna supplement the shortage of animal feed by purchasing crop residues from the neighbouring villages. Even in ZDE and ZM the migration of livestock is declining due to shortage of labour and because most of children in rural areas these days are going to school. Despite the fact that households in all villages supplement the shortages of animal feed by migration or purchase of feed, there is acute shortage of feed in the Central Highlands of Eritrea so that animals are often underfed. This is reflected in the slower growth and lower weight of livestock.

Shortage of labour is another major constraint for livestock production in the region. Farmers in the study area deal with the problem of shortage of labour by keeping their livestock together. Mostly farmers form groups (consisting of

[20] Some times referred to just Bahri, Semienawi Bahri is a part of the green belt zone in the eastern escarpment that enjoys two seasons of rainfall in a year.
[21] When households migrate with their livestock to Semienawi Bahri, they do not only tend their livestock but also grow crops on own or rented land.

varying members depending on the number of livestock) and tend their livestock in rotations, where the number of days a household is responsible is proportional to their livestock. Alternatively farmers hire a village herder to care for their animals in a communal system, which costs them between three and four Nakfa per head per month. In addition, the households provide the meal of the herder in rotations.

5.7 Tree planting

As discussed in Chapter two, the vegetative cover in the highlands of Eritrea is highly degraded with most areas almost devoid of the natural vegetation. However, some acacia woodlands and bush lands still remain in many parts of the highlands. The three regions included in our study vary considerably in terms of land cover. ZDE has relatively better natural vegetation cover compared to ZDW and ZM. The possible reason for less natural vegetation in ZDW is, most likely, the use of land for annual crop production. This is because owing to the flat topography and fertile soils almost all the land in this region is favourable for crop production. On the other hand, the lower vegetative cover in ZM is the result of a higher population density and its proximity to the capital city. Information about the area under natural vegetation and the extent of vegetation cover for the various regions was not available.

Plantations of eucalyptus have been practised in the highlands of Eritrea for a long time. Most of the plantations have been done in the ZM (see chapter two). Communal as well as individual plantations exist both in Zibanuna and Embaderho villages. However there are no community plantations in Maiaha and individual trees are insignificant.

Table 5.14 Eucalyptus plantations in the study villages, 2002.

	Area under plantation (ha)	Average number of trees per HH	Maximum number of trees	Minimum number of trees	Farmers with no trees (%)
Maiaha	0.0	1.4	6	0	60
Zibanuna	21.5	15.6	50	0	20
Embaderho	46.9	26.0	70	0	40

Source: Own In-depth Survey (2002).

Table 5.14 shows the area under eucalyptus plantations and the number of trees farmers own in the three study villages. The area under eucalyptus plantations (communal and individual) in Zibanuna and Embaderho villages is 21.5 and 46.9 hectares respectively. This is about 2.6 and 1.9 percent of the total area of the two villages respectively. Similarly the number of households with no trees

in the study villages constituted 60%, 20% and 40% percent of the total respondents in Maiaha, Zibanuna and Embaderho respectively.

The use of trees for construction purposes was the most commonly cited reason for planting trees in all regions followed by fuelwood. Other objectives mentioned often by households who plant small numbers of trees were, shade and memorial for the martyrs of the war for liberation. The major reason for not planting trees given by households in all regions is lack of land which is a result of the communal system of land ownership (see Chapter three). Other constraints mentioned include, lack of labour, lack of fencing material, and poor survival rate of trees (mostly due to pests).

5.8 Summary

An extensive field study was undertaken to understand the farming systems in the Central Highlands of Eritrea, to explore farmers' perceptions on the major constraints to their farming activities and to obtain some parameters to the mathematical model described in the previous chapter. The results show that the regions in the Central Highlands vary considerably both in terms of resource endowments, as well as the extent of use of external inputs and other modern agricultural practices. The regions also vary with respect to access to additional grazing land in the eastern escarpments and access to markets (proximity to major towns) and development of infrastructure. In all regions shortage of male labour resulting from the war of independence and mobilization of labour for the recent border war has considerably affected agricultural activities.

The major parameters obtained from the fieldwork include the size and composition of labour, land and livestock resources, labour and oxen requirement for various farming activities and the timing of those activities. Farmers' perceptions of the impact of soil erosion and the application of manure and fertilizer application on crop yield were also explored. The results generally show that farmers are aware of the problems of land degradation and believe that most of their croplands need stone bunds and fertilization. Farmers emphasize that shortage of rainfall is the major bottleneck to crop production and the most important reason for the low levels of application of chemical fertilizers. Shortage of labour is the major reason mentioned by most farmers for the low levels of soil conservation. The communal land tenure system is also a serious constraint to tree planting and soil conservation activities in the Central Highlands of Eritrea.